IMPACT OF COMPUTER-ASSISTED AND SCIENCE PROCESS INSTRUCTIONS ON RETENTION AND PERFORMANCE IN BIOLOGY AMONG VARIED ABILITIES SECONDARY SCHOOL STUDENTS IN KADUNA, NIGERIA

BY

Stanley, MAIKANO

B.Sc. Ed. (Biology) UniJos, M.Ed. (Science Education) ABU Zaria.

PhD/EDUC/0941/2009-2010.

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DEPARTMENT OF SCIENCE EDUCATION

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ZARIA.

OCTOBER, 2016.

DECLARATION

I hereby declare that this thesistitled, " Impact of Computer-Assisted and Science Process Instructions on Retention and Performance in Biology among Varied Abilities Secondary School Students in Kaduna, Nigeria " has been written by me and that it is a record of my own research work. It has not been presented in any previous application for a higher degree. All quotations and sources of information are specifically acknowledged by means of references.

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Stanley, MAIKANO

Date

CERTIFICATION

This thesis titled, "Impact of Computer Assisted and Science Process Instructions on Retention and Performancein Biology amongVaried Abilities Secondary School Students in Kaduna, Nigeria" by Stanley Maikano, PhD/Educ/0941/2009-2010 meets the regulations governing the award of degree of Doctor of Philosophy in Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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Dr. S.S. Bichi **Date**
Chairman, Supervisory Committee

--- ------------------------------------

Dr. S.S. Obeka(Very Rev) Date
Member, Supervisory Committee.

--- ------------------------------------

Dr. (Mrs.) T.E. Lawal **Date**
Member, Supervisory Committee.

--- ------------------------------------

Dr. Mamman Musa **Date**
Head, Dept. of Science Education.

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Professor KabiruBala.
Dean, School of Postgraduate Studies **Date**

DEDICATION

This work is dedicated to my mother (Mrs. Fatu Maikano),my late father (Pastor Maikano Lett), my beloved wife (Mrs. Maikano Adeola Ajoke) and children (Sylvester, Abigail and Rejoice) for their inspiration and encouragement.

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ABBREVIATIONS

BSPS: Basic Science Process Skills.

BPT: Biology Performance Test

CG: Control Group.

CAI: Computer Assisted Instruction.

CAI: Computer Aided Instruction.

EG 1: Experimental Group 1.

EG 2: Experimental Group 2.

ISPS: Integrated Science Process Skills.

LM: Lecture Method.

SPA: Science Process Approach.

OPERATIONAL DEFINITION OF TERMS

Mixed Ability Grouping: is the practice of teaching students of different ages and ability levels together in the same classroom without dividing them or the Curriculum into steps labeled by 'grade' designations. The different grades and their corresponding scores/ability levels according to WAEC (2010) include:

High Ability: students who scored grades, A 1 (75-100%), B 2 (70-74%). This was used to test high ability students.

Medium Ability: students who scored grades, B 3 (65-69%), C 4 (60-64%), C 5(55-59%), C 6 (50-54%). This was used to test medium ability students.

Low Ability: students who scored grades, D 7 (45-49%), D 8 (40-44%),F 9 (0-39%). This was used to test low ability students.

Computer- Assisted Instruction (CAI): is a learning process that requires the use of computers and digital knowledge as a medium for instruction to the students.

Computer-Aided Instruction (CAI): is an application of computer in implementing teaching instructions. It is an integration of software and hardware.

Science Process Approach (SPA): It is an instructional strategy that is activity- based and student-centred which usually leads to the acquisition of the science process skills which could be basic (observation, counting) or integrated (experimentation, control of variables).

Science Process Skills (SPS): these are skills acquired by students when SPA is used as a medium for instruction. SPS can either be basic (observation, counting) or integrated (hypothesis testing, controlling variables) amongst others.

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ABSTRACT

This study investigated the impact of computer-assisted and science process instructions on retention and performance in biology amongvaried abilities secondary school students in Kaduna, Nigeria.The design was quasi-experimental, involving pretest, posttest and postpost test. A sample of 153 SS II students was drawn from a population of 3841. Biology Performance Test (BPT) was used to collect data. The reliability of BPT was calculated using Pearson's Product Moment Correlation Co-efficient (PPMC) to be 0.84. Four null hypotheses were tested at $p \leq 0.05$ level of significance using the one way and two ways Analysis of Variance (ANOVA). The following findings were made: (i). No significant difference was observed in the academic performance of students exposed to computer-assisted instruction (CAI) and science process approach (SPA)because these methods of instruction are student-centred but significant difference was found in the academic performance of the students exposed tolecture method (LM)(ii). No significant difference was observed in the mean academic performance scores of students with low, medium and high abilities exposed to CAI and SPA while there was a significant difference in the mean academic performance scores of the subjects with low, medium and high abilities exposed to LM. Students with varied abilities achieved higher using the CAI and SPA while on the other side students with varied abilities achieved lower using the LM. CAI and SPA enhance studentslearning at their own pace hence they are suitable for students with varied ability levels. (iii). There was no significant difference in the retention ability of students exposed to CAI and SPA but there was significant difference in the retention ability ofthose students exposed to LM. (iv). There was no significant difference in the academic performance of male and female students exposed to CAI, SPA and LM. On the basis of these findings a number of recommendations were made for the improvement of teaching biology in secondary schools. One such recommendation is that biology teachers should incorporate the use of CAI and SPA instructional strategies into the main stream of pedagogy in the teaching of biology as they appear to have high potentials for enhancing academic performance and retention on the part of the learners.

CHAPTER ONE

THE PROBLEM

1.1.1 Introduction

Science as a discipline is an organized body of knowledge and a process of inquiry which can be developed through observation and experimentation. Scientific knowledge is often applied and geared towards problem solving in order to enhance the living standard of man which is termed technology. Different scientists define science differently according to their perception and understanding of the subject matter. For example, Gottlieb (2005) defined science as an intellectual activity carried on by humans designed to discover information about the natural world in which we live and to discover the ways in which this information can be organized and utilized to benefit human race. The primary aim of science according to Gottlieb (2005) is to collect facts (data) and the ultimate purpose is to discern the order that exists between and among the various facts.

According to Maikano (2007) learning is a process by which concepts, ideas or information are communicated from the source to the recipient. Traditionally, the primary source of information is the teacher while the recipients are the students. Learning as a process takes place using different methods. The recent global method of learning is through the Computer- Assisted Instruction (CAI). Serkan (2015) defined CAI as the most often referred to drill-and- practice, tutorial or simulation activities offered either by themselves or as supplements to traditional and teacher directed instruction. It refers either to the use of Computer by school staff to organize students data and make instructional decision or to activities, in which the computer evaluates students test performance, guides them to appropriate instructional resources and keeps the record of their progress. CAI allows the students to have the control of the learning materials, thereby guiding them to learn at their own pace.

Computer-Assisted Instruction (CAI) is a learning process that requires the use of computers and digital knowledge. In CAI instruction the teacher usually develops softwareusing a particular topic for example plant concepts in biology. In CAI teaching the students are properly guided on the concepts they are expected to learn and they always learn this at their own pace. According to Serkan (2015) CAI also most often referred to drill- and –

practice tutorial or simulation activities that the students often use to learn as a supplement to traditional and teacher directed instruction.Urdan and Weggen (2000) reported that CAI education and training is one of the most promising delivery methodologies associated with digital knowledge and that Schools stand to gain many benefits associated with Computer Assisted Instruction (CAI). Some of these benefits include decreased travel cost; just-in-time learning and higher retention through personalized learning are just a few of the potential benefits.However when delivery Computer- Assisted Instruction (CAI)there are some special design concerns. Selecting a delivery technique or combination of techniques is the most important of these concerns. CAIdelivery techniques fall into two categories, these are: Individualized Computer- Assisted Instruction (ICAI) and Cooperative Computer-Assisted Instruction (CCAI). In ICAI one Computer is given to one student while in CCAI, a minimum of two students and a maximum of four students are given one Computer to learn with. In this study the ICAI category was adopted.

Experimental Group 1 (EG 1) is the group that learnedBiology concepts using the Computer-Assisted Instruction (CAI). CAI is the use of Computers to generate data at the students request and illustrate relationship in models of social or physical reality.Such Computers further execute programmes developed by the researcher and provide general enrichment in relatively unstructured exercises designed to stimulate and motivate students learning ability. In this study CAI was used to see if it can improve on the academic performance and retention of low ability students. Experimental Group 2 (EG 2) learned concepts of biology using the Science Process Approach.According to Gagne (1970) reported in Mari (2001) Science Process Approachis a method of teaching science which originated from the United States of America in the 1960's during the development of such new science curricula as the Science-Process Approach (SAPA), the Elementary Science Study (ESS) and the Intermediate Science Curriculum Study (ISCS). SPA is a learning process that leads to the acquisition of Science Process Skills. Science Process Skills are intellectual skills needed to learn concepts and broad principles used in making valid inductive inferences. In this study SPA was used in order to ascertain if it can improve on the Academic Performance and Retention of Low Ability students.

Eze (2005) stated that the teaching/learning process has to do with attainment of set objectives of instruction that is reflected on the academic performance of the students. In science instruction for instance, if a learner accomplishes a task successfully and attains the specified goal for a particular learning experience, he is said to have achieved. The attainment of the goal of science education is a major concern of education policy makers such as the Ministry of Education (MOE), National Education Research and Development Council (NERDC) and one of such goal is the inculcation of good academic achievement for all by the end of 21stcentury. Wilson (2001) reported that since the foundation of academic achievement is laid in schools, the use of innovative teaching method such as theSPA and CAI approaches becomeimperative. CAI also known as the Computer-Assisted Instruction describes education that occurs only through the computer medium while SPA is an instructional strategy that promotes the acquisition of Science Process Skills.

According to Bichi (2002) Students' retention is very important in any teaching/learning situation. Permanent and meaningful learning is the ultimate target of our educational endeavour. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students. Retention is the ability to retain and consequently remember things experienced or learned by an individual at a later time. It takes place when learning is coded into memory lane. Thus, appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane,Oyedokun (1998) in Bichi (2002). Adeniyi (1997) reported in Bichi (2002) stated that the nature of the material to be coded contributed to the level of retention. Materials are related to the quality of retention in terms of their meaningfulness, familiarity, concreteness and image evolving characteristics.

Several factors such as the teachers, learning environment, students amongst others are known to influence retention. Bichi (2002) reported that anything that aids learning should improve retention while things that lead to confusion or interference among learned materials decrease the speed and efficiency of learning and accelerates forgetting. Retention level in relation to age has been investigated by several researchers. Cross (1994) in Bichi (2002) reported that retention increases from infancy throughout the teenage years followed by a slow recession in middle age. Studies on retention and instructional strategy have attracted the attention of many researchers in recent years. In this study the retention level of studentstaught conceptsof biology using the Computer-Assisted Instructional Strategy was investigated and compared with that of students taught the same biology concepts using the science process approach and lecture method.

Another important issue is that of the influence of gender and teaching methods in science. According to Adesoji (2008) reported that the impact of instructional strategies on students academic performance in science suggest that there is a relationship between gender and teaching methods. Differences in the performance of both male and female students in science subjects when exposed to various instructional strategies are reported by Okeke (2001) to be insignificant. However, some research findings such as those of Isyaku and Kalgo (1996), Koleoso, Oyekan and Olabode (1999) and Mari (2001) revealed consistent differences between the academic performance of male and female learners in performing tasks in science. Mari (2001) for instance, reported thatstudents academic performance in science was significantly high when taught by teachers of opposite sex. However Ogunleye (2001) observed that it is also on record however that other researchers revealed conflicting results of no difference in academic performance. Okeke (2001) reported that the reasons researchers attribute to gender related differences in academic performance between male and female learners include the innovative nature of the instructional approach used, students cognitive ability levels, psychological and socio-cultural factors. It will therefore be interesting to find out if there may be a link between CAI, SPA and LM in gender related differences in academic performance between male and female students because the activities associated with the Science Process Approach may be too cumbersome to the girls since they do not like activity based work. That notwithstanding, issues regarding gender and science still remains a controversy. One of such controversy according to Adesoji (2008) is that girls do not like practical work and can't handle the enquiry method. Another controversy is whether biology is viewed by students as predominantly feminine or masculine subject. A gender stereotypic view on teaching method is yet another issue that is of concern in science teaching.

In order to address some of the controversies surrounding gender and academic performance in science, this study introduced the gender and academic performance variable. The purpose is to find out whether CAI, SPA and LM instructional strategies are gender friendly or not. The present study therefore attempts to find out whether CAI, SPA and LM teaching strategies will have any gender related impact on the students academic performance.According to the International Association for the Evaluation of Education Performance (2003) during the past decade, there has been a concerted effort to find out why there is a shortage of women in the sciences, mathematics, engineering and technical fields. According to American National Board (2006) in the year 2000, 22% of America's scientists and engineers were women, compared to half of the social scientists. Women who do pursue careers in science, engineering, and mathematics most often choose fields in the biological sciences, where they represent 40% of the workforce, with smaller percentages found in mathematics or computer science (33%), the physical sciences (22%), and engineering (9%). Part of the explanation can be traced to gender differences in the cognitive abilities of middle-School students. In late elementary school, females outperform males on several verbal skills tasks: verbal reasoning, verbal fluency, comprehension, and understanding logical relations Hedges &Nowell (2004). However, Voyer and Bryden (2006) observed that males, on the other hand, outperform females on spatial skills tasks such as mental rotation, spatial perception, and spatial visualization. Fennema, Sowder and Carpenter (2007) also observed that males also perform better on mathematical achievement tests than females. However, gender differences do not apply to all aspect of mathematical skill. Males and females do equally well in basic mathematical knowledge, and girls actually have better computational skills. Performance in mathematical reasoning and geometry show the greatest difference. Casey, Nuttal and Pezaris (2009) also pointed out that males also display greater confidence in their mathematics skills, which is a strong predictor of mathematics performance.

In this study, an attempt was made to investigate if academic performance in biology using the CAIand SPA teaching methods is gender stereotyped. Students' responses from the pretest and posttest of CAI, SPA and LM will be grouped according to gender and analyzed to see if there is any significant difference. Whether grouping students on the basis of their ability levels will have any impact on their academic performance is another variable considered in this study. Although there are research findings on the impact of instructional strategies on students of varied ability levels, none appeared to have been reported that examined the impact of CAI, SPA and LM on academic performance in biology students of different ability levels. The few reported are inconclusive. For instance while Anasalone and Rubin (2006) maintained that science instruction is more effective when students are grouped according to their ability levels. Others like Gamoran& Weinstein, (2005); Mallery, (2006) reported otherwise, according to them, students in the low ability group are often stigmatized and this affects them academically. Ability grouping according to Oakes (2001) and Lynch (2005) is the dividing of subjects into classes geared for different levels for students of different abilities (high, medium and low achievers). The ability level of students is also described by Aremu (2001) as a construct of his academic performance. Moreover Salami (2000) discovered that students academic performance depends on its cognitive ability. It is the practice of teaching students of different ages and ability levels together in the same classroom, without dividing them or the curriculum into steps labeled by 'grade' designations. The practice is also known by several other terms which basically designate the same concept; ungraded education, multi-age grouping, mixed age grouping, open education, vertical grouping and family grouping.

Research evidence supporting the academic advantages of ability groupings seems to be inconclusive. For instance, studies within the Nigerian environment according to Adesoji (2008) have shown that students are qualitatively different in their ability levels and in learning. However, according to Adesoji and Okebukola (1992) as reported in Iroegbu (2001) indicated that some studies have also shown earlier that method of instruction can influence the academic performance of low achieving students, Adesoji (1992); Okebukola (1992) and Iroegbu (1998). However, academic performance of low ability students has been found to be lowest while that of high ability students was the highest.Adesoji (2005) reported that it has also been observed that the constructivist's problem solving strategies were effective in teaching students of different ability. Several other studies outside Nigeria favoured this arrangement while others revealed insignificant academic gains. Evidence gathered from these studies revealed that students achieve better when they are in high ability groups. The reason is that the students are challenged and motivated to meet up with average academic achievement in the high groups. In Nigerian educational system, classrooms are generally composed of students with different academic ability levels. Hence any innovation in instructional strategy should consider the influence of students academic ability levels. Therefore when biology is taught using constructivism and on the basis of ability level (high, medium, low). It is envisaged that meaningful learning may take place because this approach to biology instruction enables students to construct and learn concepts at their own pace. In this study, the students were grouped on the basis of their ability levels (high, medium & low) and CAI, SPA and LM instructional strategies were used as treatment in order to observe if there is any significant academic performance or not between these groups.

Whether the teaching of the students using the lecture method will have any impact on their academic performance is another variable considered in this study. According to Okebukola (2009) the lecture method is the process often used in the teaching of students in the classroom. In this process, the teacher is the facilitator to learning while the students are recipients. The lecture method has two approaches to learning. The first approach is the oral approach in which the teacher does most of the talking while the students are passive listeners. The second approach consists of the use of printed materials like text books, handouts among others. In this method of learning, the students merely read their lecture notes and in most cases commit it to memory without the proper understanding of what they are supposed to learn. Although this method enables the teacher to cover a good part of the course outline within a short period, the students cannot meaningfully learn science in this way. Biology is the subject that this study is focused on. As a result of this some literature about biology will be reviewed. According to Microsoft Encarta Premium Library (2015), Biology is the science of life. The term was introduced in Germany in 1800 and popularized by the French naturalist Jean-Baptise de Lamarck as a means of encompassing the growing number of disciplines involved with the study of living things. Studying living forms, their structure, function, reproduction, growth, organization and relations with the environment. The subject biology is made up of the following disciplines: botany, taxonomy, zoology, anatomy, physiology, microbiology, embryology, genetics, ecology, evolution, parasitology among others. Today's biology is subdivided into hierarchies based on the molecule, the cell, the organism and the population. Molecular biology which spans biophysics and biochemistry has made the most fundamental contributions to modern biology. Much is now known about the structure and action of nucleic acids and protein, the key molecules of all the living matter. The discovery of the mechanism of heredity was a major breakthrough in modern science. Another important advance was in understanding of how molecule conduct metabolism, that is, how they process the energy needed to sustain life.Cellular biology is closely linked with molecular biology. To understand the functions of the cell, the basic structural unit of living matter, cell biologists studies its components on the molecular level. Organismal biology, in turn, is related to cellular biology because the life functions of multicellular organisms are governed by the activities and interactions of their cellular components.

This study is streamlined to SS II biology concepts which include: taxonomy of plants, gaseous exchange in plants, transpiration, pollination and autotrophic nutrition. These biological concepts were taught for six weeks in the course of this study using the CAI, SPA and LM. At the end of which the academic performance and the retention of the students were measured using the Biology Performance Test (BPT).

1.1.2 Theoretical Framework

The theoretical framework for this study is based on constructivism. Constructivism is relevance to this study because the students used for this study were expected to use their prior knowledge to construct new concepts. According to Glaserfield(2000), Constructivism is an idea formed by combining pieces of knowledge. This revolves round the claim that, individuals usually construct meanings in their attempt to make sense of the world around them. The understanding an individual derives from a learning situation depends on both the incoming ideas/knowledge and the individual's organization of the knowledge and deliberate re-structuring of his pre-existing conceptual frame work, Driver (1986), Tobin (1990) and Glasserfield (2000) pointed out that individuals construct their own knowledge as a result of their interaction with specific phenomenon. Such constructs (Prior Knowledge) form the basis upon which new knowledge is anchored.

The study of psychological theories of learning is very important and valuable because the learning theories are the fundamental theoretical foundations for the present innovative instructional strategies which are used in the teaching-learning process in science. This study dealt with Ausubel's theory of learning and its application to science teaching and curriculum development. According to Ausubel as cited in Abdullahi (1982) stressed the value of prior (that is, previous) knowledge in students learning. It is generally accepted that what a student already knows could aid or hinder new learning. According to Ausubel as cited in Abdullahi (1982) meaningful learning occurs where there is appropriate link between prior knowledge and new learning task, that is, interaction between the students appropriate element in the knowledge that already exists and the new material to be learnt. When there is no such interaction, no learning occurs. The parts of the learner's cognitive structure (that is, prior knowledge) which can provide the interaction necessary for meaningful learning is called subsumers that is prior knowledge or knowledge already existing in the cognitive structure as subsumers. Ausubel defined subsumers as a principle or a generalized body of knowledge that the learner already acquired that can provide association or anchorage for the various components or the new knowledge. That is a new learning must be linked to the existing knowledge to create meaning. If the prior knowledge has no subsumers, advance organizers can be introduced. According to Urevbu (2000), advanced organizers are alternative set of link, anchors or constructs.

The applications of Ausubel's theory of learning to science teaching and curriculum development are:

- Teaching of science must begin with new learning or knowledge in a sequential manner.
- Science teacher must present no new material on science until the learner is ready.
- The use of expository method in teaching science is supported as this can lead to high level of understanding and generally as against the use of discovery approaches which are extremely time consuming.
- Science teaching must not begin until the teacher is sure of previous knowledge (that is, the construct) and if not, it should be provided (subsumers).
- Contents in the curriculum must be arranged in sequential order, that is, from simple to complex.
- Determination of the stability of what is learned depends on the discriminability of the new material from previous learning.

The theoretical framework of this study is therefore hinged on the theory of Constructivism where the construct (prior knowledge) was used to develop new knowledge. This theory in the course of this research work was applied in CAI, SPA and LM to study its impact on them vis-à-vis the academic performance and retention of the students.

1.2 Statement of the Problem.

The driving force to conduct this study is the dwindling poor performance of students in Biology examinations as confirmed by West African Examination Council (WAEC) (2010, 2011, 2012, 2013 and 2014) Chief Examiners report. Moreover, the statistics of students' performance in WAEC (biology) examinations in Kaduna State indicated an average yearly rate of failure of over 60% as reflected in Table 1.1

Table 1.1 Students Performance Trend (percentage) in WAEC/SSCE Biology from 2010 to 2014.

2010			2011			2012			2013			2014		
Credit	**Pass**	**Fail**	**Credit**	**Pass**	**Fail**	**Credit**	**Pass**	**Fail**	**Credit**	**Pass**	**Fail**	**Credit**	**Pass**	**Fail**
18.10	**20.23**	**60.67**	**18.13**	**30.27**	**60.60**	**22.10**	**15.0**	**62.90**	**25.06**	**14.1**	**60.3**	**22.0**	**18.9**	**60.1**

Source: Kaduna Educational Resource Department.

The observed failure is mostly attributed to improper exposure to laboratory activities, poor science background at the Junior Secondary, lack of problem solving ability (Mari, 2001), inability to read and understand examination questions (WAEC, 2012, 2014), students perception of biology practical as a difficult task, lack of qualified teachers, lack of teaching facilities, lack of equipped laboratories, inadequate coverage of syllabus (Bunkure, 2012), persistent use of lecture or expository method of teaching.

Another motivation to conduct the present study is derived from the global introduction of the Computer-Assisted Instruction (CAI) as one of the most recent approaches to learning. Hoare (2008) stated that CAI represents a global change in teaching style. He further stated that the schools failing to embrace this technological progress in learning will not be able to meet the global needs of digital knowledge based societies and as a result will not survive the change in the paradigm of education. Education is a global commodity therefore Nigerian approach to it must follow the global trend which is the CAI.

Hassan (2013) in a survey research about the problems and challenges of CAI in some Nigerian schools found out the followings:

- Awareness of CAI among the Nigerian schools is very high but investment and government commitment to develop CAIapplication is very poor and below expectation.
- Most teachers at the secondary school level, especially those located in rural areas are not computer literate making it difficult for them to use the CAI for teaching.
- The computers and their accessories are not available in most secondary schools and where they are available, the quantity is not enough to cope with the number of the students.

The observed problems made this study relevant to see whether it could give solution to these problems in order to make CAI application in the sciences meaningful. The major aim of any science teaching is to promote the meaningful learning of the concept taught to enhance the application of learnt knowledge to real life situation. This study will try to find out if CAI can be used to achieve this.If education is a global commodity and if it is to serve as an instrument for effective global development, there is need for science educators globally to devise the means of enhancing learning to meet the global demand and standard. As a result of this, the Nigerian schools should not be left out. The need therefore arose to search for, or investigate a global method of instruction that would address the problems of students' achievement in science subjects, particularly Biology. This is with a view to establish what might be considered an appropriate instructional strategy that would promote meaningful learning. This is then the rational for this study.

Researchers,Davis(2001) and Okebukola (2002) have suggested the use of constructivist and conceptual change of instructional strategies to enhance the academic performance in science. A number of studies have been carried out in Science Education, notably Bichi (2002)& Lawal(2008) bothreported the usefulness of constructivist instructional strategy on students performance and retention of Biology concepts at the secondary school level. The present study is aimed at finding ways that CAI can be used in schools in order to improve the learning of science, Biology in particular.

1.3 Objectives of the Study

The major objective of the study was to investigate the Impact of Computer-Assisted and Science Process Instructions on Retention and Performance in Biology among varied Abilities Secondary School Students in Kaduna, Nigeria and also to:

1. determine whether the use of Computer-Assisted Instruction is more effective than the use of Science Process Approach when students are taught biology concepts.
2. ascertain whether the students taught biology concepts using the Computer-Assisted Instruction perform academically better than those students taught the same concepts using the Science Process Approach strategy.
3. investigate whether the Computer-Assisted Instruction is more inclined to the male than female or gender friendly when students are taught biology concepts.
4. investigate the retention ability of learned biology concepts after students' exposure to Computer-Assisted Instruction, Science Process Approach and the Lecture Method of teaching among SS II Secondary School Students of different ability levels in Kaduna State.
5. ascertain whether the Computer-Assisted Instructional strategy has impact on students with low, medium and high learning abilities.

1.4 Research Questions.

The study sought answers to the following research questions:

1. What is the effect of Computer-Assisted Instruction, Science Process Approach and Lecture Method on the academic performance of Biology students?
2. What is the effect of Computer-Assisted Instruction, Science Process Approach and Lecture Method on academic performance in biology among secondary school students with varied learning abilities (high, medium & low).
3. What is the difference in the postpost test mean scores of secondary school students taught biology using Computer-Assisted Instruction, Science Process Approach and Lecture Method?

4. What is the difference in the performance of male and female students taught biology using the Computer-Assisted Instruction, Science Process Approach and Lecture Method of instruction?

1.5 Null Hypotheses

The following null hypotheses were tested at $P \leq 0.05$ level of significance.

$H0_1$ There is no significant difference in the academic performance of Secondary School Students taught biology concepts using Computer-Assisted Instruction and their counterparts taught the same concepts using Science Process Approach teaching strategy and Lecture Method.

$H0_2$ There is no significant difference in the mean academic performance scores of secondary school students with varied abilities (high, medium and low) taught biology using Computer-Assisted Instruction, Science Process Approach and Lecture Method.

HO_3 There is no significant difference in the retention ability of Secondary School Students taught biology concepts using Computer-Assisted Instructional strategy, Science Process Approach and Lecture Method.

HO_4 There is no significant difference in the academic performance of male and female Secondary School Students taught biology usingthe Computer-Assisted Instruction, Science Process Approach and Lecture Methods.

1.6 Significance of the Study

Basic understanding of Biology concepts is necessary to all the citizens of Nigeria in the 21^{st} century because biology formed the pivot in the study of the most professional courses in the sciences like medicine, pharmacy, agriculture, nursing among others. Furthermore, the findings of this study are aimed towards the attitudinal change of the students and even teachers towards a better teaching and learning of biology. Specifically, the significance of this study is outlined in the following paragraphs:

i. The findings of this study will be fruitful to various organizations such as Science

Teachers Association of Nigeria (STAN), Nigerian Union of Teachers (NUT) and National Education Research and Development Council (NERDC) among others who are engaged in scientific and technical activities for the development of the country.

ii. The findings of this study will hopefully facilitate a change in attitude of Biology educators and students towards more effective methods of teaching such as Computer-Assisted Instruction and Science Process Approach.

iii. It is hoped that the Computer-Assisted Instruction and Science Process Approach will enhance students' performance and stimulate their interest to biology because the methods are learner friendly.

iv. The need to train creative and inventive citizens for the development of the nation is always on the priority list. It is hoped that this study will give an insight to brighter biology education in the 21st century.

v. This research would be of immense benefit to both education planners and science curriculum planners to modify where necessary the current science curriculum by incorporating the use of constructivist strategy in biology instruction in particular and science oriented subjects in general. This will provide for more interactive lessons in the curriculum which will serve as a source of motivation to the students.

vi. The findings of this study will help teachers training institutions like the Colleges of Education and the Universities to incorporate the strategy into their existing curricula.

vii. The study is also important in view of the proper implementation of National Policy on Education (FRN, 2015) which emphasizes the acquisition of appropriate skills, abilities and competence both mentally and physically as equipment for the individual to live in and contribute to the development of his society.

viii. Furthermore, professional bodies and associations, such as the Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), National Education Research and Development Council (NERDC) amongst others will find the recommendations of this study useful in order to upgrade their educational materials.

ix. And that the finding of the study will add new information to the frontier of knowledge in relation to the existing literature.

1.7 Scope of the Study

This study examined the impact of Computer-Assisted and Science Process Instructions on Retention and Performance in Biology among Secondary School Students with varied Abilities in Kaduna, Nigeria. The research is delimited to SS II (Biology) students in Kaduna State because at this level the students are well exposed to Biology concepts in school. The curriculum investigated in the study centered on: taxonomy of plants, gaseous exchange in plants, transpiration, pollination and photosynthesis. The CAI package used in this study was the power point. In this package the students in the experimental group 1 learnt the biology concepts using the Microsoft power points slides. For the Science Process Approach students (EG 2), they used 3 basic process skills (observing, classifying, collecting and recording) and 2 integrated process skills (experimenting and controlling variables) in the course of this study. The conclusions of the study were therefore being limited to the population from which the samples were drawn.

1.8 Basic Assumptions

The following basic assumptions were made:

i. Students in the sample must have had good exposure to Biology concepts through the traditional teaching method but are not to computer- assisted instruction and science process approach instructional strategies.

ii. Students understood the items in the research instrument, [the Biology Performance Test (BPT)] and therefore responded to them accordingly.

iii. The selected topics were appropriate for the level of students used for the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This study investigatedthe impact of two teaching strategies on performance and retention in Biology among Secondary School students with varied abilities in Kaduna, Nigeria. In this chapter, a review of related literature is made in an attempt to put the present study in a proper perspective. The review is organized under the following sub-headings:

- Teaching of Biology at Secondary Schools in Nigeria.
- Computer-Assisted and Computer-Aided Instructions.
- Science Process Approach and Students Performance.
- Traditional Method of Science Teaching
- Other Science Teaching Methods
- Gender Issues in Science Education.
- Retentionof learned concepts in Science.
- Ability Levels of Students in Science
- Overview of Similar Studies.
- Implications of Literature Reviewed on the Present Study

2.2 Teaching of Biology at Secondary School Level in Nigeria

The major aim of teaching is to promote the understanding of the concepts being taught with a view of applying such knowledge to real life situations. Okebukola (2010) reported that the consistent poor performance and negative attitude towards Biology attest to the fact that Biology teaching has not been properly done. Hence, the concepts being taught are not properly understood. This improper method of Biology teaching has led to a vigorous search for appropriate teaching methods that will best achieve the aim of Biology teaching.

Researchers like Aghadinuno (2005) and Olarewaju (2006) reported that students achieve poorly in Secondary School science subjects especially Biology. These researchers express the view that teachers shy away from activity-oriented teaching methods which are known to be effective and rely on teaching methods that are easy but most often inadequate and inappropriate. Based on such findings, according to Akubuilo (2010) and Adewole (2012) several attempts have been made to investigate the effectiveness of teaching methods on achievement in Biology. Results from these investigations indicated that innovative teaching methods such as Computer- Assisted Instruction, Science Process Approach, Guided Discovery, Co-operative Learning, Inquiry methods among others are more effective than the traditional lecture method in enhancing students' cognitive achievement in Biology.Achievement in teaching/learning process has to do with attainment of set objectives of instruction. In Biology instruction for instance, if a learner accomplishes a task successfully and attains the specified goal for a particular learning experience, he is said to have achieved. The attainment of the goal of science education, biology inclusive is a major concern of education policy makers and of such goal is the inculcation of scientific achievement for all by the end of the 21st century. Since the foundation of scientific achievement is laid in schools, especially secondary schools, the use of innovative teaching methods such as the Computer-Assisted Instruction, Science Process Approach become very imperative.

According to Kamba (2009) and Mari (2001) the Computer-Assisted Instruction and the Science Process Approach is a student-centered activity oriented teaching strategies in which the teacher directs the students to discover educational experiences using the computers and science laboratory activities. Furthermore, studies on the effect of teaching methods on attitude towards biology are still inconclusive. Okeke (2006) found out those activity-based and problem solving teaching strategiesare better than the traditional lecture method in promoting positive attitude towards biology. However, some other researchers like Aghadinuno(2005) and Aigboman (2007) indicated that secondary school students in Nigeria generally show negative attitude towards biology. This inconsistency raises some doubts as to whether some other factors such as the level of intelligence of the teacher, socio-economic status of the parents and the learners characteristics, such as the scientific achievement level do contribute to the students negative attitude towards biology even when abstract teaching methods are used. Based on this, this study will investigate the impact of Computer-Assisted Instruction and Science Process Approach on academic performance and retention of biology concepts among secondary school students with varied abilities.

2.3.1 Computer-Assisted and Computer-Aided Instructions.

Computer-Assisted Instructional (CAI) also most often referred to drill and practice, tutorial or simulation activities offer either by themselves or as supplements to traditional and teacher directed instruction. It refers either to the use of computer by school staff to organize students' data and make instructional decision or to carry out some activities, in which the computer evaluates students test performance, guides them to appropriate instructional resources and keeps the record of their progress.

According to Cauldron (2001) it is also defined as that in which computers generates data at the students' request and illustrate relationships in models of social or physical reality. Such computers further execute programmes developed by the teachers or students and provide general enrichment in relatively unstructured exercises designed to stimulate and motivate the students.The common applications of microcomputer in Biology teaching are the following: simulation of natural phenomena and experiments, drill and practice, tutorial on data processing and analysis, the interface experiments among others. Doing experiment or laboratory activity is an integral part of biology instruction. Simulations of some natural phenomena like pollination, growth, excretion among others in biology are things that can easily be achieved using the developed computer software.

Further research by Bunkure (2008) revealed that CAI enhances learning rate which determine the students performance. Students learning rate is faster with CAI than with conventional instruction. In some research studies, the students learned the same amount of material in less time than the traditionally instructed students did; in other words, they learnt more material in the same time. This enhanced learning rate is accompanied by high performance and retention of learnt concepts. Further claims were that if students receiving CAI learnt better and faster than the students receiving conventional instruction alone, do they also retain their learning better?, the answer according to the researchers who have conducted comparative studies of learning retention is yes. In this research, the researcher will find out if students' scores on delayed tests indicated that the retention of content learnt using CAI is superior to retention following the traditional instruction alone.

Hounshell and Hill (2008) reported that previous research work found positive effects associated with microcomputer use in science education applications, higher performance and more positive attitudes were observed in high school biology course that was computer loaded. Also scientific reasoning skills were found to be enhanced using a microcomputer based curriculum. Educators have also recognized the importance of evaluating the success of their efforts. According to Burg and Cheloud (2001) multitude of studies have been undertaken to assess whether CAI has find positive effect on student learning. However, it was noted that these findings are conflicting. For instance studies by Ariand and Ross (1987) cited in Bunkure (2008) generated result showing direct correlation between CAI and improved student test scores. This conflict in independent research results related to CAI and student learning has lead a number of researchers to attempt to develop a consistent conclusion by analyzing a large body of existing studies in quantitative manner.

Further, review of the literature indicates the following importance of Computer-Assisted Instruction in the school curriculum and performance of student:

- It increases motivation and reinforcement. Interactive science games stimulate learning through fun competition by bringing science to video age in a format they respond to. It was noted that senior secondary school biology students that had interactive videodisc/computer lessons indicated an overall level satisfaction with the strategy. Daniel and Lasisi (2009) reported that students frequently remarked that video-disc instruction gave them more efficient use of instructional time than the conventional mode. They noted that further than that, the computer appears to be a strong motivational device for students identified as educationally disadvantaged and it broadens the scope of the scientific content that can be included in the curriculum.

- It improves problem solving and critical thinking skills. Studies by Adamu (2001) reported that thoughtfully designed computer software can present multiple dynamically linked representations in ways that are impossible with static, invert media such as books and chalk boards. Some of the most fruitful applications of computer technology derived its capacity to present educationally powerful, dynamic visual image particularly in physics and mathematics, different representation of complex idea emphasizes different aspects of the idea and afford different sorts of analysis.

- It reduces time and cost to tolerable level. This indicates that with CAI we can take the results of real experiment difficult or costly to reproduce in teaching situation and make computer simulations.

Adamu (2001) found that computer simulated experiments were as effective as heads on laboratory work. The internet also offers many opportunities for teachers and students to correspond directly on topics of interest in the sciences. It should however be pointed out that some of the literature did mention far short comings of CAI in science teaching and learning. Adamu (2001) indicated that while computer environments have some potential as learning tools, they also limit interactions in significant ways rendering them less than ideal for everyday classroom use. They did a study that investigated how computers and modeling software contributed to students' interaction and learning in a physics course. These results and their interpretation show that although the computer micro world contributed in significant ways to the maintenance and coordination of students' physics conversations, yet the computer environment was sometimes 'unready to hand' so that students spend more time learning the software rather than physics.

Computer-Aided Instruction is an application of computer in implementing teaching instructions. It is an integration of software and hardware. According to Douglas (2000) Computer-Aided Instruction is diverse and rapidly expanding spectrum of computer technologies that assist the teaching and learning process. CAI is also known as Computer-Assisted Instruction. Examples of CAI applications include guided drill and practice exercises, computer visualization of complexobjects and computer-facilitated communication between students and teachers.

2.3.2 Types of Computer-Aided Instruction (CAI)

Douglas (2000) further stated that the information that helps to teach or encourages interaction can be presented on computers in the form of text or in multimedia formats, which include:

- Photographs
- Videos
- Animation
- Speech

- Music

The guided drill is a computer programme that poses questions to students, returns feedback, and selects additional questions based on the students responses. Recent guided drill systems incorporate the principles of education in addition to subject matter knowledge into the computer programme. Sultan (2006) noted that computer also can help the students to visualize objects that are difficult or impossible to view. For example, computers can be used to display human anatomy, molecular structures or complex geometrical objects. Exploration and manipulation of simulated environments can be accomplished with CAI ranging from virtual laboratory experiments that may be too difficult, expensive or dangerous to perform in a school environment to complex virtual worlds like those used in airplane flight simulators. Douglas (2000) further observed that CAI tools, such as word processors, spreadsheets and data bases; collect, organize, analyze and transmit information. They also facilitate communication among students, between students and instructors, and beyond the classroom to distant students, instructors and experts.

Sultan (2006) stated that CAI systems can be categorized based on who controls the progression of the lesson. Early systems were linear presentations of information and guided drill which control was directed by the author of the software. In modern systems and especially with visualization systems and simulated environments, control often rests with the students or with the instructors. This permits information to be reviewed or examine out of sequence and related material also may be explored. In some group instructional activities and the lesson can progress according to the dynamics of the group.

Douglas (2000) noticed that the Computer-Aided Instruction has some advantages and disadvantages.

Advantages of Computer-Aided Instruction (CAI).

- CAI can dramatically increase the students access to information.
- The programme can adapt to the abilities and preferences of the individual student.
- CAI increases the amount of personalized instruction a student receives.

- Many students benefit from the immediate responsiveness of computer interactions and appreciate the self-paced and private learning environment.
- Computer-learning experiences often engage the interest of students, motivating them to learn.
- CAI increases independence and personal responsibility for education.

Disadvantages of Computer-Aided Instruction (CAI).

- In some applications, especially those involving abstract reasoning and problem-solving processes, CAI has not been very effective.
- Critics claim that poorly designed CAI systems can dehumanize or regiment the educational experience and thereby diminish student interest and motivation.
- CAI systems are difficult and expensive to implement and maintain.
- Some students failures can be traced to inadequate teacher training in CAI systems.
- Students training in the computer technology may be required as well and this process can distract them from the core educational process.
- Although much effort has been directed at developing the CAI systems that are easy to use and incorporate expert knowledge of teaching and learning, such systems are still far from achieving their full potentials.

The summary of the literature reviewed shows that instruction supplemented by properly designed Computer-Assisted Instruction (CAI) is more effective than the instruction without CAI. It is however noticed that the students do spend more time learning the computer software instead of dedicating such time to their learning. Therefore the practical strategy to be used in the present study will include the use of Microsoft Power Point Presentation (MPPP) to teach the plant concepts of S.S. 2 biology. Using this approach, the concepts will be subdivided into slides for easy learning. The slide show runs automatically when the simple command is given to the computer, this will help the students to save their learning time that could be used to study the software. This will make the biology lessons to be more meaningful and purposeful and so could therefore enhance better students' understanding in a rapid form.

2.4 Science Process Approachand Academic Performance in Science

In the past two decades, educators have shown increased interest in the processes involved in learning science. Ajagun (2008) observed that the general consensus of Science Educators in Nigeria and the World over tend to be inclined towards the inquiry based approach in the teaching/learning process, and the development of a wide range of skills in the learners. Shaw (2007) pointed out that science curricular which emphasize the development of process skills were evolved with the assumption that these skills can be acquired by all students when exposed to instruction that are based on such science process skills.

Coppola (2002) reported that a Process means series of actions or tasks performed in order to do, make or achieve something. A gradual process of performing and achieving educational goals and objectives. Urevbu (2000) observed that in the teaching and learning of science, processes mean observation, classification, communication, counting numbers, measurements, raising questions, formulating hypotheses, prediction, operational definitions, controlling and manipulating variables, experimenting, data collection, interpreting data, inference, manipulating apparatus among others. One of the most important and pervasive goals of schooling is to teach the students to think. All schools subjects should share in accomplishing this overall goal. Science contributes its unique skills, with its emphasis on hypothesizing, manipulating the physical world and reasoning from data. The scientific method, scientific thinking and critical thinking have been terms used at various times to describe these science skills. Today the term "Science Process Skills" is commonly used. Popularized by the curriculum project, Science-A Process Approach (SAPA), these skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists. SAPA grouped process skills into two types: basic and integrated. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills.

According to Mari (2001) The Basic Science Process Skills (BSPS) include:

- Observing- using the senses to gather information about an object or event. Example, describing a pencil as yellow.

- Inferring- making an “educated guess” about an object or event based on previously gathered data or information. Example: saying that the person who used a pencil made a lot of mistakes because the eraser was well worn.
- Measuring- using either standard and nonstandard measures or estimates to describe the dimensions of an object or event. Example: using a meter stick to measure the length of a table in centimeters.
- Communicating- using words or graphic symbols to describe an action, object or event. Example: describing the change in height of a plant over time in writing or through a graph.
- Classifying- grouping or ordering objects or events into categories based on properties or criteria. Example: placing all rocks having certain grain size or hardness into one group.
- Predicting- stating the outcome of a future event based on a pattern of evidence. Example: predicting the height of a plant in two weeks’ time based on a graph of its growth during the previous four weeks.

Mari (2001) also stated that the Integrated Science Process Skills (ISPS) include:

- Controlling variables: being able to identify variable that can affect an experiment outcome, keeping most constant while manipulating only the independent variable. Example: realizing through past experiences that amount of light and water need to be controlled when testing to see how the addition of organic matter affects the growth of beans.
- Defining operationally- states how to measure a variable in an experiment. Example: stating that bean growth will be measured in centimeters per week.
- Formulating Hypotheses- stating the expected outcome of an experiment. Example: the greater the amount of organic matter added to the soil, the greater the bean growth.
- Interpreting Data- organizing data and drawing conclusions from it. Example: recording data from the experiment on bean growth in a data table and forming a conclusion which relates trends in the data to variables.
- Experimenting- being able to conduct experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally

defining those variables, designing a ‘fair’ experiment, conducting the experiment, and interpreting the results of the experiment. Example: the entire process of conducting the experiment on the effect of organic matter on the growth of bean plants.

- Formulating Models- creating a mental or physical model of a process or event. Examples: the model of how the processes of evaporation and condensation interrelate in the water cycle.

Learning Basic Process Skills: numerous research projects have focused on the teaching and acquisition of basic process skills. For example, Padilla, Cronin, and Twiest (2000) surveyed the basic process skills of 700 middle school students with no special process skill training. They found that only 10% of the students scored above 90% correct, even at the eighth grade level. Several researchers have found that teaching increases levels of skill performance. Thiel and George (2009) investigated predicting among third and fifth graders, and Tomera (2009) observing among seventh graders. Tomera (2009) also pointed out that from these studies, it can be concluded that basic skills can be taught and that when learned, it can be readily transferred to new situations. Teaching strategies which proved effective were:

- Applying a set of specific clues for predicting.
- Using activities and pencil and paper simulations to teach graphing.
- Using a combination of explaining, practice with objects, discussions and feedback with observing. In other words- just what research and theory has always defined as good teaching.

Other studies evaluated the effect of NSF- Funded Science Curricula on how well they taught basic process skills. Studies focusing on the Science Curriculum Improvement Study (SCIS) and SAPA indicate that elementary school students, if taught process skills abilities, not only learn to use those processes but also retain them for future use. Researchers, after comparing SAPA students to those experiencing a more traditional science programme, concluded that the success of SAPA lies in the area of improving process oriented skills ,Wideon (2005) andMcGlathery, (2000). Thus it seems reasonable to conclude that students' learn the basic skills better if they are considered an important object of instruction and if proven teaching methods are used.

Learning Integrated Process Skills: several studies have investigated the learning of integrated process skills. Allen (2009) found that third graders can identify variables if the context is simple enough. Both Quinn and George (2005) and Wright (2001) found that students can be taught to formulate hypotheses and that this ability is retained overtime.

Others have tried to teach all of the skills involved in conducting an experiment. Padilla, Okey and Garrad (2002) systematically integrated experimenting lessons into middle school science curriculum. One group of students was taught a two week introductory unit on experimenting which focused on manipulative activities. A second group was taught the experimenting unit, but also experienced one additional process skill activity per week for a period of fourteen weeks. Those having the extended treatment outscored those experiencing the two week unit. These results indicate that the more complex process skills cannot be learned via a two week unit in which science content is typically taught; rather experimenting abilities need to be practiced over a period of time.

Further study by Padilla, Okey and Dillashaw (2009) reported that experimenting abilities shows that they are closely related to the formal thinking abilities described by Piaget. A correlation of +.73 between the two sets of abilities was found in one study. In fact, one of the ways that Piaget decided whether someone was formal or concrete was to ask that person to design an experiment to solve problem. Chiapetta (2009) also observed that most early adolescents and many young adults have not yet reached their full formal reasoning capacity. One study found only 17% of seventh graders and 34% of twelfth graders fully formal Renner, Grant and Sutherland (2008).

In teaching biological science processes, teachers cannot expect students to excel at skills they have not experienced or been allowed to practice. Teachers cannot expect mastery of experimenting skills after only a few practice sessions. Instead students need multiple opportunities to work with these skills in different content areas and contexts. Teachers need to be patient with those having difficulties, since there is a need to have developed formal thinking patterns to successfully “experiment”. According to National Teachers Institute (2002), the current issue in the teaching of science agreed with the statement that, “if you give somebody a fish, you feed him/her once. But if you teach him/her how to fish, you feed him/her for the rest of his/her life”. Therefore we should not feed the young learners with the product of science; instead, we should expose them to the processes of science so that they too can generate knowledge in science rather than being perpetual consumers of knowledge of science.

The process approach according to Urevbu (2000) was developed by group of scientists in United State of America, under the leadership of Robert Gagne, emphasizing on the process of science. Out of the processes stated above, the easier ones are observation and classification, which are very necessary in the teaching and learning of science today. Pemida (2004) stated that, process approach is an instructional method in which the process skills are emphasized in the learning of science. Ngufian (2004) added that since science is a doing subject, emphasis should be placed on the process rather than the products so that the learners can operate with excitement and manipulate their environment with previous skills. The process skill approach is an outcome of the commission on science education of the American Association for the Advancement of Science (AAAS). Process approach is an investigative approach aimed at assisting students to learn rather than memorize science. It centers upon the idea that what is taught to children should resemble what scientists do and what they carryout in their scientific activities. Process skill in this context refers to actions and operations that encouraged students in order to facilitate the learning of science. This approach emphasizes very strongly the concept of "learning by doing." The approach consists of intellectual skills usually developed through exposure to the method. Oraifo (2009) enumerated such intellectual skills to include observation, identification, classification, hypothesizing, making time and space relationship, measurement, organization of data, experimenting, making references, communicating information, describing, controlling variables, interpreting data, predicting and making conclusion. The approach provides a practical and effective way of teaching science.

Process approach tends to promote the skills which science is supposed to develop in students. These skills according to Association Certificate in Education Series (ACES, 2008:2) include the following:

- Observing carefully and thoroughly
- Reporting completely and accurately what is observed
- Organizing information acquired
- Generalizing on the basis of acquired information
- Predicting as a result of the generalization
- Designing experiments (including controls where necessary) to check the prediction
- Using models to explain phenomena where appropriate
- Continuing the process of inquiry when new data do not conform to predictions.

Therefore, by the skills students acquire by learning science, the subject teaches the learners the simple process of science. The process approach therefore emphasizes teaching students to develop process skills which can lead to scientific knowledge and problem solving. The students are also given opportunity to raise questions and find solutions. In this approach what scientists are supposed to do are considered to be important. According to UNESCO (2010) the way of learning through process skills require students to have opportunity for:

Activity seeking evidence for themselves through their own senses

- Testing their ideas against evidence and previous experience
- Becoming aware of ideas other than their own
- Seeking more effective way of testing ideas.

Also, according to Kimball (2007), Shayer (2006) and Trowbridge (2000) the process skills learned in science have been shown to enhance intellectual development, performance and transfer to other curriculum areas. These imply that there should be plenty of handling and investigating of materials and objects. There should be plenty of discussion in the class room between the students and the teacher and among the students. The major roles of the teacher in the process approach include:

- Ensuring that the students have real thing to observe, have and investigate, and also have access to evidence against which to test their idea.
- Finding out about the students' existing ideas and taking these seriously as the starting point of learning.
- Making available access to a range of ideas from others, that is other students, books, media, visitors, visits where possible etc.
- Discussing with students/teacher ways of improving their tested ideas and their use of evidence.
- Ensuring that the students reflect upon and communicate their results in a variety of appropriate ways (UNESCO 2001).

A reasonable portion of the science curriculum should emphasize science process skills according to the Science Teachers Association of Nigeria (STAN). In general, the research literature indicates that when science process skills are a specific planned outcome of a science programme, those skills can be learned by students and make them to perform better. This was true with the SAPA and SCIS and other process skills studies cited in this review as well as with many other studies not cited.

Science teachers need to select curricula which emphasize science process skills. In addition they need to capitalize on opportunities in the activities normally done in the laboratory/classroom. While not an easy solution to implement, it remains the best available at this time because of the lack of emphasis of process skills in the classroom activities. In this study the students in the Experimental Group 2 (EG2) were engaged in the Science Process Approach through laboratory activities like observation, classification, collecting and recording, experimentation, controlling of variables among others. The focus of this is to investigate whether the Science Process Approach will lead to the acquisition and development of the Science Process Skills among the students.

2.5 Traditional Method of Science Teaching

This is the lecture method; this method consists of two approaches. The first approach is the oral (lecture) approach in which the teacher does most of the talking and uses the chalkboard sparingly while the students remain passive listeners. This is often called the "chalk and talk" method. The second approach involves the use of printed materials like textbooks, science fiction, science magazines, etc., to teach a concept usually in place of student-teacher interaction. Students merely read, and in most cases commit to memory, without proper understanding of what they are supposed to be learning (Okebukola, 2009). Although this method enables the teacher to cover a good part of the course outline within a short period, students cannot meaningfully learn science in this way. They can only succeed in learning by rote, but will often miss the essential parts of science teaching, especially those on how a scientist works.

The lecture instructional strategy is often the cornerstone of university teaching, a lecture can be an effective method for communicating theories, ideas, and facts to students. Typically a structured presentation, a lecture should be designed to include certain procedures in order to be effective procedures that research and expert lecturers have identified as essential to assist students learning. The basic purpose of lecturing is the dissemination of information. As an expert in your field, you identify important information for the learner and transmit this knowledge in the lecture. The lecture method is recommended for high consensus disciplines, those in which there is agreement on the fundamental principles and procedures, such as mathematics and the natural sciences.

The lecture method of teaching has numerous advantages, the basic ones among which include:

- It provides an economical and efficient method for delivering substantial amounts of information to large number of students.
- It affords a necessary framework or overview for subsequent learning, e.g., reading assignments, small group activities, discussion.
- It offers current information (more up to date than most texts) from many sources.
- It provides a summary or synthesis of information from different sources.
- It creates interest in a subject as lecturers transmit enthusiasm about their discipline.

There are disadvantages of using the lecture method as a primary method. An effective lecture requires both extensive research and preparation and effective delivery skills to maintain students' attention and motivation. In addition, the lecture method has other draw backs. These are:

- It does not afford the instructor with ways to provide students with individual feedback.
- It is difficult to adapt to individual learning differences.
- It may fail to promote active learning unless other teaching strategies, such as questioning and problem-solving activities are incorporated into the lecture.
- It does not promote independent learning.

An effective lecture is composed of three components; Introduction, Body and Conclusion. These are all designed to promote and support learning.

The introduction usually is the first three to five minutes of the lecture. This time is crucial in determining how well students learn and retain the information to be presented. The main purpose is to provide a framework for students' learning, providing the structure for the lecture's content information. It is also necessary to gain students' attention. The introduction should do the following:

- Establish a relationship with the audience. Make warm-up comments and initiate rapport to set the tone of the class. Establish friendly communication to provide a positive learning environment in which students' feel comfortable.
- Gain attention and foster motivation. Relate to students' goal and interests. You might

present a meaningful problem to students' and describe the lecture as a solution to the problem. You might also introduce the lecture by describing how it will help students' to be successful in their education and careers or by relating it to your students' inherent curiosity.

- Prompt awareness of relevant pre-existing knowledge. Students' need to see how the "new" lecture information relates to their existing knowledge or experience. This not only promotes interest and motivation, but also is a first step in cognitive information processing.
- Clarify the purpose of the lecture and describe how it is organized. Research supports a correlation between clarity of objectives and students' achievement; students will achieve at higher levels if they know what knowledge and skills they should gain from this instruction. This can be achieved by announcing the lecture topic and making a statement about the topic and how it will be developed.

The body of the lecture covers the content in an organized way. Since this component is allotted the greatest amount of class time, it includes many more teaching procedures than the introduction or conclusion. This involves the lecturer consulting his lecture material and at the same time maintaining a rapport with the students. Lecture material is a combination of facts, concepts, principles and generalizations. Concepts represent a class of terms (an idea usually expressed in a word) and principles communicate relationship among concepts. Generalizations are relationships between or among concepts expressed at a higher level of abstraction than a principle. In a lecture, it is best to present a concept (one idea) by first defining it and then giving many concrete examples of the concepts. As you introduce new concepts, link them together into principles, and then into generalizations, each time adding concrete examples as you develop these relationships. Lectures should be organized based on the relationship of the ideas presented. Remember to include audiovisual aids while delivering your lecture. Using power point slides, transparencies, or even the chalkboard will enliven and strengthen the presentation of ideas and, thus, assist students' learning.

It is crucial to provide opportunities for active learning during any instruction, including a lecture. Active learning allows students' opportunity to practice using the lecture information and obtain feedback on the accuracy of their responses. For example, during the lecture, ask students or give students' problem-solving activities that encourage them to use the information they should gain from the lecture. Capturing and sustaining the students' attention during lecture method instructional strategy is very important. A lecturer can maintain attention of the students' throughout his lecture by employing techniques such as:

- Vary students' activities, lecture for 15 minutes and then provide an active learning activity.
- Change the mode of presentation (for example, oral to visual).
- Employ concept related humor.
- Demonstrate enthusiasm about your subject/course.
- Encourage note taking by speaking slowly and repeating important information.
- Provide motivational clues ("On the next examination you will be asked to -----").

The conclusion, the most frequently neglected component of the lecture, should be used to reinforce students' learning of the information as well as to clarify any misconception regarding their understanding of the concepts presented. In concluding a lecture, the following points are important:

- Repeat and emphasize main points. This procedure will help you to get feedback as to whether or not students' identified the important information. It is also helpful to rephrase information in order to clarify key ideas.
- Encourage question from students. To allow students time to review their notes and thoughts, pause for a few moments after asking for questions. Remember, however, that it is often difficult for students to respond to the vague "Any question?", instead, ask specific, leading questions. By doing so, you will encourage your students to review their notes and formulate questions of their own. In this way, any misconception can be clarified and understanding can be reinforced.
- Relate content to previous and subsequent topics. The last few statements in the conclusion should provide a connection between this lecture and previous lectures (as well as those to follow). As students' see the relationship among major concepts presented in different lectures, they gain a sense of direction.

In lecture delivery, non-verbal behaviours play a significant role in effective public speaking: they can enrich or elaborate the spoken message. There are basically two aspects to non-verbal behavior, these are the body language and voice. The following four elements make up the body language:

i. Speaker –audience distance: the more objects and distance psychological as well as physical-between speaker and audience, the more formal the atmosphere. If you desire to create a more informal atmosphere, you should reduce these barriers. Move from behind the lectern from time to time and walk in the aisles as you present information or carry on discussion with students'.
ii. Body movement and stance: to communicate, you must, compensate for distance by employing larger gesture and more volume. Body movement and posture can convey messages to your audience. Being animated during your lecture helps convey your own enthusiasm and interest to the students; they recognize that you are not bored, nervous or tense.
iii. Facial expression; a significant portion of the emotional impact of a speaker's message is conveyed by facial expression. Facial expressions tell students how to feel about them and yourself and give students cues to help them interpret the content of the message. Regular eye contact helps you to establish credibility.
iv. Gestures: purposeful movements of the head, arms, hands and shoulders accentuate or dramatize ideas. Three characteristics of effective gestures include relaxation, vigor, and timing. Use your body to indicate a change of topic or transition.

Voice variables allow the speaker to make a message clear and interesting. Some of the vocal characteristics of good speaking are as follows:

i. Strength: speak loudly enough so that the audience does not have to strain to her.
ii. Enunciation: make an effort to speak crisply, avoiding slurring or skipping parts of words in order to limit the possibility of misunderstanding.
iii. Pronunciation: meet your audience's expectation in regard to acceptable pronunciation.
iv. Rate of speech: in a large lecture, with students concentrating on note taking, a rate of 120 to 130 words per minute is comfortable.
v. Variety: vary the characteristics of your voice in terms of rate, pitch, stress, pauses, volume and inflection.
vi. Pauses: pauses can provide emphasis and allow students' time to think and take notes. Furthermore, pausing indicates that you are a conscientious speaker who thinks about what you are going to say.

Additional hints for a successful lecture include the following:

- Present an outline of the lecture (use the black board, overhead transparency or handout) and refer to it as you move from point to point.
- Repeat points in several different ways, include examples and concrete ideas.
- Use short sentences.
- Stress important points through your tone or explicit comments.
- Pause to give listeners time to think and write.
- Learn students' names and make contact with them during the lecture.
- Avoid racing through the last part of the lecture. This is a common error made by instructors wishing to cram too much information into the allotted time.
- Schedule time for discussion in the same or separate class periods as the lecture.
- Prepare: preparation reduces stress, frustration, insecurity and consequent ineffectiveness.

In this study, the students in the Control Group (CG) were taught some concepts of biology using the Lecture Method. Their academic performance rate and retention level were compared with those students taught the same concepts using the Computer Assisted Instruction (EG 1) and Science Process Approach (EG 2) in order to see if there is any significant difference.

2.6 Other Science Teaching Methods

The concern of this section is to give an overview of biology and explain teaching strategies used in teaching the subject. According to Okebukola (2010) the purpose of all teaching is to make the students learn or know what they are taught. Teachers teach to impart knowledge and skills to the students. Microsoft Encarta Premium Library (2015) reported that Knowledge, however, is a complex issue which can be conveniently broken down into three areas or domains according to Bloom's taxonomy of educational objectives namely:

1. Cognitive domain: this deals with the recall and remembering of information, understanding and re-organization of information, the use and application of learnt information to other situations, and finally, the analysis, synthesis and evaluation of a given piece of information.
2. Psychomotor domain: this deals with the skills of manipulation, the use of hands, especially in practical work, for example, the ability to use a burette to measure

volume, a microscope to observe micro-organisms or an electric bell to set up an electric circuit.

3. Affective domain: this deals with attitudes and feelings. For instance honesty, co-operation, neatness and openness are positive attitudes which fall into this area of knowledge.

In the teaching of biology and other science subjects, the thinking skills should be tailored in such a way that they start from concrete to the abstract taking note of the following:

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Also, with reference to teaching methods, there exist today many approaches to the teaching of science in schools. Some of these methods among others according to Bichi (2002) are:

i. Laboratory Activity Method
ii. Lecture Method
iii. Discussion Method
iv. Guided Discovery Method
v. Expository Method
vi. Concept Mapping Method
vii. Problem Solving Method
viii. Field Trip Method
ix. Project Method

A brief overview of some of these science teaching methods is given here:

Science Process Approach is another teaching method in science**.** According to Mari (2001) this method of science teaching originated in United States of America (USA) in 1960s. The method assumes that science is much more than an encyclopedia collection of facts and those children even in the primary grades will derive much more from the study of science if they learn the behavior of scientists. Brown (2000) pointed out that although the behaviors of a scientist are complex, they have been classified into a number of process skills, some simple and some more complexes. The acquisition of these intellectual activities of the scientist, the process skills form the goal of science instruction. In this method of instruction, the ability to read and the mastery of subject content is not as essential as it is in many traditional curricula. Thus, inquiry into science can begin as early as nursery school. Success does not depend on reading skills but on process skills ability in science. Content is used to develop process skills and both teacher and students are actively involved in categorizing and synthesizing information from nature. The importance of science process skills in inquiry is significant as a result they are described as scientific reasoning skills. German (2000) pointed out those classroom studies of scientific reasoning in science education have centered on the basic and integrated science process skills as key elements in inquiry. Gagne (1970) in Mari (2001) described them as the foundation for scientific inquiry. According to Mari (2001) these skills enable students to think logically, ask reasonable questions, and seek appropriate answers and solve daily problems. Science Process Approach is an instructional strategy that does lead to the acquisition of the Science Process Skills. According to Gagne (1970) cited in Mari (2001), Science Process Skills are intellectual skills needed to learn concepts and broad principles used in making valid inductive inferences. The commission on science education of the American Association for the Advancement of science (AAAS) has identified eleven process skills which are considered to be representative of problem solving activity. These process skills are categorized into two namely:

a). Basic Science Process Skills, that is, observing, measuring, inferring, predicting, classifying, collecting and recording.

b). Integrated Science Process Skills, that is, interpretation of data, controlling variables, defining operationally, formulating hypotheses and experimenting .According to Gagne (1970) the process skills are hierarchically organized with the ability to use each upper level process being dependent on the ability to use the simpler underlying process.

Finley (1983) identified the major feature of the process skills as:

a). each process is a specific intellectual skill used by all scientists and applicable to understand any phenomena.

b). each process is an identifiable behaviour of scientists that can be learned by students.

c). being generalizable (transferable) across content domains and contribute to rational thinking in everyday life.

This study assumes that students are capable of acquiring these science process skills that scientists employ in scientific investigation through planned practical activities in the laboratory. There is a high relationship between practical activities in the laboratory and the acquisition of science process skills. The exposure of students to laboratory work may have a positive influence on the development of their science process skills. The basic science process skills that the students were engaged with in the experimental group 2 during this research work are: observation, classification, collecting and recording while the integrated process skills were experimentation and controlling of variables. At the end of the study, the students were examined carefully through posttest to see whether they have acquired these skills. According to Lee (1993) in Mari (2001) the use of science process approach and the development science process skills have been described as major goals of teaching science. This is because the two variables are known to correlate highly with academic achievement in science. Norman (2004) reported that the use of science process approach and the development of science process skills promote students general achievement. Educators have also pointed out that science process approach is essential for students to undertake inquiry that involve the use of process skills. Several studies conducted by Boyer & Linn, (1998) and Padilla, (2005) dealt with students acquisition of science process skills. One of the characteristics of these investigations is the implied correspondence between the science process skills and academic achievement. Padilla (2005) reported that to show that the science process approach and acquisition of science process skills are correlated suggests that the influence of one on the other can be determined. If two variables are correlated, one may be influencing the other, a follow up experimentally study will determine this. This study provides empirical information that will further shed light on the effect of science process approach on students science process skills acquisition.

Ogunleye (2009) reported that the Laboratory Method is the activity based teaching method**.** One of the objectives of teaching science in schools is to communicate the spirit of science and to ensure that students acquire the process skills of science. This cannotbe effectively achieved unless the students are exposed sufficiently to practical work and the laboratory experimentation. According to Olarewaju (2006), Science courses typically include laboratory sections in which the students conduct experiments that replicate or illustrate a scientific principle introduced in the course. Laboratory sections do usually augment the lectures or discussions. The laboratory is a forum for science teachers and their students to interact with materials, under controlled conditions, when seeking to find answers to problems in nature in a bid to understand and interpret the natural phenomena. Ogunleye (2009) observed that most secondary schools established over the years still remain without functional science laboratories. Others have the laboratories that are not sufficiently equipped. In an attempt to reduce this shortage of equipment, a lot has been said about, 'improvisation' in science teaching which refers to the act of using alternative materials and resources to facilitate instruction whenever there is a lack or shortage of some specific first hand teaching aids. Improvisation is a way of substituting, replacing or supplementing standard materials with locally available materials or resources but many science teachers are not trained in the act of improvisation; hence they cannot equally teach their science students how to improvise. This study will investigate the use of Science Process Approach in the acquisition of science process skills using the laboratory teaching method among the secondary school students.

The Field Trip Methodin contrast to conventional classroom takes place in a more opened environment, with fewer teachers' sanctions and more flexible, potentially evaluation procedures. The participants often are able to move around at their own pace and to explore on their own. Furthermore, field trips can provide the students with concrete experiences unavailable in the classroom, Koran and Baker (2000) and Orion (2010) have shown that well designed, planned and structured field trips can provide an effective instructional experience. By providing an alternative to the normal science classroom setting, field trips can promote motivation and achievement. According to Koran and Baker (2000) field trips can be successful as an instructional strategy provided that:

- The teacher is familiar with the area to be visited.
- Students are prepared and well informed about the objectives of the field trip and
- The field trip provides a meaningful experience that would not be available in the classroom.

Richinson (2004) identified that a major barrier to field trip learning is centered on young people's health and safety. Some of the hazards associated to the field trip learning are:

- Allergic reactions to vegetation and insects.
- Injuries from natural elements like stones and tree stump.

- Reduction in sight lines from trees.
- Concern about water safety around aquatic elements.
- Bees' sting.
- Bites from snakes

Richinson (2004) suggested the following safety measures during field trip:

- Compost bins could be strategically situated to reduce the risk of bees' sting.
- Trees could be planted in such a way that sight lines are not compromised.
- Allergic reactions to vegetation and insects can be controlled by putting on an overall coat.
- Injuries from natural elements like stones, tree stump can be avoided by putting on canvas shoe.
- In case of field trip in an aquatic environment like streams, rivers, the use of live guard could be of assistance in times of danger.

According to Awotua (2002) Project Method is an activity based and student centred teaching strategy that is commonly used in the teaching of science**.** A science project is an investigation using the scientific method to discover the answers to a scientific problem. Before starting a project, you need to understand the scientific method involved. The scientific method is the 'tool' that scientists use to find answers to questions. It is the process of thinking through each possibility to find the best solution to a scientific problem. The scientific method according to Mari (2001) involves the following steps:

- Doing research
- Identifying the problem
- Stating a hypothesis
- Conducting project experimentation
- Reaching conclusion.

The project method agrees with the scientific discoveries arising from human interaction with nature. This method of discovery is characterized by a sequence of steps, although these steps or procedures may vary from one field of inquiry to another. The general identifiable features that form the major steps in scientific project method include: observation, problem definition, hypothesis formulation, experimentation, conclusion and theory formulation.

Observation is the first step in scientific project method. It is either an activity of living being, such as human which consists of receiving knowledge of the outside world through the senses or the recording of data using the scientific instruments. Observations that are made using the sense organs are said to be direct observations while the indirect observation is a situation where data are recorded using scientific instrument and such data are used for observation. In science, anything that cannot be observed cannot be investigated scientifically. For instance, it is easy to observe that when a stone is thrown up, it must always come down. Observations can be classified into two; these are spontaneous or passive observation and induced or active observation. Spontaneous observation is an unexpected observation which arises from an impulse or inclination, rather than from planning or response to situations. Observation can only be meaningful if the observer either consciously or unconsciously relates observation with relevant knowledge. Active observation is the deliberate or intentional observation. In this case, the researcher carefully plans on how to study an object, a process, an event or response to a situation. Scientific observations can be enhanced by developing the habit of seeing things with an active inquiry mind. A good observation comes after so many errors and corrections; more so, it should be observed independently by other scientists and reports the same.

Awotua (2002) stated that problem definition comes after an observation has been made, the hypothetical student becomes curious, and for instance, he will decide to find out why a stone always come down when it is thrown up. To be able to define a problem, questions must be asked. Just like good observations, to be of value to science, a good question must be relevant and it must be testable. Once questions have been raised over a certain phenomenon, a good scientist then guesses what the answer to the question might be. This assumed answer is called a hypothesis. A hypothesis is a suggested explanation of a phenomenon or alternatively a reasoned proposal suggesting a possible correlation between or among a set of phenomena. Not all hypotheses relating to a particular problem are valid. The only way to decide which hypothesis is valid is to test each of the hypotheses. This is where scientific experiment is important. The outcome of the experiment according to Mari (2001) could lead to:

- Acceptance of hypothesis
- Modification of hypothesis

- Rejection of the hypothesis

Experimentation is a technique for dealing with observational errors whereby a deliberate control of some factors or variables under different conditions is applied to see what varies or what remain the same. Once guesses are made, they can be tested by experiments. Conclusion is reached after analysis of experimental results is made. Conclusions may sometimes include in clear terms the acceptance or rejection of a hypothesis. The hypothesis can also be redefined, modified and clarified when the need arises. Theory formulation, a scientific theory comprises of the collection of concepts, including abstractions of observable phenomena expressed as quantifiable properties, together with laws that express relationship between observations of such concepts. A scientific theory is constructed to conform to available empirical data about such observations and put forth as a principle explaining the phenomenon.

According to Okebukola (2009), Lecture Method consists of two approaches. The first approach is the oral (lecture) approach in which the teacher does most of the talking and uses the chalkboard sparingly while the students remain passive listeners. This is often called the “chalk and talk” method. The second approach involves the use of printed materials like textbooks, science fiction, science magazines, etc., to teach a concept usually in place of student-teacher interaction. Students merely read, and in most cases commit to memory, without proper understanding of what they are supposed to be learning. Although this method enables the teacher to cover a good part of the course outline within a short period, students cannot meaningfully learn science in this way. They can only succeed in learning by rote, but will often miss the essential parts of science teaching, especially those on how a scientist works.

The lecture instructional strategy is often the cornerstone of university teaching, a lecture can be an effective method for communicating theories, ideas, and facts to students. Typically a structured presentation, a lecture should be designed to include certain procedures in order to be effective procedures that research and expert lecturers have identified as essential to assist students learning. The basic purpose of lecturing is the dissemination of information. As an expert in your field, you identify important information for the learner and transmit this knowledge in the lecture. The lecture method is recommended for high consensus disciplines, those in which there is agreement on the fundamental principles and procedures, such as mathematics and the natural sciences.

According to Microsoft Encarta Premium Library (2015), the lecture method of teaching has numerous advantages, the basic ones among which include:

- It provides an economical and efficient method for delivering substantial amounts of information to large number of students.
- It affords a necessary framework or overview for subsequent learning, e.g., reading assignments, small group activities, discussion.
- It offers current information (more up to date than most texts) from many sources.
- It provides a summary or synthesis of information from different sources.
- It creates interest in a subject as lecturers transmit enthusiasm about their discipline.

There are disadvantages of using the lecture method as a primary method. An effective lecture requires both extensive research and preparation and effective delivery skills to maintain students' attention and motivation. In addition, the lecture method has other draw backs. These are:

- It does not afford the instructor with ways to provide students with individual feedback.
- It is difficult to adapt to individual learning differences.
- It may fail to promote active learning unless other teaching strategies, such as questioning and problem-solving activities are incorporated into the lecture.
- It does not promote independent learning.

An effective lecture is composed of three components; Introduction, Body and Conclusion. These are all designed to promote and support learning.

The introduction usually is the first three to five minutes of the lecture. This time is crucial in determining how well students learn and retain the information to be presented. The main purpose is to provide a framework for students' learning, providing the structure for the lecture's content information. It is also necessary to gain students' attention. The introduction should do the following:

- Establish a relationship with the audience. Make warm-up comments and initiate rapport to set the tone of the class. Establish friendly communication to provide a positive learning environment in which students' feel comfortable.
- Gain attention and foster motivation. Relate to students' goal and interests. You might

present a meaningful problem to students' and describe the lecture as a solution to the problem. You might also introduce the lecture by describing how it will help students' to be successful in their education and careers or by relating it to your students' inherent curiosity.

- Prompt awareness of relevant pre-existing knowledge. Students' need to see how the "new" lecture information relates to their existing knowledge or experience. This not only promotes interest and motivation, but also is a first step in cognitive information processing.
- Clarify the purpose of the lecture and describe how it is organized. Research supports a correlation between clarity of objectives and students' achievement; students will achieve at higher levels if they know what knowledge and skills they should gain from this instruction. This can be achieved by announcing the lecture topic and making a statement about the topic and how it will be developed.

According to the Microsoft Encarta Premium Library (2015), the body of the lecture covers the content in an organized way. Since this component is allotted the greatest amount of class time, it includes many more teaching procedures than the introduction or conclusion. This involves the lecturer consulting his lecture material and at the same time maintaining a rapport with the students. Lecture material is a combination of facts, concepts, principles and generalizations. Concepts represent a class of terms (an idea usually expressed in a word) and principles communicate relationship among concepts. Generalizations are relationships between or among concepts expressed at a higher level of abstraction than a principle. In a lecture, it is best to present a concept (one idea) by first defining it and then giving many concrete examples of the concepts. As you introduce new concepts, link them together into principles, and then into generalizations, each time adding concrete examples as you develop these relationships. Lectures should be organized based on the relationship of the ideas presented. Remember to include audiovisual aids while delivering your lecture. Using power point slides, transparencies, or even the chalkboard will enliven and strengthen the presentation of ideas and, thus, assist students' learning.

It is crucial to provide opportunities for active learning during any instruction, including a lecture. Active learning allows students' opportunity to practice using the lecture information and obtain feedback on the accuracy of their responses. For example, during the lecture, ask students or give students' problem-solving activities that encourage them to use the information they should gain from the lecture. Capturing and sustaining the students' attention during lecture method instructional strategy is very important. According to Okebukola (2009) a lecturer can maintain attention of the students' throughout his lecture by employing techniques such as:

- Vary students' activities, lecture for 15 minutes and then provide an active learning activity.
- Change the mode of presentation (for example, oral to visual).
- Employ concept related humor.
- Demonstrate enthusiasm about your subject/course.
- Encourage note taking by speaking slowly and repeating important information.
- Provide motivational clues ("On the next examination you will be asked to -----").

The conclusion, the most frequently neglected component of the lecture, should be used to reinforce students' learning of the information as well as to clarify any misconception regarding their understanding of the concepts presented. In concluding a lecture, the following points are important according to the Microsoft Encarta Premium Library (2015):

- Repeat and emphasize main points. This procedure will help you to get feedback as to whether or not students' identified the important information. It is also helpful to rephrase information in order to clarify key ideas.
- Encourage question from students. To allow students time to review their notes and thoughts, pause for a few moments after asking for questions. Remember, however, that it is often difficult for students to respond to the vague "Any question?", instead, ask specific, leading questions. By doing so, you will encourage your students to review their notes and formulate questions of their own. In this way, any misconception can be clarified and understanding can be reinforced.
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Daniel (2006) reported that in lecture delivery, non-verbal behaviours play a significant role in effective public speaking: they can enrich or elaborate the spoken message. There are basically two aspects to non-verbal behavior, these are the body language and voice. The following four elements make up the body language:

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vii. Facial expression; a significant portion of the emotional impact of a speaker's message is conveyed by facial expression. Facial expressions tell students how to feel about them and yourself and give students cues to help them interpret the content of the message. Regular eye contact helps you to establish credibility.

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x. Rate of speech: in a large lecture, with students concentrating on note taking, a rate of 120 to 130 words per minute is comfortable.

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xii. Pauses: pauses can provide emphasis and allow students' time to think and take notes. Furthermore, pausing indicates that you are a conscientious speaker who thinks about what you are going to say.

Additional hints for a successful lecture include the following:

- Present an outline of the lecture (use the black board, overhead transparency or handout) and refer to it as you move from point to point.
- Repeat points in several different ways, include examples and concrete ideas.
- Use short sentences.
- Stress important points through your tone or explicit comments.
- Pause to give listeners time to think and write.
- Learn students' names and make contact with them during the lecture.
- Avoid racing through the last part of the lecture. This is a common error made by instructors wishing to cram too much information into the allotted time.
- Schedule time for discussion in the same or separate class periods as the lecture.

In this study, the students in the Control Group (CG) were taught some biological conceptsusing the Lecture Method. Their academic performance rate and retention level was compared with those students taught the same concepts using the Computer-Assisted Instruction (EG 1) and Science Process Approach (EG 2) in order to see if there is any significant difference.

2.7 Gender Issues in Science Education

According to Bichi (2002), the concept "gender" has attracted the attention of many psychologists, biologists, and researchers as a result of which a lot of literature exists on different aspects of the concept. In this study, gender and academic performance will be discussed. For this reason, gender and academic performance in science is reviewed briefly.

Adeniyi (2005) defined gender as the amount of masculinity and feminity found in a person and obviously while there are mixtures of both in most human beings, the normal male has a preponderance of masculinity and the normal female has a preponderance of feminity.Bandele (2000) reported that many research works carried on gender impact on academic performance have described the proportionately low performance of female students in science education programmes and careers. This gave the male a greater dominance over their female counterparts. The under representation of women in science has led to many feminist scholars to postulate that science as practiced today is 'gendered' and use to the benefit of the male world.

In Nigeria, reports from a study requesting female and male adolescents to indicate their choice of subjects revealed that the adolescents selected different courses that are gender biased. Ogunsola (2000) and Akanbi (2004) reported that males prefer mathematics and sciences while the females opted for reading and if science, life sciences, that is, Biological Sciences. Similarly, most girls have being found to underestimate their own academic ability and believed that boys are superior and intelligent than them and therefore more capable of handling different subject like sciences and mathematics. Ogunsola (2000) stated that boys in turn perpetuate dominance in their areas of strength thereby dominating most of the laboratories and computer rooms. This argument can however be valid in situations where co-educational schools exist. In most northern states were schools are single sexed, this argument may not hold water. Bichi (2002) reported an argument among scholars that female students do not like practical work and cannot handle enquiry method but Ermosho (2007) countered that the lack of female interest as well as low performance was because they don't experience science through activities. Buttressing this point Ermosho (2007) argued that girls interest towards science increases when science is related to their concerns and with the use of effective instructional methodologies.

Jacob (2002) reported that on average, girls do better in schools than boys. Girls get higher grades and complete high school at a higher rate compared to boys. National Center for Education Statistics (2003) observed that standardized achievement tests also show that females are better at spelling and perform better on tests of literacy, writing and general knowledge. An international aptitude test administered to fourth graders in 35 countries, for example, showed that females outscored males on reading literacy in every country. Although there were no differences between boys and girls in fourth grade on mathematics, boys began to perform better than girls on science tests in fourth grade (International Association for the Evaluation of Education Achievement, n.d.). Girls continue to exhibit higher verbal ability throughout high school, but they begin to lose ground to boys after fourth grade on tests of both mathematical and science ability. These gender differences in mathematics and science achievement have implications for girls future careers and have been a source of concern for educators everywhere.

During the past decade, there has been a concerted effort to find out why there is a shortage of women in the science, mathematics and technical fields (AAUW, 2000). American National Science Board (2005) observed that in 2000, 22% of America's scientists and engineers were women, compared to half of the social scientists. Women who do pursue careers in science, engineering and mathematics most often choose fields in the biological sciences, where they represent 40% of the workforce, with smaller percentages found in mathematics or computer science (33%), the physical sciences (22%) and engineering 9%.

Hedges and Nowell (2006) reported that part of the explanation can be traced to gender differences in the cognitive abilities of middle-school students. In late elementary school, females outperform males on several verbal skills tasks: verbal reasoning, verbal fluency, comprehension and understanding logical relations. Voyer and Bryden (2006) observed on the other hand that males outperform females on spatial skills tasks such as mental rotation, spatial perception and spatial visualization. Fennema and Carpenter (2007) also reported that males also perform better on mathematical achievement tests than females. However, gender differences do not apply to all aspects of mathematical skill. Males and females do equally well in basic mathematics knowledge and girls actually have better computational skills. Performance in mathematical reasoning and geometry shows the greatest difference. Casey and Pezaris (2007) also observed that males always display greater confidence in their mathematical skills, which is a strong predictor of mathematics performance.

The studies mentioned above dealt mainly with achievement but the impact of Computer-Assisted instructional strategy on both sexes was neglected, hence the focus of this study. In this study, an attempt will be made to investigate if the use of Computer-Assisted Instructional teaching strategy and Science Process Approach is gender-stereotyped or not.

2.8 Retentionof Learned Concepts in Science

According to Bichi (2002), permanent and meaningful learning is the ultimate target of our educational endeavor. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students.Retention is the ability to retain and consequently remember things experienced or learned by an individual at a later time. It takes place when learning is coded into memory. This, appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane Oyedokun (1998) in Bichi, (2002). The nature of the material to be coded contributed to the level of retention. Materials are related to the quality of retention concreteness and image evolving characteristics Adeniyi (1997).

Several factors are known to influence retention. Bichi (2002) reported that anything that aids learning should improve retention while things that lead to confusion or interference among learned materials decrease the speed and efficiency of learning and accelerate forgetting. Retention level in relation to age has been investigated by several researchers. Cross (1974) in Bichi (2002) reported that retention increases from infancy throughout the teenage years followed by a slow recession in middle age. Studies on retention and instructional strategy have attracted the attention of many researchers in recent years. For instance, Ezenwa (1993) compared the effectiveness of concept mapping and guided discovery teaching strategies on students' retention of some chemistry concepts. Analysis of the results showed a significant difference between the concept mapping and guided discovery post-test scores in favour of concept mapping. It follows that the concept mapping method enables students to have better understanding of concepts taught and retain more knowledge of chemistry concepts than the guided discovery method. Fisher (2005) compared the effectiveness of Computer-Assisted Instructional teaching method and the traditional lecture method with reference to performance, retention and creativity. He found that students exposed to Computer-Assisted Instructional teaching method have higher cognitive retention level than their counterparts taught using the traditional lecture method.

In this study, the retention ability ofstudents taught someconcepts of biology using the Computer-Assisted Instruction and Science Process Approachwill be investigated among SS II Secondary School Students in Kaduna, Nigeria.

2.9 Ability Levels of Students in Science

Bunkure (2012) stated that ability grouping is based on educators' judgments of students' abilities. When assigning students' to tracks, educators examine prior test scores or other performance measures they have administered or that have been provided by educators from other grades or schools. Students are then grouped with others who have been judged to be at a similar ability level for instructional purposes. Ability grouping has been an extremely controversial practice as reported by Ansane (2006) and Rubin (2006) evidenced by the fact that it "has been the subject of more research studies than almost any other educational practice'' George and Alexander (2003) observed that the proponents of ability grouping (including many parents and teachers) maintain that teachers can more specifically target an instruction in order to meet the needs of students when they are grouped by ability. Gamoran and Weinstein (1998), Mallery and Mallery (1999) observed that the opponents maintain that intended gains for students in all tracks too often fail to materialize, that students are too often grouped so that their ability tracks correlate with income, social class, and race; and that identification of students with low ability groups bring about stigmatizing result. Over time, secondary schools have varied in their use of heterogeneous grouping and ability grouping. While middle grades advocates like Doda (2005), George & Alexander (2003) frequently favour heterogeneous grouping, studies of practices in secondary schools indicate a trend toward more ability grouping. In a nationwide study, McEwin, Dickson, and Jenkins (2003) reported that 78% of secondary schools in 2001 used some degree of ability grouping. This compared to only 68% of schools surveyed in American in the year 1993 McEwin, Dickson & Jenkins (1996). Valentine and his colleagues found that 82% and 85%, respectively of secondary schools surveyed used some degree of ability grouping in studies published in 1993, Valentine, Clark, Irvin, Keefe, & Melton, (1993) and Valentine, Clark, Hackman, &Petzko (2002). George (2008) observed that interestingly, those secondary schools that are considered exemplary engage in less tracking than other secondary schools.

Gamoran and Weinstein (1998) and Slavin (1990, 1993) in their reviews of research on ability grouping, concluded that few studies yield results fovourable to the practice. Further, Catsambis, Mulkey, & Crain (2001) found that when young adolescent students are assigned to high ability groups in mathematics, the academic self-concept of the males diminishes while that of the females thrives. By contrast, males placed in low ability mathematics groups actually experienced increased self-concept, at least temporarily.

Ansalone and Biafora (2004) found that teachers continue to support ability grouping (tracking) as a result of their managerial concerns about the complexities of teaching students with diverse learning needs. Tracking may make the teachers work easier even if it is not the most effective way to serve the students. This finding is interesting considering that another study Yonezawa& Jones (2006) found that students regarded tracking policies as unjust and inequitable. In response to the negative outcomes of tracking, many schools have begun to implement 'detracking' measures (i.e., concentrated efforts to move from ability grouping or tracking to heterogeneous grouping while maintaining appropriately high standards for all the students involved). Oakes and Lipton (2002), reflected on a decade of schools' effort to detrack, noted that schools must take the issue more seriously than simply moving students from homogeneous to heterogeneous groups.

Watanabe (2006) found that teachers must learn how to appropriately initiate dialogue about tracking and detracking: "As any experienced teacher can tell you, 'tracking' and 'detracking' are not the equivalent of 'forward' and 'reverse' on a car" according to Rubin &Noguera, (2004). Teachers implementing heterogeneous grouping as an alternative to tracking must also be careful not to perpetuate inequalities within their detracted classrooms and, thereby, "re track" their students within the midst of the apparently heterogeneous group. This is so, because detracting is inherently difficult, some will argue that an alternative solution is to maintain tracking but focus on the assurance of quality of instruction provided to the students in the lower tracks. Gamoran and Weinstein (2008) warned, however, that this nobly intended alternative is inherently flawed. Ability grouping, while addressing instructional differentiation, is powerless to address the unequal distribution of status which led to the choice of ability grouping in the first place.

Gamoran and Weinstein (2008) studied eight secondary schools that had implemented some form of detracting as part of their school wide reform and restructuring efforts. Only one of the schools had adopted heterogeneous grouping for all subjects, and, in this school, the instruction was rarely characterized by higher order thinking. The other seven schools offered at least one high track class (often algebra) and several had 'honors' sections of other classes. In general, the researchers isolated classrooms in which teachers demonstrated high quality instruction across all schools, substantiating that detracting in and of itself is of limited value if the school does not also addresses the overall quality of instruction.

While the Gamoran and Weinstein (2008) study is extremely useful, it is limited in application due to the lack of control group comparisons, a limitation frequently found in the literature Mulkey, Catsambis, Steelman, & Crain (2010). In attempting to overcome this limitation, Mulkey and associates examined data from the National Education Longitudinal Survey (NELS: 88) for differences in mathematics performance and self-concept between tracked and untracked eighth grade students. Few of the effects of tracking were positive. Students placed in a higher mathematics track in the eighth grade experienced diminished mathematics self-concept in the tenth and twelfth grades, when compared with those eighth graders in non-tracked settings. This trend was particularly problematic for males.

Research has also addressed the effects of heterogeneous versus ability grouping on students with special needs. Obviously, students with special needs, like other students, need interactions with peers, opportunities to develop higher level thinking, recognition of their contributions, and equal access to quality instruction. Research on heterogeneous grouping of lower achieving students, including those with special needs, has indicated positive effects on students' academic performance, self-esteem, and interpersonal relationships according to Slavin, (2001); Villa & Thousand (2003). Hence, Braddock (2000) advocated for schools to develop flexible criteria that allows students with high commitment, regardless of demonstrated ability, to decide to take more challenging classes. These recommendations are supported by Mulkey and associates (2005) who found positive linkages between students' freedom to make academic choices and their later academic performance.

Heterogeneous groupings that include students with special needs may or may not have inclusion provisions (e.g., specific accommodation to assure success of students with special needs, teaming of the exceptional education teacher with the regular classroom teacher). Daniel and King (2007) observed that if students with disabilities are to be included, it is important that teachers receiving training to work with inclusionary practices that help meet the needs of these students. Otherwise, the academic performance and behavior of all students in the class may suffer. Villa, Thousand, Meyers and Nevin (2006), in a study of administrators and teachers at schools practicing heterogeneous grouping found that the participants favoured including students with disabilities in general education settings, rather than assigning them to 'Pullout' programmes.

Penzulli and Reis (2007) reported that educators have frequently debated the most effective way to meet the needs of gifted learners in the middle grades. Experts in education for the gifted have argued for curriculum differentiation and flexible scheduling to allow some ability grouping for young adolescents who are identified as gifted. George (2007) observed that other educational experts have maintained that gifted learners can be adequately served in heterogeneous middle grades classrooms. This debate is far from being resolved, and more research is needed to look at the performance of middles grades gifted learners taught in varying instructional settings. As Oakes and Lipton (2002) noted, "Many elementary and secondary schools have taken the position that well designed heterogeneous classes can meet the needs of most intellectually gifted students. But many schools also provide special activities for high achievers either within the regular classroom or after the school. Heterogeneous or non-graded education is the practice of teaching children at different ages and ability levels together in the same classroom, without dividing them or the curriculum into steps labeled by "grade" designation. The practice is also known by several other terms which basically designate the same concept; ungraded education, Multi-age grouping, Mixed age grouping, Open education, Vertical grouping and Family grouping.

According to Lakpini (2007), grouping students base on their ability may be done at random or in some systematic ways. Ability grouping is usually done by placing students with basically similar cognitive ability in the same group. Bunkure (2012) observed that in Nigerian situation, middling average or medium ability level student is usually lower than 95% of the group's total population. According to West African Examination Council (WAEC) 2003 to 2014 regulation, there are nine levels of performance grades, that is grades 'A' to 'F' comprising of six grades with A, B, C, D, E, as passes while F as failure. The different grades and their corresponding scores according to WAEC (2014) include:

1. High ability:A 1 (75-100%), B 2 (70-74%).
2. Medium ability: B 3 (65-69%), C 4 (60-64%), C 5 (55-59%), C 6 (50-54%).
3. Low ability: D 7 (45-49%), D 8 (40-44%), F 9 (0-39%).

According to Lakpini (2007) the ability grouping was determine as follows:

1. High ability level upper 25%
2. Medium ability level middle 50%
3. Low ability level bottom 25%, this grouping was based on students' performance on Biology Performance Test (BPT).

In this research work, the researcher will investigate whether the Computer-Assisted Instructional strategy will have any impact on the secondary school students' academic performanceand retention in biology concepts with Low, Medium and High abilities and compare it with Science Process Approach and the Lecture Method instructional strategies.

2.10 Overview of Similar Studies

Bichi (2002) and Nwafor (2007) reported that available literature indicated that many studies have been carried out to investigate relative impacts of different instructional strategies on students academic performance in science. This study is titled, 'Impact of Computer-Assisted and Science Process Instructions on Retention and Performance in Biology among Varied Abilities Secondary School Students in Kaduna, Nigeria.' In line with this, some similar studies were overviewed here.

Mudasiru, Moyusuf and Emmanuel (2010) investigated the, Effects of Computer-Assisted Instruction (CAI) on Secondary School Students Performance in Biology. Also, the influence of gender on the performance of students exposed to CAI in individualized or cooperative learning settings package was examined. The research was a quasi-experimental involving a 3x2 factorial design. The sample for the study comprised of 120 first year senior secondary school students (SSS 1) sampled from three private secondary schools in Oyo State, Nigeria. The students pretest and posttest scores were subjected to Analysis of Covariance (ANCOVA). The findings of the study showed that the academic performance of students exposed to CAI either individually or cooperatively were better than their counterparts exposed to the conventional classroom instruction. However, no significant difference existed in the academic performance of male and female students exposed to CAI in either individual or cooperative settings. Based on this research finding, some recommendations were made on the need to develop relevant Computer-Assisted Instructional packages for teaching biology in Nigerian Secondary Schools.

Owusu, Monney, Appiah and Wilmot (2010) investigated the Comparative Efficiency of Computer-Assisted Instruction (CAI) and Conventional Teaching Method in Biology on Senior High School Students in Ghana. A science class was selected in each of two randomly selected schools. The pretest, posttest, non-equivalent quasi-experimental design was used. The students in the experimental group learned biology concepts (cell cycle) through the CAI, whereas the students in the control group were taught the same concepts by the conventional approach. The conventional approach consisted of lecture, discussion and question and answer teaching methods. Mann-Whitney U tests were used to analyze students pretest and posttest scores. The results indicated that students that were instructed by the conventional approach performed better on the posttest than those instructed by the CAI. However, the performance of low achievers within the experimental group improved after they were instructed by CAI. Even though the CAI group did not perform better than the conventional approach group, the students in the CAI group perceived CAI to be interesting in learning when they were interviewed.

Hassan and Usman (2013) studied the Effects of Computer-Assisted Instruction and Conventional Teaching Method on Secondary School Students Academic Performance in Biology in Jaba Local Government Area of Kaduna State, Nigeria. Two research questions and two hypotheses were formulated for the study. The design adopted for this study was quasi-experimental. Two hundred and two (202) secondary school students from four selected schools in Jaba Local Government Area were used as research sample. The experimental group was exposed to Computer-Assisted Instruction package in biology while the control group was taught the same topics with conventional lecture method. A 40 item Biology Achievement Test (BAT) with a reliability coefficient of 0.80 was used to collect data for the study. The data were analyzed using Analysis of Variance (ANOVA). The hypotheses were tested at 0.05 level of significance. The findings of the study showed that students taught biology with Computer-Assisted Instructional package in biology performed better than those taught the same concepts with conventional teaching method and gender has no effect on their biology achievement scores. It was recommended that biology teachers should continuously use computer packages in teaching biology as it guarantees improvement in students achievement in biology.

Yassanne, Garraway and Lashley (2014) investigated the Impact of Integrating Computer-Assisted Instruction in the teaching of biology. They reported that over the past decade, the number of students who gained satisfactory passes at the Caribbean Secondary Education Certificate (CSEC) in biology in Guyana has been few. This poor performance may be attributed to the traditional method of teaching that was used to teach biology. This study therefore ascertained if the integration of Computer-Assisted Instruction into the teaching of biology would enhance students academic performance. The study was guided by a null research hypothesis. Hence, the related literature reviewed for this study showed that integrating Computer-Assisted Instruction into the teaching of biology can enhance students academic performance in the subject. A quasi-experimental, pretest, posttest, nonequivalent control group research design was used for the study. The study used two intact grade 10 classes. One class was assigned the experimental group and the other class was assigned the control group through a simple coin toss. The experimental group was taught biology using the Computer-Assisted Instruction while the control group was taught the same topic using the traditional method of teaching. A 20-item multiple-choice Biology Achievement Test (BAT) was prepared by the researcher and was used for both the pretest and posttest. Face and content validation of the instrument was achieved through the contributions from two grade 11 biology teachers and a measurement and evaluation specialist from the University of Guyana. A reliability coefficient of 0.75 was obtained using the Pearson Product Moment Correlation Coefficient after a pilot test of the instrument. Data collected were analyzed using the mean, standard deviation and t-test. The results of the study showed that there was a significant difference between the academic performance of students in biology who were exposed to Computer-Assisted Instruction and those exposed to the traditional method of teaching. It was therefore recommended that Computer-Assisted Instruction be integrated into the teaching of biology to enhance students academic performance in science.

Serkan and Dincer (2015) studied the, Effect of Computer-Assisted Instruction (CAI) on the Secondary School Students Achievement in Science. This study was designed, to see the effect of Computer-Assisted Instruction as a supplementing strategy on the academic achievement of secondary school students in the subject of science. The major objectives of the study were: (1). to find out the relative effects of Computer-Assisted Instruction as supplementary strategy on the academic achievement in science. (2). to explore the difference between treatment effects on the students of high and low intelligence and (3). to investigate the difference between treatment effects on male and female students. To achieve the objectives of the study, following null hypotheses were tested: (1). There is no significant difference between the mean scores of the students taught science with CAI as supplementing strategy and without CAI; (2). There is no significant difference between the mean scores of the high achievers and low achievers of experimental and control groups; (3). There is no significant difference between the mean scores of male and female students of experimental and control groups. Secondary school students studying science subjects constituted the population of the study. The students of 9^{th} class of The City School, H-8, Islamabadin Pakistan were selected as sample of the study.

To carry out the above study, only students studying biology as elective subject were included in the sample. Sampled students were assigned to two groups, i.e. experimental group and control group. Both the groups were equated on the basis of their achievement scores in previous semester in the subject of biology. Each group comprised of 20 students. The study was based on 'Operant Conditioning' theory of Skinner. There were two different treatment patterns applied during the experiment. Both the groups were taught through routine method by the same teacher. The Computer-Assisted Instruction was used as additional strategy for the experimental group. During the experiment period, the experimental group received the treatment of independent variable, i.e. Computer-Assisted Instruction whereby the experimental group was exposed to certain web-sites consisting of drill and practice, tutorials, simulations and animation. In the mean while the control group was kept busy in other activities such as guided practice and independent practice. This was adopted to control the variables of time and to realize the primary objective of the study. The experiment continued for six weeks. In order to find out the treatment effects, a teacher-made posttest was administered to the experimental as well as control group immediately after the treatment (teaching) was over. The purpose of this test was to measure the achievement of the students constituting the sample of the study. Final data were collected from 40 students, 20 from each group. The achievement scores of the sample were obtained as a result of the posttest. After obtaining the score, the lists were prepared for each group and the means, standard deviations and the differences between the means were computed. Significance difference between the mean scores of both the groups on the variables of previous achievement was tested at 0.05 levels by applying t-test. To see the treatment effects for male and female students as well as high and low levels of achievement of both the groups, the factorial design (2x2 analysis of variance) was applied. For this purpose the students of both groups were divided into two halves, namely; high achievers (above the mean score) and low achievers (below the mean score) on the basis of scores on previous achievement test. Analysis of data revealed that the students taught through Computer-Assisted Instruction as supplementary strategy performed significantly better. The students with high achievement level showed better results than those with low achievement level when taught through the Computer-Assisted Instruction. The Computer-Assisted Instruction was found equally effective for both male and female student.

Based on the similar studies reviewed, the following findings were made:

i. Mudasiru, Moyusuf and Emmanuel (2010) investigated the Impact of Computer-

Assisted Instruction and the Lecture Method on the academic performance of Secondary School Students. The statistic used to analyze the data in this study was the Analysis of Covariance (ANCOVA).

ii. Owusu, Monney, Appiah and Wilmot (2010) studied the Effect of Computer-Assisted Instruction and the Conventional Teaching Method on the Academic Performance of Secondary School Students in Biology. The statistic used here was the Mann-Whitney U test.

iii. Hassan and Usman (2013) compared the Impact of Computer-Assisted Instruction and Lecture Method on the Academic Performance of Secondary School Students in Biology. The statistic used here was the One-Way Analysis of Variance (ANOVA).

iv. Yassanne, Garraway andLashley (2014) investigated Effects of Computer-Assisted Instruction and Traditional Teaching Methods on the Academic Performance of Secondary School Students in Biology. The statistics used here were the mean, standard deviations and t-test.

v. Serkan and Dincer (2015) investigated the Effect of Computer-Assisted Instruction and Conventional Lecture Method on the Academic Performance of Secondary School Students in Biology. The statistic used here was the t-test.

In this study, three instructional strategies namely; Computer-Assisted Instruction, Science Process Approach and Lecture Method were used to teach some concepts in biology to SS II Secondary School Students. The new variables introduced to make this study feasible were Science Process Approach, Retention and Ability Levels (high, medium and low) of the Secondary School Students.

2.11 Implications of the Literature Reviewed for the Present Study

The literature review is done in such a way that the research works that are carried out by some science scholars/researchers in the past that have direct bearing with the present study are reviewed. Specifically, the reviewed literatures are summarized as follows:

i. Mudasiru, Moyusuf and Emmanuel (2010) investigated the impact of computer-assisted instruction and the lecture method on the academic performance of secondary school students in biology in Oyo, Nigeria.

ii. Owusu, Monney, Appiah and Wilmont (2010) studied the effect of computer-assisted instruction and the conventional teaching method on the academic performance of secondary school students in biology in Ghana.

iii. Hassan and Usman (2013) compared the impact of computer-assisted instruction and lecture method on the academic performance of secondary school students in biology in Jaba Local Government Area of Kaduna, Nigeria.

iv. Yassanne, Garraway and Lashley (2014) investigated effects of computer-assisted instruction and traditional teaching methods on the academic performance of secondary school students in biology in Caribbean secondary school Guyana.

v. Serkan andDincer (2015) investigated effects of computer-assisted instruction and conventional lecture method on the academic performance of the students 9th class of the City School, H-8, Islamabad, Pakistan.

Based on the reviewed literatures, this study intends to cover the following gaps in the teaching of biology at the secondary school level which were not covered by the previous studies:

i. Teaching the plant aspects of SS II secondary school biology through the development of Computer software that will be used for learning through the Microsoft power point presentation.
ii. Teaching the biology concepts of SS II secondary school biology using three instructional strategies, these are; Computer Assisted Instruction, Science Process Approach and Lecture Method with a view to comparing their impacts.
iii. Retention was also introduced as a variable in this study which was not used in the other cases reviewed.
iv. Gender was also introduced as a variable in this study which was not used in the other studies reviewed.

Thus when these items are considered in the present study, it makes it remarkably different and an improvement over others.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The main purpose of this study was to determine the Impact of Computer- Assisted and Science Process Instructions on Retention and Performance in Biology among Secondary School Students with varied Abilities in Kaduna, Nigeria. In the last chapter, literature related to the study was reviewed. The focus of this chapter is to outline the methodology employed in conducting the study. Specifically, this chapter is presented under the following sub-headings:

- Research Design
- Population of the Study
- Samples and Sampling Technique
- Instrumentation
- Validation of Instrument
- Pilot Testing
- Reliability of the Instrument using the PPMC
- Item Analysis of the Instrument
- Table of Specification based on Blooms Taxonomy
- Administration of Treatment
- Data Collection Procedure
- Data Analysis

3.2 Research Design7

The research design is quasi-experimental involving pretest, posttest and postpost test. In this design the subjects under study are not confined in one place throughout the study period.Three groups of students were used for data collection; the experimental group 1 (EG 1), experimental group 2 (EG 2) and the control group (CG). A pretest was administered to the three groups in order to determine theirgroup equivalence and the abilitylevels of the three groups. The students in each of the three groups were classified according to ability levels (low, medium and high). In this design, the experimental group 1 (EG 1) students were taught some concepts of S.S. II biology using the Computer-Assisted Instruction (CAI), while experimental group 2 (EG 2) students were taught same concepts using the Science Process

Approach (SPA). The students in the control group were taught same concepts using the lecture method (LM). At the end of the treatment a posttest was administered to the three groups to determine the effectiveness of the treatment with regard to performance. Two weeks later, a postposttest (O_3) was administered. This is to determine the retention level of learned concepts. The same instrument (BPT) was administered as pretest, posttest and postposttest. The design is illustrated in Figure 3.1

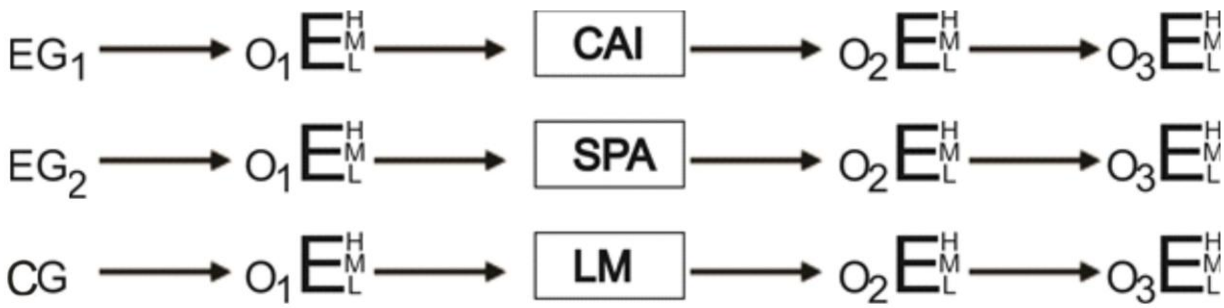

Figure 3.1 Research Design

Where:

EG 1: Experimental Group 1

EG 2: Experimental Group 2

CG: Control Group

CAI: Computer Assisted Instruction

SPA: Science Process Approach

LM: Lecture Method.

O_1: Pretest (to ascertain their group equivalence and ability levels (low, medium and high).

O_2: Posttest (to ascertain their performance level)

O_3: Postpost test (to ascertain their retention level)

H: High ability

M: Medium ability

L: Low ability

This design has the following advantages:

i. The scores obtained from the pretest were used to statistically find out if there was any difference between the groups at the start of the study, that is, to ensure equality of three groups academically at the start of the experiment. The pretest result was also used to stratify the subjects according to their ability levels.

ii. Individual as well as group mean pretest and posttest scores can be calculated making it possible for one to determine the superiority of one teaching strategy relative to the other.

iii. It also gives an indication of the concept attainment ability gained by students following instruction.

iv. It is also logical to accept that any difference in the performance of the groups could be attributed to the treatment given, since the treatment administered is the only difference between the three groups (EG 1, EG 2 and CG).

3.3 Population of the Study

The population of this study was all the Senior Secondary School Students in Sabon-Tasha education zone of Kaduna State. There are seventeen (17) Senior Secondary Schools. The schools comprised of co-educational and single sex (female) schools owned by government. Two of the schools were female schools while fifteen were co-educational institutions. Senior Secondary two students from the three schools were selected for the study because they had covered substantial concepts of biology curriculum and were relatively stable for the experiments of this nature. The total number of SS II Students in the seventeen schools was 3841 of which 2079 were male and 1762 were female. The SS II students have an average of 17 years. This category of students are targeted for the study because they are relatively established and stable in secondary education more than the SS I students who have not yet settled down while the SS III students were busy preparing for their S.S.C.E. The details of the population are shown in Table 3.1

Table 3.1 Population of the Study

Name of School	Nature of School	SS 2 Enrolment	Gender	
			Male	Female
1. Government SecondarySabon-Tasha.	Co-education	290	180	110
2. Government SecondarySchool, Kakuri.	Co-education	240	185	55
3. Government SecondarySchool, Mararaban Rido.	Co-education	200	120	80
4. Government SecondarySchool, Iddah.	Co-education	306	200	106
5. Government SecondarySchool, Nasarawa.	Co-education	300	190	110
6. Government SecondarySchool, Narayi.	Co-education	280	100	180
7. Government GirlsSecondary School, Barnawa.	All girls	200	-	200
8. Government SecondarySchool, Iburu.	Co-education	200	124	76
9. Government SecondarySchool, Television.	Co-education	210	140	70
10. Government SecondarySchool, Kujama.	Co-education	210	125	85
11. Government SecondarySchool, Kudenda.	Co-education	165	100	65
12. Government SecondarySchool, Kajuru.	Co-education	150	90	60
13. Government SecondarySchool, Ungwar Romi.	Co-education	250	160	90
14. Government SecondarySchool, Kufana.	Co-education	175	95	80
15. Government SecondarySchool, Kasuwan Magani.	Co-education	240	150	90
16. Government SecondarySchool, Jere.	Co-education	220	120	100
17. Queen AminaCollege, Kaduna.	All girls	205	-	205
Total		**3341**	**2079**	**1762**

Source: (Sabon-Tasha Educational Zone 2015).

3.4 Sample and Sampling Technique

A sample is a subset of the population of which measurement has been done and from which generalizations are drawn to cover the entire population. Sampling is described as the process of selecting units or subsets (e.g. people, organizations or schools) from a population of interest so that by studying the sample one may fairly generalize relative to the population from which they are chosen.

The sample selected in this study consisted of one hundred and fifty three (153) Senior Secondary year two (SS II) biology students drawn from three (3) Government Secondary Schools in Sabon-Tasha Zone, Kaduna. Simple random sampling technique was used to select three (3) government schools within the Sabon-Tasha Education Zone Kaduna State, Nigeria for this study. This was to minimize location and environmental differences as suggested by (Fraenkel&Wallen, (2000), Kerlinger and Lee, (2005) andOgunleye, (2000) and in addition to meet up with the researcher's constrains of time and resources. Thus having two schools for the experimental groups 1 & 2 and other one school for the control group. The two government schools were purposely selected from the 3 randomly selected schools for the experimental groups 1 & 2 because they have the facilities needed to conduct this research work, that is, a well-equipped computer and science laboratories while in the control group the class room was used to teach the students. The experimental sample for EG 1 and EG 2 is (N= 102) consisted of 60 boys and 42 girls while the control group on the other hand consisted of 30 male and 21 female. The strata of the ability levels in the experimental groups 1, 2 and control group are as follows:

Table 3.2 Schools showing the Ability Levels

School	High	Medium	Low	Total
G.S.S. Sabon- Tasha (EG 1)		17	1717	
G.S.S. Kakuri (EG 2)171717				
G.S.S. Narayi (CG)	17	1717		
Summary	**5151**	**51**	**153**	

The assessment of the students in the two experimental groups and the control group were randomly done to avoid bias. Details of the sample selected are presented in Table 3.3

Table 3.3 Samples Selected for the Study

Schools	Male	Female	Total
1. Government Secondary School, Sabon-Tasha, Kaduna.	30	21	51
2. Government Secondary School, Kakuri-Kaduna.	30	21	51
3. Government Secondary School Narayi, Kaduna.	30	21	51
Total 90 63	**153**		

In order to ensure relative similarities in the variable of interest such as gender, the sample schools were drawn from co-educational government secondary schools within the Sabon-Tasha Education Zonelocated in Kaduna State. This is to ensure uniformity in the nature of subjects selected for the study. Simple random sampling technique was used to select a total of 153 students from threegovernment secondary schools. It was not possible to select the same number of boys and girls because the proportions of schools in terms of gender are not the same. The three groups were then used for data collection.

This sample size is sufficient enough for the study as it conforms to the sizes recommended by Fraenkel andWallen, (2000), Ogunleye, (2000), Kerlinger and Lee, (2005). The Biology Performance Test (BPT) was administered to the samples of each of the three schools selected as pretest. This was to ensure the equivalence of the subjects at the start of the work. The scores obtained from the pretest were subjected to analysis. The choice of these three schools from different locations was to avoid interaction between the groups during the period of the treatment, thus eliminating the effect of students' interference which might affect the study.

The subjects in the two experimental groups and the control group were stratified on the basis of gender and ability levels using the results obtained from the pretest. The topics that were used for this study are drawn from some biology concepts of Senior Secondary 2 biology Curriculum Published in 2008 by the Nigerian Educational Research and Development Council (NERDC), Sheda-Abuja. These topics were selected for the following reasons: the topics have a lot of students' activities and beside that, the topics feature in the SS II biology syllabus plant concepts which not much research work has been done on it.

3.5.1 Instrumentation.

One instrument was used for data collection namely: Biology Performance Test (BPT). BPT centered mainly on the cognitive test. The BPT is aperformance test adopted from the West African Examination Council (WAEC) past examination papers. It consists of 50 structured questions on the plant concepts of Senior Secondary II biology with a maximum score of 50 marks (see Appendix 1 for details). The instrument (BPT) was validated by five Senior Lecturers with minimum qualification of PhD in Science Education Department of Ahmadu Bello University, Zaria and three Biology teachers with not less than 10 years teaching experience at the Secondary School level. The validators were requested to critically examine and assess all the items of the instrument with reference to the following terms of reference:

- Is the content of the instrument correct, recent and appropriate to SS II standard?
- Are the items clear, precise and of standard?

The items in the BPT were found to be recent and appropriate to the SS II. The instrument was then pilot-tested using the SS II biology students of Government Secondary School Television, Kaduna that was not included in the study but has similar characteristics as the sampled schools. This was to ascertain the facility index and to test the reliability of the instrument using Pearson's Product Moment Correlation Coefficient (PPMC) formula.

The lesson plans used for the three groups in this study were the Microsoft Power Point Presentation (MPPP) through the application of the Computer-Assisted Instruction (CAI) which was used for the Experimental Group 1 (EG 1). It is found in Appendix III located on page 117. The lesson plan used for the Experimental Group 2 (EG 2) was the Science Process Approach (SPA) through the use of Science Process Skills (SPS). The Basic Science Process Skills (BSPS) used here were observation, illustration, labeling, counting, grouping among others while the Integrated Science Process Skill (ISPS) used in this study were experimentation and the control of variables. This SPA lesson plan is found in Appendix IV located in page 136. The third lesson plan used for the Control Group (CG) in this study is the traditional lecture method which is found in Appendix V located on page 158. All these lesson plans were validated by the Head of Biology at the secondary schools used for this study which have more than 10 years of teaching experience each.

3.5.2 Validation of Biology Performance Test (BPT)

The instrument Biology Performance Test (BPT) was adapted from WAEC and modified by the researcher. The instrument was validated by five Senior Lecturers with minimum qualification of PhD in Science Education Department of Ahmadu Bello University Zaria and three Biology teachers with not less than 10 years of teaching experience at the Senior Secondary School level, by assessing the content and face validity. The assessors were requested to examine the instrument (BPT) for the following features:

i. Ascertain the reliability of the instrument before use in the final study.
ii. Whether the test items conform to the subject matter they are supposed to test?
iii. Determine whether the study is feasible or not
iv. To ascertain suitable time duration required by the students to complete the test items
v. Whether the questions match the ability level of the students
vi. To eliminate ambiguity and assess clarity of the items
vii. To determine discrimination level and difficulty of the test items

Difficult and problem areas that were observed in the test items were carefully noted and corrected to enable the instrument to be used finally from the result of the pilot study.

3.5.3 Pilot Testing of the Instrument

The S.S. II students of Government Secondary School, Television- Kaduna were identified and used for the pilot testing of the instrument (Biology Performance Test), the test method used for this pilot testing is the test and retest method at interval of 2 weeks in line with Tuckman (1975) and Sambo (2005). The school chosen was not part of the population of the study. The subjects used were the SS II students studying biology. The purpose of this pilot study was to determine the characteristics of the test items which include their difficulty and discrimination indices as well as the reliability coefficient**.** Forty students participated in the pilot study. The result of the pilot study was used to:

i. Determine the number of weeks that would be suitable for conducting the study.
ii. Determine difficulties if any, in the activities set for the students.
iii. Determine the amount of materials that would be required to effectively teach the subjects during the main study.
iv. Assess the clarity of the items of the BPT.
v. Calculate the reliability coefficient of BPT.

Also the facility indices and difficulty indices were determined using the scores of the students. The following amendments were thus made based on the findings of the pilot study:

i. The period of treatment for the main study was adjusted because it was found that students needed more time to get used to the new instructional strategy at the initial stage.
ii. The last week (week 6) of the treatment was dedicated for revision and the administration of the test instrument (BPT).

3.5.4 Reliability Coefficient of the Instrument using the PPMC

The data generated from the pilot study were used to determine the reliability coefficient of the instrument Biology Performance Test (BPT) test items. The test and retest method with the interval of 2 weeks in line with Tuckman (1975) and Sambo (2005) recommendation was used.Pearson's Product Moment Correlation Coefficient statistic was used for analysis in which the Correlation Coefficient r-value of 0.84 was recorded. This shows that the instrument is highly reliable for data collection in this study. In addition the reason why this study employed Pearson's Product Moment Correlation Coefficient (PPMC) formula on the scores obtained from the pilot study according to Olayiwola (2007) is that the PPMC formula is found to be particularly useful to teachers and it is always applicable when items are in multiple response form. The detailed calculation using SPSS Statistical Software (version 17.0) is shown in Appendix VI. Using this software a reliability, r= 0.84 was obtained.

3.5.5 Item Analysis of BPT

Item analysis was carried out on the data generated from the pilot study in order to determine the facility index of the items. The Facility Index (FI) of a test according to Wiseman (2002) is the percentage of candidates/students that got an item right. It is determined by using the formula: FI = R/T

Where R = number of correct responses

T = total number of students

Wiseman (2002) recommended values within the range of 0.30 to 0.70 for good test item values in assessing performance. For the present study 0.30 to 0.65 was chosen for the study. After the analysis, all items with difficulty indices below 0.2 were discarded as being too difficult while those with indices of 0.20 to 0.50 were selected for the final BPT instrument with some modification or reframing. Items with indices of 0.30 to 0.65 were selected without any modification while those with indices above 0.65 were modified and accepted. Details of the selection are contained in appendix 8 at the end of this report.

The summary of the items selected after the analysis is given thus:

Items selected without modification:

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 25, 26, 28, 29, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50.

The items selected with modifications are: 27, 31, and 32.

3.5.6 Table of Specification based on Bloom's Taxonomy.

A table of specification based on Cognitive Structure according to Bloom's Taxonomy of Educational objectives was constructed for the generation of the BPT items. This covered all the topics within the content area. This Table is shown in Figure 3.4

Table 3.4 Table of Specification

Objective/ Content	Weight (percentage)	Knowledge **26**	Comprehension **28**	Application **18**	Analysis **10**	Synthesis **08**	Evaluation **10**	Total **100**
Taxonomy Of plants	38	05	05	02	01	03	03	19
Exchange of Gases in plants	02	-	-	01	-	-	-	01
Transpiration	18	02	03	01	01	01	01	09
Pollination	18	03	02	01	01	01	01	09
Autotrophic nutrition	24	03	03	02	01	02	01	12
Total	**100**	**13**	**13**	**07**	**04**	**07**	**06**	**50**

Source: (Adapted from Mudasiru (2010)).

The weighting was assigned to each content primarily based on the area ofcoverage, work load and time involved. The topics (Taxonomy of plants, gaseous exchange in plants, transpiration, pollination and autotrophic nutrition) were used for this study because the researcher can easily use them to teach using the Computer-Assisted Instruction, Science Process Approach and the Lecture Method. The items on the research instrument (Biology Performance Test) centred on the cognitive aspect of Bloom's taxonomy hence the Table of Specification was used in order to ensure that all the aspects of cognitive test (knowledge, comprehension, application, analysis, synthesis and evaluation) as itemized by the Bloom's

Taxonomy of Educational objectives were fully covered by the research instrument.

3.6 Instructional Procedure.

Three instructional strategies were used for this study, these are:

1. Computer-Assisted Instructional Strategy (CAI).
2. Science Process Approach Instructional Strategy (SPA).
3. LectureMethod Instructional Strategy (LM).

Computer-Assisted Instructional Strategy (CAI).

The students in the Experimental Group 1 learnt the following topics; Taxonomy of Plants, Gaseous exchange in Plants, Transpiration, Pollination and Autotrophic Nutrition using a Computer Software that was developed by the researcher. This Computer Software was developed using the Microsoft PowerPoint Slides, the topics were aligned sequentially from simple to complex using the Microsoft slides. The students learnt the topics in a gradual manner using the slides. The Individualized Computer-Assisted Instruction was used where each student was given a computer system that was used to aid the learning process. The researcher discussed the findings of the students in order to ensure that the objective of this study was not derailed. The findings of the researcher after the evaluation revealed that the students actually learnt what they are supposed to learn. Summary of this learning is presented in Figure 3.2

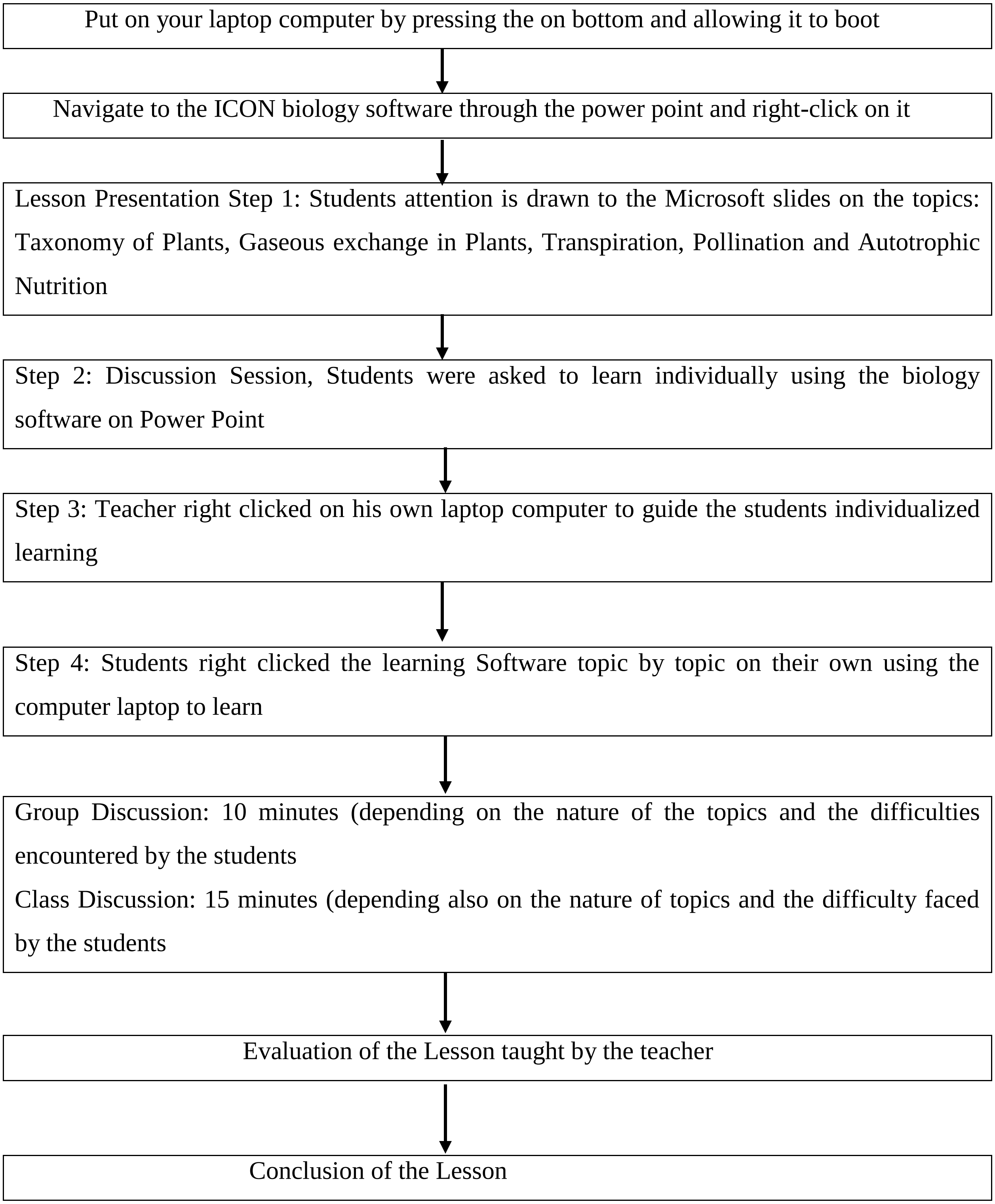

Figure 3.2, Treatment Flowchart of Experimental Group 1, Computer-Assisted Instruction using the laptop.

Source: Serkan D. (2015).

Science Process Approach Instructional Strategy (SPA).

The students in the Experimental Group 2 learnt the same topics, that is, Taxonomy of Plants, Gaseous exchange in Plants, Transpiration, Pollination and Autotrophic Nutrition using the Science Process Approach. According to Mari (2001), the commission on science education of the American Association for the Advancement of Science (AAAS) has identified 11 process skills which are considered to be representative of problem solving activity. These process skills are categorized into two groups depending on their complexity. These are the Basic Process Skills considered to be simple and the Integrated Process Skills which are complex. Summary of these process skills is given in Table 3.5

Table 3.5 Summary of Science Process Skills

Basic Process Skills	Integrated Process Skills
• Observing	Interpretation of data
• Measuring	Controlling variables
• Inferring	Defining Operationally
• Predicting	Formulating hypotheses
• Classifying	Experimenting
• Collecting and recording	

Source: (Mari, 2001).

Five process skills were used in this study out of the eleven process skills outlined by the American Association for the Advancement of Science. Out of these five process skills, three were basic skills (observing, classifying, collecting and recording) while the other two were the integrated process skills (experimenting and controlling of variables). The students acquired these science process skills through the biology laboratory activities in the course of this study. The findings of the researcher after the evaluation revealed that the students acquired the process skills that they are supposed to acquire. Summary of this learning is presented in Figure 3.3

The teacher reviewed the students Prior Knowledge on Observation, Classification, Collection and Recording, Experimentation and the Control of Variables

↓

Lesson Presentation Step 1: Students attention was drawn to the use of the basic process skills (Observation, Classification, Collection and Recording) to learn using the Specimens given as specified in the Lesson Plan

↓

Step 2: Students were instructed to use the Integrated Process Skills, that is, Experimentation to carry out 2 experiments. These are Experiment to show the process of Transpiration and the Experiment to test a leaf for starch produced during photosynthesis

↓

Step 3: Using the Experiment 1 and 2 above, the students learnt how to control some variables like temperature, relative humidity, light, water supply, use of reagents among others

↓

Step 4: Teacher moved around the laboratory in order to guide the students learning

↓

Group Discussion: 15 minutes (depending on the nature of the practical work and the difficulties faced by the students)
Class Discussion: 20 minutes (depending on the nature of the practical work and difficulties encountered by the students)

↓

Evaluation of the laboratory activities

↓

Conclusion of the Lesson

Figure 3:3 Treatment Flowchart of Experimental Group 2, Science Process Approach Instructional Strategy.

Source: Mari (2001).

Lessons notes were prepared to teach the selected concepts of SS II biology (appendices iii, iv, and v). The experimental group 1 was taught the biology concepts using the CAI; experimental group 2 was taught the same concepts using SPA while the control group was taught the same concepts using the LM. The study was conducted during the first six weeks of the second term. Before the commencement of the treatment, the students in the two experimental groups and the control group were given the performance test as pretest in order to determine their group equivalence and based on this they were classified into ability levels as Low, Medium and High. This treatment lasted for six weeks.

3.7.1 Administration of Treatment to EG 1

The teaching of the concepts of biology to the EG 1was done by the researcher. This was to ensure effective utilization of the computers and also to ensure that the teaching procedure was in conformity with the direction of the objectives. The teacher bias that might arise as a result of using research assistants was overcome. The first lesson in the classes was for revision and familiarization of the researcher with the students and at the same time revising the previous related work. The teaching lasted for a period of six weeks at the rate of two hours per week.

3.7.2 Administration of Treatment to EG 2

The EG 2 was taught the same concepts of SS II biology by the researcher but using the Science Process Approach Instructional Strategy. The teaching of biology to EG 2 was done by the researcher in order to eliminate any bias that may arise when research assistants are used. The teaching lasted for a period of six weeks at the rate of two hours per week.

The students in the experimental groups 1 and 2, including the control group were stratified on the basis of ability levels and gender. The stratum of the ability levels in the experimental group 1 is as follows: high ability = 17, medium ability = 17, low ability = 17 and based on gender (boys = 30 and girls = 21), the stratum of the ability levels in the experimental group 2 is as follows: high ability = 17, medium ability = 17, low ability = 17 and based on gender (boys 30 and girls 21). On the other hand the stratum of the ability levels in the control group is as follows: high ability = 17, medium ability = 17, low ability = 17 and based on gender (boys = 30 and girls = 21). The assessments of members of these sub-groups were done using the result of the pretest as a guide. The grouping of the students based on their ability levels in the EG 1, EG 2 and CG was based on the results of the pretest. Each ability group included members that scored high, average and low marks in the pretest. This was to ensure an even distribution in terms of their level of performance. The researcher used one lesson to acquaint the students in the experimental group 1 and 2 with the objectives of the constructivist's instructional strategy. The experimental group 1 was exposed to biology instruction using the CAI while the experimental group 2 was exposed to biology instruction using the SPA. This comprised of computer individualized instruction for EG 1 and science process approach for EG 2, discussions were also used. Each session started with brain storming questions aimed at high lighting the existence and nature of competing viewpoints. The students were allowed to explore the concepts in question through computer instruction, practical activities and problem solving in small group discussions. In the exploration session, they were asked focusing questions that were meant to lead them to observe and discuss their experiences. This is with a view to stimulate the students to articulate the inconsistencies and discrepancies between the phenomenon under consideration and their own previously held ideas.

The control group was taught the same concepts of biology by the researcher using the lecture method of instruction. They were exposed to the teaching using the lecture method for a period of six weeks of 2 hour lectures per week. The teaching notes prepared by the researcher and validated by panel of educationists were strictly adhered to in the teaching of the control group (see Appendix 6). The lessons were presented by lecture method with important points written on the chalk board. Notes were given to the students after each teaching period. The students were referred to relevant biology text books (Modern Biology and Practical Biology by Iloeje) for more information. Written assignments were given to the subjects after each lesson. The entire teaching lasted for a period of six weeks. A posttest was administered to the groups (EG 1, EG 2 and CG) in the last week of the treatment (week 6).

The same test was re-administered as postpost test after two weeks from the date of the last test. The different scores obtained during pretest, posttest and postpost test were used for data analysis.

3.8 Data Collection Procedure

The data were collected through the research instrument called the Biology Performance Test (BPT). Three types of data were collected during this research work. These are:

- Pretest(to ascertain their group equivalence and ability levels (low, medium and high).
- Posttest (to ascertain their performance level).
- Postpost test (to ascertain their retention level).

3.9 Procedure for Data Analysis.

The responses of the students in the Biology Performance Test (BPT) were scored using the marking guide shown in Appendix II. Each correct response was scored one point with a maximum score of 50 marks. Probability level at $P \leq 0.05$ was used for retaining or rejecting the stated null hypotheses. The null hypotheses are re-stated below and the statistical analysis to be used as follows:

HO_1 There is no significant difference in the academic performance of secondary school students taught biology concepts using the Computer-Assisted Instruction and their counterparts taught the same concepts using Science Process Approach teaching strategy and Lecture Method.

One Way ANOVA was used to test this hypothesis because the observed variance in this variable is partitioned into three components, these are: (CAI, SPA and LM).

HO_2 There is no significant difference in the mean academic achievement scores of secondary school students taught biology concepts using Computer-Assisted Instruction,Science Process Approach and Lecture Method with varied learning abilities (high, medium and low).

Two Ways ANOVA was used to test this hypothesis because the observed variance in this variable is partitioned into nine components, these are: CAI (H, M, L), SPA (H, M, L) and LM (H, M, L).

HO_3 There is no significant difference in the retention ability of secondary school students taught biology concepts using Computer-Assisted Instructional strategy, Science Process Approach and Lecture Method.

One Way ANOVA was used to test this hypothesis because the observed variance in this variable is partitioned into three components, these are: (CAI, SPA and LM).

$H0_4$ There is no significant difference in the academic achievement of male and female secondary school students taught biology concepts using the Computer-Assisted Instructional Strategy, Science Process Approach and Lecture Method.

Two –Ways ANOVA was used to analyze this data because the observed variance in this variable is partitioned into six components, these are: CAI (male and female), SPA (male and female) and LM (male and female).

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

Data collected for this study were statistically analyzed in this chapter. The posttest and Postpost test scores obtained were processed using the Statistical Package for the Social Science (SPSS), 17th edition. Means and Standard Deviations of the analysis were used for answering the research questions while the hypotheses were tested using analysis of Variance (ANOVA). The demographic/descriptive information of the subjects engaged in the study was also analyzed.

4.2 Demographic Characteristics of Respondents

A total of 153 SS II Biology students were used for the study. The experimental sample for EG 1 and EG 2 is (N=102), consisted of 60 boys and 42 girls. The strata of the ability levels in the experimental groups 1 and 2 are: EG 1 (H=17, M=17 & L=17) = 51. EG 2 (H=17, M17 & L=17) = 51. The control stratum (N=51) on the other hand consisted of 30 boys and 21 girls. The stratum of their ability levels in the control group is high=17, medium=17 and low= 17. In terms of gender the sample has 90 boys and 63 girls. The distribution of the subjects by group, gender and treatment preferences is given in Table 4.1

Table 4.1: Distribution of Subjects by Groups, Gender and Treatment Preferences.

Group	N	Sex		Treatment Preferences		
		Male	Female	CAI	SPA	LM
EG 1	51	30	21	51	_	_
EG 2	51	30	21	_	51	_
CG 51	30	21 _	_	51		
Total	**153**	**90**	**63**			

Table 4.1 shows that out of the 153 SS II Biology students used for this study, 90 of them were boys while 63 were girls. 51 of the students were used for the EG 1 (CAI), 51 students were also used for the EG 2 (SPA) while 51 of the students were also used for the CG

(LM). The distribution helps to throw light on the number of subjects used in the main study (performance and retention) and sub-groups (ability levels and gender) of the study.

Table 4.2: Distribution of Subjects based on their Ability Levels

Ability Levels	High	Medium	Low
EG 1 (CAI)	17 17	17	
EG 2 (SPA)	17	17	17
CG (LM)	17 17	17	
Total	**51**	**51**	**51**

Table 4.2 shows that out of the 153 students used to test their performance based on ability levels, 51were in high ability stratum, 51 medium ability and 51 low ability.

4.3 Data Analysis and Results Presentation

Three types of data were generated using the BPT. These are:

i. Pretest data to determine the group equivalence and ability levels of EG 1, EG 2 and the CG

ii. Post test data to determine the performance after instruction

iii. Postposttest data to investigate retention ability of the subjects under study

In the following paragraphs, these data were analyzed and used to answer the research questions and also test the corresponding null hypotheses.

Research Question 1

Is there any difference in the academic performance of secondary school students taught biology using Computer-Assisted Instruction, Science Process Approach and Lecture Method Instructional Strategies?.

To answer this question, descriptive statistics were used. Means and standard deviations of students post test scores were calculated and used to draw Table 4.3a

Table 4.3a: Means and Standard Deviations of Students Posttest Scores in Biology in the Experimental and Control Groups

Group	N	Mean	SD	SE	MD
Exp. Group 1 (CAI)	51	38.73	3.13	0.43	
					0.16
Exp. Group 2 (SPA)	51	37.62	3.13	0.43	
					0.16
Control Group (LM)	51	25.88	4.24	0.59	

SD: Standard Deviation; SE: Standard Error and MD: Mean Difference.

Note: MD= SE (LM) – SE (CAI & SPA).

It can be seen from Table 4.3a that EG 1 exposed to CAI has a mean score of 38.73, EG 2 exposed to SPA has 37.62 while CG exposed to LM has a mean score of 25.88. This means that the students exposed to CAI and SPA performed higher than those exposed to LM. It is empirically established that EG 1 and EG 2 students exposed to CAI and SPA respectively performed higher than their counterparts in the CG. This finding answers research question 1.

In order to establish if the difference is statistically significant inferential statistics was used to test the null hypothesis.

Hypothesis 1

There is no significant difference in the academic performance of secondary school students taught biology using the Computer-Assisted Instruction and their counterparts taught the same concepts using Science Process Approach teaching Strategy and Lecture Method.

To test HO_1, One Way Analysis of Variance (ANOVA) was used. Summary of the analysis are shown in Table 4.3b.

Table 4.3b: Results of One-Way Analysis of Difference in Performance of the Experimental and Control Groups.

Source of Variation	Sum of Squares(SS)	DF	Mean Square(MS)	F	PR
Between Groups	5267.231	2	2633.615	210.321	.001S
Within Groups	1915.846	153	12.522		
Total	7183.077	155			

Significant at P≤0.05

From Table 4.3b, the result shows that the P value 0.001 observed is less than the alpha P value of 0.05 at df 2,153. Since the P value observed (0.001) is less than 0.05 the difference is significant. Therefore the null hypothesis which says: There is no significant difference in the academic performance of secondary school students taught biology using the computer-assisted instruction and their counterparts taught the same concepts using science process approach teaching strategy and lecture method is rejected. Since the observed P value is less than P≤0.05 level of significance, this suggests that there exist evidence to conclude that there is a significant difference among the teaching methods. To indicate the groups that show significant difference, a post hoc Scheffe's test was used and the result is presented in Table 4.3c

Table 4.3c: Results of Scheffe's Multiple Comparisons of Posttest Performance Scores of Experimental and Control Groups.

Dependable Variable	Treatment		Mean Difference	Std. Error	P	Remark
Achievement	CAI	CAI	1.115	.694	.278	NS
		LM	11.731	.694	.001	S
	SPA	SPA	1.115	.694	.278	NS
		LM	11.731	.694	.001	S
	LM	LM	11.731	.694	.001	S

Significant at P≤0.05 Level

From Table 4.3c P value observed for EG 1 (CAI) is 0.278, EG 2 (SPA) is also 0.278, this value is higher than the P value of LM which is 0.001. This shows that the CAI and SPA treatment have produced statistically significant effect on the performance of the experimental groups 1 and 2 against the control group. Therefore the null hypothesis 1 is rejected at P≤0.05.

Research Question 2

What is the effect of Computer-Assisted Instruction, Science Process Approach and Lecture Method on academic performance in biology among secondary school students with varied learning abilities (high, medium & low).

To answer this question, descriptive statistics were used. Means and Standard Deviation of the posttest scores based on varied abilities were calculated and used to draw Table 4.4a.

Table 4.4a: Means and Standard Deviations of the Posttest Scores of the High, Medium and Low Ability Groups Exposed to CAI, SPA and LM Instructional Strategies

Level	Group	N	Mean	SD	MD
High	CAI	17	39.12	1.616	0.17
	SPA	17	39.12	1.616	0.17
	LM	17	39.24	1.78617	
Medium	CAI	17	38.12 2.342171.27		
	SPA	17	38.12 2.342171.27		
	LM	17	33.82 3.61017		
Low	CAI	17	37.12	2.0882.19	
	SPA	17	37.12 2.0882.19		
	LM	17	24.59 4.273		

It can be seen from Table 4.4a that the performance level of high, medium and low abilities students exposed to CAI is (H=39.12, M=38.12, L=37.12) and SPA (H=39.12, M=38.12, L=37.12). This indicated slight difference in their mean scores. However in the LM (H=39.12, M=33.82, L=24.59), high, medium and low showed some difference in their mean scores, that is the high performed highest, medium higher and low high. This answered the research question 2.

In order to establish if the difference is statistically significant, inferential statistics was used to test the null hypothesis.

Hypothesis 2

There is no significant difference in the mean academic performance scores of secondary school students taught biology with varied abilities (high, medium and low) using the Computer- Assisted Instruction, Science Process Approach and Lecture Method.

To test HO_2, Two-Ways Analysis of Variance (ANOVA) was used to analyze the post-test performance scores of the 9 groups. This provided the means of testing the null hypothesis 2. Summary of the analysis is shown in Table 4.4b

Table 4.4b: Results of Two-ways Analysis of Variance to Determine the Performance Abilities of High, Medium and Low Students Exposed to CAI, SPA & LM.

Source of Variation	Type 111 Sum of Squares(SS)	DF	Mean Square(MS)	F	P	Remark
Corrected Model	2987.307	8	373.413	56.588	.001	S
Intercept	201178.458	1	201178.458	30486.868	.001	S
Level	998.993	2	499.497	75.694	.001	S
Group (CAI & SPA)	1054.327	2	527.163	79.887	.001	S
Level2 Group(L M)	933.987	4	233.497	35.384	.001	S
Error	950.235	144	6.599			
Total	205116.000	153				
Corrected total	3937.542	152				

Significant at P≤0.05

From the results in Table 4.4b, it is clear that the P value observed for the CAI, SPA and LM is 0.001 which is less than the alpha P≤0.05. This shows significant difference in the academic performance of the subjects with high, medium and low abilities exposed to CAI, SPA and LM respectively. However, the observed difference was based on their abilities level. It was observed that the high group performed highest, the medium group higher and the low group high with the exception of the low group in the LM which performed fairly good. Therefore the null hypothesis which predicted no significant difference in the performance of the high, medium and low abilities exposed to CAI, SPA and LM is rejected. The direction of significant difference was again determined using the Scheffe's test of multiple comparisons. These results were shown in Table 4.4c.

Table 4.4c: Results of Scheffe'sMultiple Comparisons Posttest Performance Scores of High, Medium and Low Abilities Students Exposed to CAI, SPA and LM

Scheffe Test	Level I	Level J	Mean difference (I – J)	Std. Error	P	Remark
	High	Medium	2.47	.509	.001	S
		Low	6.22	.509	.001	S
CAI	Medium	High	2.47	.505	.001	S
		Low	3.75	.509	.001	S
	Low	High	6.22	.509	.001	S
		Medium	3.75	.509	.001	S
	High	Medium	2.47	.509	.001	S
		Low	6.22	.509	.001	S
SPA	Medium	High	2.47	.509	.001	S
		Low	3.75	.509	.001	S
	Low	High	6.22	.509	.001	S
LM		Medium	3.75	.509	.001	S

Mean difference is significant at P≤0.05 level

Table 4.4c showed the observed P value of 0.001 for the abilities group (H, M, L) for the CAI, SPA and LM, this is less than the alpha P value of 0.05. This revealed that significant differences exist among the nine groups (CAI= H, M, L; SPA H, M, L & LM H, M, L). Between CAI and LM, the difference is in favour of CAI, between SPA and LM the difference is in favour of SPA. This means that on either side the high, medium and low abilities in CAI and high, medium and low abilities in SPA that is the EG 1 and EG2 performed better than their counterparts in the control group. The scores of CAI (high=39.12, medium=38.12, low 37.12), while that of SPA (high=39.12, medium=38.12 and low 37.12), these are higher compared to the LM (medium=33.82 and low 24.59). Note that, the analyzed results revealed that there was significant difference in the performance of the high ability students exposed to CAI, SPA and LM. hence the null hypothesis 2 is rejected.

Research Question 3

Is there any difference in the retention ability of secondary school students taught biology using computer-assisted instruction, science process approach and lecture method?.

To answer this question, descriptive statistics were used. Means and standard deviations of the postpost test scores were calculated and used to draw Table 4.5a.

Table 4.5a: Mean and Standard Deviation of Students Retention Ability Scores in Biology in Experimental and Control Groups

Group	N	Mean	SD	SE	MD
Exp. Grp. 1(CAI)	51	37.73	3.267	.453	.02
Exp. Grp. 2 (SPA)	51	37.77	2.579	.358	.07
Control Grp. (LM)	51	28.06	2.585	.430	

In Table 4.5a that EG 1 exposed to CAI has a mean score of 37.73; EG 2 exposed to SPA has 37.77 while the CG exposed to LM has a mean score of 28.06. This means that the students exposed to CAI and SPA retained higher the learnt biological concepts compared to the subjects in the LM. It is empirically established that EG 1 and EG 2 students exposed to CAI and SPA retained the learnt concepts higher than their counterparts exposed to the LM. This finding answers the research question 3.

In order to establish if the difference is statistically significant inferential statistics was used to test the hypothesis.

Hypothesis 3

There is no significant difference in the retention ability of secondary school students taught biology using the computer-assisted instruction, science process approach and lecture method.

To test $HO_{3,}$ One- Way Analysis of Variance (ANOVA) was used. Summary of the analysis are shown in Table 4.5b.

Table 4.5b: Results of One-Way Analysis of Variance in Retention Level of the Experimental and Control Groups.

Source of Variation (Retention)	Sum of Squares (SS)	DF	Mean Squares (MS)	F	P	Remark
Between Groups	3256.654	2	1628.327	203.493	.001	S
Within Groups	1224.288	153	0.002			
Total	4480.942	155				

Significant at P≤0.05 Level.

In Table 4.5b, the result showed that atdf 2,153 and P- value at alpha level 0.05 is greater than the significant level of 0.001 observed. This means that there are significant differences in the Postpost test performance mean scores of the three groups. By extension, it implies that the students taught using CAI and SPA instructional strategies retained the learnt concepts higher compared with their counterparts taught the same concepts using the LM. Therefore the null hypothesis 3 of no significant effect of CAI, SPA and LM retention level is rejected.

Similarly, to determine the direction of significance difference in retention level of the students in the three groups, a multiple comparison (post-mortem analysis) was carried out on the Postpost test performance scores using the Scheffe's test. The results are presented in Table 4.5c

Table 4.5c: Results of Scheffe's Multiple Comparison Test of Postposttest Retention Scores of Experimental and Control Groups

Dependable Variable	Treatment		Mean Difference	Std	P	Remark
Retention	CAI	CAI	0.038	.555	.998	NS
		LM	9.673	.555	.001	S
	SPA	SPA	0.038	.555	.998	NS
		LM	9.712	.555	.001	S
		LM	9.712	.555	.001	S

Significant at P≤0.05 Level

From Table 4.5c, the P value of the students exposed to CAI and SPA is 0.998 which is greater than the alpha P≤0.05 which indicates no significant difference in the retention abilitiesof the students exposed to CAI and SPA. However, the observed P value of the students exposed to LM is 0.001 which is less than the alpha P≤0.05 which indicates significant difference. This implies that CAI and SPA had significant effect on the retention level of the subjects in EG 1 and EG 2 which is in disparity with the CG (LM). Hence the null hypothesis 3 is rejected.

Research Question 4

What is the difference in the posttest mean scores of male and female students taught biology using computer-assisted instruction, science process approach and lecture method?.

To answer this question, descriptive statistics were used. Means and standard deviation of the posttest scores were sorted according to gender and used to draw Table 4.6a

Table 4.6a: Means and Standard Deviations of Male and Female Post test Performance Scores Exposed to CAI, SPA and LM

Group	Sex	N	Mean	SD	MD
Exp. Group 1(CAI)	Male	23	38.52	2.086230.61	
	Female	23	37.83	2.570230.21	
Exp. Group 2 (SPA)	Male	23	38.09	2.429	0.54
	Female	23	38.30	2.4580.32	
Control Group (LM)	Male	23	35.78	2.969	
	Female	23	36.00	2.780	

From Table 4.6a**,** the mean of CAI is 38.52 for male and 37.83 for female. In SPA the mean for male is 38.09 while that of female is 38.30 and in the LM the mean for the male is 35.78 while that of the female is 36.00. This result clearly shows that there is no difference in the academic performance of male and female students exposed to CAI, SPA and LM. In other words, these three methods of teaching are gender friendly. This answered the research question 4.

In order to determine the existence or otherwise of significant differences among the male and female academic performance exposed to CAI, SPA and LM, Two- Ways Analysis of Variance (ANOVA) was performed on the posttest performance scores of EG 1, EG 2 and CG. This provided a platform for answering the corresponding hypothesis 4 (HO_4) which is re-stated below.

Hypothesis 4

There is no significant difference in the academic performance of male and female students taught biology using the Computer-Assisted Instruction, Science Process Approach and Lecture Method.

To test $HO_{4,}$ Two-Ways Analysis of Variance (ANOVA) was used. Summary of the analysis are shown in Table 4.6b

Table 4.6b: Results of Two- Ways ANOVA for Test between Male and Female Academic Performance exposed to CAI, SPA and LM.

Source of Variation	Sum of Squares (SS)	DF	Mean Squares (MS)	F	Sig.	Remark
Corrected Model	167.971	5	33.594	5.111	.001	S
Intercept	193238.377	1	193238.377	29398.262	.001	S
Group 2	161.319	2	80.659	12.271	.001	S
Sex	0.261	1	0.261	0.040	.842	NS
Group 2 Sex	6.3196	23.196	0.486	0.616	.842	NS
Error	867.652	132	6.573			
Total	194274.000	138				
Corrected total	1035.623	137				

Significant at P≤0.05 Level.

From the Result in Table 4.6b, it is clear that the observed P value under sex (gender) is 0.842. This value is greater than the alpha P≤0.05, which means that there is no significant difference in the academic performance of male and female students exposed to CAI, SPA and LM instructional strategies. Therefore, the null hypothesis 4 which predicted no significant difference in the academic performance of male and female students exposed to CAI, SPA and LM is accepted. The direction of significant difference was again determined using the Scheffe's test of multiple comparisons. The results are shown in Table 4.6c.

Table 4.6c: Results of Scheffe's Multiple Comparisons of Posttest Performance Scores of Male and Female Students Exposed to CAI, SPA and LM.

Scheffe Test Difference	Group	Gender	Mean	Std.	Sig	Remark
	CAI	Male	1.11	.69	.27	NS
		Female	1.12	.69	.27	NS
	SPA	Male	1.11	.69	.27	NS
		Female	1.22	.69	.27	NS
	LM	Male	1.11	.69	.27	NS
		Female	1.13	.69	.27	NS

Significant at P≤0.05 Level.

The results in Table 4.6c revealed thatthe observed P value is 0.27 which is greater than the P≤0.05 alpha level of significance.This indicated no significantdifferences exist in the academic performance of male and female students exposed to CAI, SPA and LM. This means that the three methods of instruction are gender friendly; hence the null hypothesis 4 is accepted.

4.4 Summary of Findings

1. There is no significant difference in the academic performance of students exposed to CAI and SPA instructional strategies but there is significant difference in the academic performance of those students exposed to the traditional lecture method.

2. There is no significant difference in the mean academic performance scores of secondary school students taught biology with Low Ability, Medium Ability and High Ability using the CAI and SPA but there is significant difference in the mean academic performance scores of secondary school students taught biology concepts with Low Ability, Medium Ability and High Ability using the LM in favour of the High and Medium Ability categories.

3. There is no significant difference in the retention ability of secondary school students taught biology using Computer Assisted Instruction and Science Process Approach instructional strategies but there is significant difference in the retention ability of secondary school students taught biology concepts using the Lecture Method.

4. There is no significant difference in the academic performance between male and female secondary school students taught biology using the Computer Assisted Instructional strategy.

5. There is no significant difference in the academic performance between male and female secondary school students taught biology using the Science Process Approach instructional strategy.

6. There is no significant difference in the academic performance between male and female secondary school students taught biology concepts using the traditional lecture method of instruction.

7. No gender difference existed in the academic performance among secondary school students exposed to CAI, SPA and LM. That is CAI, SPA and LM instructional strategies are gender friendly.

4.5 Discussion of Results.

This study investigated the impact of Computer-Assisted and Science Process Instructionson Retention and Performance in Biology among Varied Abilities Secondary School Students in Kaduna, Nigeria. To achieve this purpose, the students in the Experimental Group 1 (CAI) were taught Biology using the Computer-Assisted Instructional strategy. Subjects in the Experimental Group 2 (SPA) were taught the same concepts using the Science Process Approach and the subjects in the Control Group (LM) were taught the same concepts but using the traditional lecture method of instruction. The three groups (E.G.1, E.G.2 and C.G.) were pre-tested, post testedand Postpost tested where their academic performance were compared according to the variables being measured. The data generated from the administration of the instrument, namely Biology Performance Test (BPT) were analyzed according to the demands of the hypotheses and the analysis was carried out using the SPSS Statistical Package Version 17.0. The findings were summarized in 4.4 and are consequently discussed in this section.

The result from Table 4.3 shows that the subjects in the Experimental Group 1 (CAI) and Experimental Group 2 (SPA) who were taught biology using the Computer-Assisted Instruction and Science Process Approach respectively performed significantly better than their counterparts in the Control Group (CG) who were taught the same concepts but using the traditional instructional method (LM). The significant difference in performance in favour of the Experimental Group 1 and Experimental Group 2 suggests a greater effectiveness of the CAI and SPA instructional strategies over the lecture method of instruction.

This finding is in conformity with those of Bichi (2002), Nwafor (2007) and Lawal (2009) who reported the usefulness of the approach in students' academic performance of Biology concepts. This finding also agree with earlier findings of Mari (2001) in Chemistry, Etukudo (2002) in Chemistry conducted in Nigeria which confirmed that SPA has been effective in enhancing students' academic performance in other subjects than the conventional classroom instruction. The findings is also supported by the findings of Bunkure (2012) in Physics and Mudasiru (2010) in Biology conducted in Nigeria which confirmed that CAI has been effective in promoting students' academic performance than the conventional classroom lecture method of instruction. The superiority of the strategy over the traditional teaching method has also been reported by Owolabi (2002) who compared the effectiveness of the strategies with the traditional methods in the teaching of Physics.

The effectiveness of CAI and SPA teaching approaches may be attributed to the pattern of the instruction itself which is constructivist in nature and learner-centered which thus provide a variety of activities for the students to control their actions in the process of learning. The relatively poor performance of students in the control group in Biology Performance Test (BPT) is an indication that the lecture method adopted in teaching Biology by science teachers is not quite effective in promoting meaningful learning in Biology. This is supported by the observation of Owolabi (2006) that meaningful learning takes place when teaching is structured alongside instructional strategies that promote active participation of students in the learning process.

The result of this study is also an indication that students of all ability groups perform significantly better in class rooms where CAI and SPA teaching strategies are used. This finding is in agreement with those of Chinwe (2009), Wilkinson and Townsend (2002) who independently reported that good teaching strategy can circumvent problems with low ability groups while maintaining high performance with the high achievers. It can thus be inferred from the result of the present study that low performance among low ability students can be remedied by exposing them to CAI and SPA instructional strategies. The findings from this study indicated that CAI and SPA instructional strategies can enhance academic performance among students of all ability levels. It also shows that teaching through CAI and SPA instructional strategies can influence students in a given ability group to achieve significantly better than others of the same group taught via traditional lecture method.

The results (Table 4.4) from testing null hypothesis 2 showed that there is no significant difference in the mean academic performance scores of students with respect to ability grouping (high, medium and low ability groups) when taught Biological concepts using the CAI and SPA instructional strategies. The insignificant difference between the three mean scores of CAI and SPA: CAI High 39.12, Medium 38.12 and Low 37.12. SPA: High 39.12, Medium 38.12 and Low 37.12 obtained for High, Medium and Low ability students respectively suggests that the CAI and SPA instructional strategies led to more effective learning of Biological concepts than the traditional lecture method of instruction. The summary of the differences of the three ability groups with respect to academic performance using the 2 Ways ANOVA test showed no significant difference in the academic performance of the three groups of students in the CAI and SPA. Thus, revealing the effectiveness of the strategies. The findings of this research agreed with those of Allania (2005) and Anaso (2008) who independently compared the academic performance of students in ability based and mixed ability groups in science and reported a higher students' academic performance when exposed to Physics instruction using the CAI and SPA instructional strategies.

The result from testing hypothesis 3 showed that there is no significant difference in the retention ability of secondary school students taught biology using the CAI and SPA instructional strategies using the postpost test result but there is significant difference in the retention ability of students taught using the LM instructional strategy using the postpost test result (see Table 4.4). The results as shown in the table reveals that students in CAI and SPA academically performed nearly equal in the postpost test performance test thus retained the taught concepts. This however is not the same with the students taught using the lecture method of instruction where their retention ability is lower compare to the CAI and SPA according to postpost test performance result. The result agrees with the earlier findings of Bichi (2002) and Lawal (2009) who also reported the effectiveness of a constructivist approach when they both investigated the effects of constructivist instructional approaches on the academic performance and retention of Biology concepts taught to senior secondary school students. The findings further suggest that the CAI and SPA instructional strategies led to more effective learning and higher retention ability than the traditional lecture method.

The insignificant difference in the retention of biology using the CAI and SPA in this study could be linked to the instructional strategies used; these are the CAI and SPA constructivist instructional strategies. These strategies (CAI and SPA) provide for active learning process in which the students had to think hard to solve the given problems as a result of which meaningful learning resulted. Blair et al (1986) in Bunkure (2012) believe that meaningful learning improves retention while confusion or interference decreases the speed and efficiency of learning and accelerates forgetting. Studies on retention and instructional strategies seem to agree that those instructional strategies that are characterized by active learning such as CAI and SPA instructional strategies yield permanent and meaningful learning that is readily retained and remembered at will by the learner. Ausubel et al (1978), Adeniyi (1997) and Oyedokun (1998) in Bunkure (2012). Hence the need for science teachers to emphasize constructivist strategies in the teaching of science.

Null Hypothesis 4 centered on gender-related differences in the academic performance in relation to the variables of the study. The results showed that there was no significant difference between the posttest means scores of male and female subjects using the CAI, SPA and LM. CAI : Male 38.52, Female 37.83; SPA: Male 38.09, Female 38.30 and LM: Male 35.78, Female 36.00 (Tables 4.5 to 4.7 confirmed these). With reference to gender when traditional teaching method was used. Thus the CAI, SPA and LM constructivist instructional strategies favour both male and female subjects equally in the learning of Biology. The fact that no disparity existed in the academic performance of the male and female subjects, that is neither the male nor the female performed significantly better than the other seem to make the methods (CAI, SPA and LM) gender friendly. These findings of no significant difference in academic performance of boys and girls taught using constructivist instructional strategy is supported by the findings of Eya and Mgbo (1997), Samba (1998), Oyedokun (1998), Lakpini (2006) and Maikano (2007).

Also Olorukooba (2001) found in her study that using cooperative instructional strategy which is also constructivist-based to teach secondary school students chemistry helped them to improve on their academic performance. Therefore the findings of this study revealed that when a good instructional strategy is used, it will improve on the students' academic performance and retention.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1.1 Introduction.

This study investigated the impact of two teaching strategies on performance and retention in Biology among Secondary School students with varied abilities in Kaduna, Nigeria. In this chapter, summary, conclusion and recommendations were made based on the findings of this study. The chapter is presented in the following format:

- Introduction
- Summary
- Major Findings
- Contributions to Knowledge
- Conclusion
- Recommendations
- Limitations of the Study
- Suggestions for Further Studies

5.1.2 Summary

This study investigated the Impact of Computer-Assisted and Science Process Instructions on Retention and Performance in Biology among Varied Abilities Secondary School Students in Kaduna, Nigeria. It also investigated the impact of gender related differences on students' academic performance in Biology when exposed to CAI, SPA and Conventional Lecture Method of Instruction.

The sample comprised of a total of 153 Senior Secondary II Biology Students drawn from threeGovernment Secondary Schools in Sabon-Tasha Education Zone of Kaduna State. The nature of the two Experimental Groups (E.G. 1 and E.G. 2) of this study however, required that the research samples were purposively selected. This is because a research on CAI and SPA must necessarily be conducted in schools where computer and functional science laboratories are available for the students use and where the students are computer literate and also are exposed to science practicals. A 50 item multiple choice research instrument, the Biology Performance Test (BPT) with a reliability coefficient of 0.84 was used to collect the data. The data generated were analyzed according to the demands of the four hypotheses formulated to guide the study and the design of the study as reported in chapter 3.

Data analysis was carried out using SPSS Statistical Package Version 17.0, the discussion of the results and summary of the findings were reported accordingly. Analysis of the results indicated a superiority of CAI and SPA instructional strategies over the traditional lecture method and that CAI, SPA and LM were found to be gender friendly and suitable for students of varied ability levels.

The Experimental Group 1 (CAI) and the Experimental Group 2 (SPA) performed better than their counterparts exposed to Lecture Method (LM). The results also clearly indicated that the academic performance of the High Ability Students exposed to CAI, SPA and LM is high, indicating that CAI, SPA and LM instructional strategies are good for the High Ability Students. In this study, the findings showed that E.G. 1 (CAI) and E.G. 2 (SPA) retained the learnt Biology concepts higher than the Control Group (LM). CAI and SPA promote higher retention ability due to their pattern of individualized and independent learning where the students have the control of the learning materials as a result of that, they do learn at their own pace. This is however different from the Control Group (LM) where the teacher is the one in control of the learning materials and he also dictates the pace of the learning process. This study also discovered that, there is no significant difference in the academic performance between the male and female secondary school students taught Biology concepts using the Computer-Assisted Instructional teaching strategy, Science Process Approach and the Lecture Method. This indicates that CAI, SPA and LM instructional strategies are gender friendly because they showed no gender disparity in terms of academic performance. Based, on this therefore, if the right method is employed for teaching Biology, it is believed that male and female will continue to perform equally well in Biology.

5.2 Summary of Major Findings

This study investigated the effects of two teaching strategies on performance and retention in Biology among Secondary School students with varied abilities in Kaduna, Nigeria. The major findings of this study are:

- There is no significant difference in the academic performance of students exposed to CAI and SPA instructional strategies but there is significant difference in the academic performance of those students exposed to the traditional lecture method of instruction.

- There is no significant difference in the mean academic performance scores of secondary school students taught biology concepts with Low Ability, Medium Ability and High Ability using the CAI and SPA but there is significant difference in the mean academic performance scores of secondary school students taught Biology concepts with Low Ability, Medium Ability and High Ability using the lecture method of instruction.
- There is no significant difference in the retention ability of secondary school students taught biology concepts using the CAI and SPA instructional strategies but there is significant difference in the retention ability of secondary school students taught Biology concepts using the lecture method.
- There is no significant difference in the academic performance between male and female secondary school students taught Biology concepts using the Computer Assisted Instruction.
- There is no significant difference in the academic performance between male and female secondary school students taught biology concepts using the Science Process Approach.
- There is no significant difference in the academic performance between male and female secondary school students taught biology concepts using the traditional lecture method.
- No gender disparity was found in the academic performance among secondary school students exposed to CAI, SPA and LM, that is to conclude that, CAI, SPA and LM instructional strategies are gender friendly.

5.3 Contributions to Knowledge

Based on the findings of this research work, the following contributions to knowledge are made:

1. CAI and SPA instructional strategies are empirically found to improve the academic performance of senior secondary school students in concepts of Biology.
2. CAI and SPA instructional strategies are found to increase the academic performance of seniorsecondary school Biology students of different learning abilities.
3. Biology concepts are retained very well when CAI and SPA are used as media of

instructions.

4. Male and Female students benefitted equally well when taught biology concepts using the CAI, SPA and LM. These methods of teaching are gender-friendly.
5. CAI and SPA instructional strategies promote the retention of Biology concepts among male andfemale students.
6. The findings of the study have added more literature on pedagogy with respect to Biologyteaching.

5.4 Conclusions

Based on the results obtained from this study, the following conclusions were made:

1. The analyzed results show that the subjects in the experimental group 1 (CAI) and experimental group 2 (SPA) performed and retained the learnt biological concepts better than their counterparts in the control group (LM).
2. Computer-Assisted Instruction and Science Process Approach enhance the learning of students with varied abilities (high, medium and low) by allowing the students to learnactively at their own pace and the teacher was only seen as a facilitator to learning.
3. Lecture Method commonly used for instruction in secondary schools is not suitable for promoting high performance and retention of learnt biological concepts.
4. High performance and retention could be promoted through the use of appropriate teaching methods like the Computer-Assisted Instruction, Science Process Approach among others.
5. The study revealed no gender-related difference in the treatment using the Computer-Assisted Instruction, Science Process Approach and Lecture Method of instructions.
6. Computer-Assisted Instruction and Science Process Approach instructional strategies could be used as effective instructional tools for eliminating gender-related differences in teaching and a step towards enhancing female students performance in science learning.

5.5 Recommendations

Based on the findings of this study, the following recommendations were made:

1. Computer-Assisted Instructional Packages should be developed for use within the Kaduna State school system, as CAI is found to enhance the teaching of Biology.
2. Since the findings of this study showed that students worked on the computers individually. Students should be encouraged to develop independent learning skills in the use of the computer.
3. The teaching of Biology in general should be conducted in such a way that the students effectively learn and retain the concepts presented to them. The use of CAI and SPA instructional strategies seems to be appropriate in achieving this goal. They should therefore be incorporated into the main stream of pedagogy in the teaching of Biology in the secondary schools.
4. The use of CAI and SPA instructional strategies in teaching Biology concepts should bepopularized and emphasized among Biology teachers.
5. It was found in this study, that gender does not play a significant role in the learning of biology using the CAI and SPA methods of teaching. A common curriculum for boys and girls and a common instructional strategy may be found adequate for secondary school Biology students at least at the secondary school level on which this study is focused.
6. CAI and SPA instructional strategies helped to encourage the students to learn at their own pace, thereby helping them to assimilate science facts into their cognitive structure. It should therefore be encouraged for teaching in the science class room.
7. It is recommended that teachers trainers like the Colleges of Education, Universities and the National Teachers Institute should incorporate CAI and SPA instructional strategiesinto their methodology curricular at all levels. This will ensure that the development of its knowledge in the teachers on training is carry out.
8. Professional Associations like the Science Teacher Association (STAN), MathematicsAssociation of Nigeria (MAN), Nigerian Institute of Physics (NIP) and research centreslike the Nigerian Educational Research and Development Council (NERDC) should incorporate CAI and SPA instructional strategies in their science

curricular at the seniorsecondary school level to encourage the use of the strategies among teachers. When these methods (CAI and SPA) are used by the teachers, it will go a long way to improveteaching and learning at these foundation levels of learning science and technology.

5.6 Limitations of the Study

The following limitations were observed regarding this study. These are:

1. The curriculum content was limited to only SS II Biology and not the entire secondary school Biology curriculum.
2. Computer use was limited only to the treatment of EG 1, Science Process Approach for the treatment of EG 2 and Lecture Method for the treatment of the CG as the three groups were exposed to pretest, posttest and postposttest using the paper and pencil approachonly.
3. Only 153 SS II Biology Students were involved in the study. It may be possible that, if larger number of subjects were used, the results obtained might be seen to have high confidence level.

5.7 Suggestions for Further Studies

From the available literature, it is obvious that not much work had been covered in the areas of CAI and SPA instructional strategies, most especially in Biology. The researcher is thus of the opinion that further studies can be carried out to cover other concepts. The following suggestions are therefore made to further expand the scope of this study:

1. Further empirical studies should be carried out on the use of computer for instructional purposes on different subjects and at different levels to provide a sound basis for the integration of computer in Nigerian Secondary Schools.
2. CAI and SPA instructional methods can be used with other teaching strategies, notably, the demonstration method, problem solving among others in the teaching of Biology concepts.
3. The study can be extended to the University students to investigate if educational level has an impact on the variables that this study dealt with.
4. There is need to further investigate the role, if any, that gender differences might play in

the interactions between different teaching strategies and the kind of curriculum or curricular as different studies seem to be showing different results.

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APPENDIX I

BIOLOGY PERFORMANCE TEST (BPT)

NAME (optional) ---

ADMISSION NUMBER --

AGE --

GENDER (1=MALE, 2= FEMALE) ---

STATUS (0=SINGLE, 1MARRIED) ---

Instruction: You are required to simply shade the correct option on the answer sheet supplied and you're also expected to provide the answers on the sheet of paper given to you for the questions where options are not provided.

1. The scientific study of plants is called:

A. Science B. Zoology C. Paleontology D. Botany.

2. Taxonomy is described as . . ..?

3. Name the two kingdoms of the living things.

4. There are . . . . Division of the Kingdom Plantae:

A. 2 B. 3 C. 1 D. 4

5. Describe the most primitive Division of the plant kingdom.

6. The most advanced Division of Plant Kingdom is the:

A. Spermatophyta B. Bryophyta C. Pteridophyta D. Thallophyta

*** Source: WAEC Past Question Papers.**

7. The term thallus refers to the:

A.Leaves B. Stem C. Root D. Undifferentiated root, stem and leaves

8. Example of thallophyte is:

A. Green algae B. Brown algae C. Fern D. Moses.

9. Why is the green alga autotrophic?

10. The habitat of spirogyra is:

A. Terrestrial B. Aquatic C. Arboreal D. Underground

11. Arrange the following in their order of evolutionary advancement.

Pteridophyta, Thallophyta, Spermatophyta, Bryophyta

12. An example of Bryophyte is:

A. Moses B. Hibiscus C. Algae D. Ferns

13. An example of Pteridophyte is:

A. Moses B. Hibiscus C. Algae D. Ferns.

14. Describe the Pinnate leaf fashion

*** Source: WAEC Past Question Papers.**

15. . . . . body is divided into leaf, stem and the root:

A. Thallophyte B. Pteridophyte C. Spermtophyte D. Bryophyte.

16 . . . . Produces enclosed seed:

17. . . . . Produces naked seeds or unprotected ovules.

18. An example of cereal is:

A. Flower B. Maize C. Oil D. Fibre.

19. State the ecological importance of legume

20. Describe the process of explosive mechanism in legume.

.

21. . ... is an example of root crop:

A. Bulb B. Potato C. Banana D. Groundnut.

22 . . . . is an example of vegetable:

A. Okro B. Orange C. Flower D. Banana.

23. . . . . is an example of aromatic plant:

A. Bulb B. Ginger C. Carrot D. Corm.

24. Describe the term latex.

25. ---------------- plants complete their life cycle within 2 years:

A. Ephemeral B. Perennial C. Biennial D. Annual.

26. Example of perennial plant is:

A. Cassava B. Pawpaw C. Mango D. Lettuce.

27. Transpiration in plants occurs through…………..?

28. Aquatic plants obtain their Carbon (iv) Oxide in the form of:

A. Fumaric acid B. Carbonic acid C. Dissolved acid D. Atmospheric acid.

29. Land plants obtain their Carbon (iv) Oxide in form of:

A. Carbonic acid B. Carbon (iv) Oxide C. Fumaric acid D. Carbonmoxide.

30. What are stomata?

31. Exchange of gases in plants occurs through the:

A. Pores B. Stomata C. Palisade D. Epidermis.

32. What is transpiration?

*** Source: WAEC Past Question Papers.**

33. Excessive transpiration in hot weather by plants can lead to:

A. Wilting B. Turgidity C. Plasmolysis D. Ex osmosis

34. What is the role of the guard cells?

35. Anther is the ……….?

36. Ovary is the ………….?

37. In flowering plant the male gamete is the:

A. Ovules B. Pollen grains C. Sepal D. Petal.

38. In the flowering plant, the female gamete is the:

A. Sepal B. Petal C. Ovules D. Pollen grains.

39. All these are the characteristics of insect pollinated flower except:

A. Colour petals B. Scent production C. Sticky pollen D. Dull petals.

40. Give an example of wind pollinated flower.

41. The fusion of the pollen grains with the ovules is:

A. Nutrition B. Reproduction C. Fertilization D. Turgidity

*** Source: WAEC Past Question Papers**

42. In plants after fertilization, the ovules formed the:

A. Seeds B. Grains C. Nectar D. Sepals

43. In plants after fertilization the ovary formed the:

A. Seeds B. Fruits C. Nectar D. Sepals.

44. Producers are also called……………..?

45. . . . . . . is an example of autotrophic nutrition:

A. Chemosynthesis B. Nutrition C. Commensalism D. Cannibalism

46. During photosynthesis, Carbon (iv) Oxide is reduced by . . . to form glucose:

A. Hydrogen ion B. Hydroxyl ion C. Water D. Ammonia.

47. . . . . . . is an internal factor affecting the rate of photosynthesis:

A. Water B. Sunlight C. Chlorophyll D. Temperature.

48. State the tworeactions of photosynthesis.

49. Example of a Chemosynthetic bacterium is the:

A. Nitrogen fixing bacteria B. Algae C. Fungi D. Saprophyte

50. When a variegated leaf is used to test for starch ….. takes place

A. White portion turns blue black B. Green portion turns blue black

C. No observable change D. Green portion turns dark brown.

APPENDIX II

MARKING SCHEME

1. D 43. B
2. Scientific act of classification 44. Autotrophs
3. Kingdom Animalia and Plantae 45. A
4. D 46. A
5. Body not differentiated into leaves, stems and roots 47. B
6. A 48. Light and Dark reactions
7. D 49. A
8. A 50. B.
9. It can produce its own food
10. B
11. Thallophyta, Bryophyta, Pteridophyta, Spermatophyta
12. A
13. D
14. Leaf with serrated margin e.g. fern
15. C
16. Angiosperm
17. Gymnosperm
18. B
19. Fixes the soil nitrogen
20. Splitting along dehiscent line
21. B
22. A
23. B
24. Milky fluid found in rubber plant
25. C
26. C
27. Stomata
28. B
29. B
30. Pores perforating the epidermis of leaf
31. B
32. Loss of water through the stomata of leaf
33. A
34. Cells that control the opening and closing of stomata
35. Male structure of flowering plant
36. Female structure of the flowering plant
37. B
38. C
39. D
40. Maize flower
41. C
42. A*** Source: WAEC Past Question Papers**.

APPENDIX III

LESSON PLAN FOR EXPERIMENTAL GROUP 1, (CAI).

WEEK 1

Name of study school: Government Secondary School Sabon Tasha (Senior) Kaduna.

Name of researcher: Maikano Stanley

Level of Group: S.S. II

Gender: Male and Female

Number of students:290

Average age: 17 years

Topic: Taxonomy of plants

Duration: 2:00 - 4**:00 pm**

BehaviouralObjectives: by the end of the lesson, the students should be able to use the Biology courseware through the Microsoft power point presentation in their computers to:

a. learn about the taxonomy of plants.

b. learn about the biology classification of plants.

Introduction: the teacher instructed the students to put on their computers and allow them to boot. After the booting, he then instructed them to click on the icon biology courseware and then follow the instructions that would be given to them by the computers. The teacher guided them through this process.

Presentation:

Step 1: Microsoft power point presentation slide 1

- Taxonomy is the act of classifying living things based on their similarities and differences.
- In taxonomy, each living species usually end up with two names.
- These two names are the Generic name and the Specific name.
- First letter of the generic name starts with capital letter while the first letter of the specific name starts with small letter.
- The generic and the specific names gave rise to the Binomial Nomenclature.

Step 2: Microsoft power point presentation slide 2

- In biology, plants are classified into 4 major groups called the Divisions or Phylum. These are:

  ii. Thallophyta

iii. Bryophyta
iv. Pteridophyta
v. Spermatophyta

Step 3: Microsoft power point presentation slides 3 – 4

Slide 3 (Thallophyta)

Thallophyta:

- Thallophyte is the common name for a group of plants that are placed in the Division Thallophyta in the plant kingdom.
- Thallophytes are characterized by the simple nature of their structure, an undifferentiated thallus that has no root, stem or leaves.
- Example of thallophyte is the green alga (spirogyra).

Slide 4 (Bryophyta)

Bryophyta:

- Bryophytes is a collective term applied to about 22,000 species of small plants that usually grow in moist areas, on soil, tree trunks and rocks.
- Bryophytes lie between the green algae from which they most likely have evolved.
- They lack true conducting tissues (vascular bundles) that is found in higher plants.
- Some species of bryophytes are aquatic and some can survive in dry, arid areas.
- Bryophytes are non-vascular embryo bearing plants of three plant divisions namely:

i. Bryophyta e.g. Moses.
ii. Hepatophyta e.g. Liverwort.
iii. Anthocerophyta e.g. Hornworts.

Step 4: Microsoft power point presentation slides 5-6

Slide 5 (Pteridophyta)

Pteridophyta:

- Pteridophyte is the common name for any of the genus fern, especially the common bracken.

- Distinguished from other ferns in part by their spore cases which are situated near the margin of the back of the leaf.
- Pteridophytes grow in open wood lands.
- The leaves (frond) arise singly from a thick underground root stalk and are divided into several pinnate.
- Bracken is from the genus Pteridium of the family Polypodiaceae.

Slide 6 (Spermatophyta)

Spermatophyta:

- Spermatophyte is an advanced form of plant kingdom.
- Body is divided into leaf, stem and root.
- Has well-developed vascular bundles (xylem and phloem).
- Seeds producing plant such as angiosperm or gymnosperm.
- Angiosperm : phylum comprising flowering plants that produced enclosed seeds.
- Gymnosperm: phylum comprising of flowering plants that produced naked seeds e.g. ponderosapine.

Students' activities: students were asked to review the Microsoft power point slides 1 to 6 and then explain briefly the biology classification of plants.

Conclusion: teacher went over the lesson and emphasized the key concepts that the students have learnt.

Assignment: usingthe Microsoft power point slides 1 to 6, write short notes on Thallophyta, Bryophyta, Pteridophyta and Spermatophyta using the Microsoft word from your computers.

Note that: the treatment flowchart for week 1, Computer-Assisted Instruction is given below.

Put on your laptop computer by pressing the On bottom and allow it to boot

↓

Navigate to the ICON biology software through the power point and right-click

↓

Lesson Presentation Step 1: Students attention is drawn to the Microsoft slides on the topics: taxonomy of plants, Thallophyta, Bryophyta, Pteridophyta and Spermatophyta.

↓

Step 2: Discussion Session, students were asked to learn individually using the biology software on power point.

↓

Step 3: Teacher right-clicked on his own laptop computer to guide the students in individualized learning.

↓

Step 4: Students right-clicked the learning software topic by topic on their own using the computer laptop to learn.

↓

Individualized Discussion with the teacher: 10 minutes (depending on the nature of the topics and the difficulties encountered by the students.
Class Discussion: 15 minutes (depending also on the nature of topics and the difficulty faced by the students.

↓

Evaluation of the lesson taught by the teacher

↓

Conclusion of the lesson

Treatment Flowchart for week 1, CAI.

WEEK 2

Name of study school: Government Secondary School Sabon Tasha (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II

Gender: Male and Female.

Number of students: 290

Average age: 17 years

Topic: taxonomy of plants

Duration: 2-4 pm

Behavioural objectives: bythe end of the lesson, the students should be able to use the biology courseware through the Microsoft power point presentation using the slides in their computers to:

a. Learn about the classification of plants using the Agricultural techniques.
b. Learn about the classification of plants based on their life cycles.

Previous knowledge: the teacher instructed the students to review their Microsoft power point presentation slides 1-6 in order to refresh their memory about the biology classification of plants.

Presentation: using the Microsoft power point slides.

Step 1:

Slide 7 (Agricultural Classification of plants).

- in Agriculture, plants are classified based on their uses to man, e.g.:

i. Cereals: seeds use as food for man, e.g. maize, rice, millet.
ii. Legume: single-chambered, flattened seedpod with two sutures, e.g. groundnut. Legume may be indehiscent or dehiscent. Legumes renew the soil nitrogen.
iii. Root crops: crops grown for its edible roots, e.g. potato, cassava.
iv. Vegetables: edible product of herbaceous plants with soft stem, e.g. cabbage, lettuce.
v. Fruits: seed bearing structure of flowering plants. It is a fertilized ovary, e.g. pawpaw, oranges, pineapple, banana.

Slide 8

vi. Beverages and drugs: beverage is a plant which extract is used as drink e.g. coffee. Drug like tobacco is grown for commercial use.

vii. Spices: aromatic flavoring made from plant parts. The term spice is applied to pungent plant products e.g. ginger, pepper.

viii. Oil: plants that their fruits/products can be processed to produce oil, e.g. palm fruits, coconut.

ix. Latex: plant with milky fluid found in specialized cells called lactiferous cells e.g. rubber plant.

x. Fibres: plants that produce a long slender thread or filament, e.g. cotton. Cotton is used in the textile industry to produce clothing materials.

Step 2:

Microsoft power point slides 9-10

Slide 9

- Plants are classified based on their life cycle into:

i. Ephemeral.

ii. Annual plants.

iii. Biennial plants.

iv. Perennial plants.

Slide 10

- Ephemeral plants are plants that do complete their life cycle more than once in a year, eg. Zea mays (maize).
- Annual plants are plants that grow, flower and produce seeds/fruits within one year, e.g. ginger.
- Biennial plants are plants that grow, flower and produce seeds/fruits within two years, e.g. Carica papaya (pawpaw).
- Perennial plants are plants that grow, flower and produce fruits/seeds in many years before they die, e.g. mango, coconut.

Evaluation: students were asked to review the Microsoft power point presentations slides 7-10 and use that to differentiate between the biennial and perennial plants.

Assignment: using the Microsoft power point presentation slides 7 to 10, write short notes on: Ephemeral, Annual, Biennial and Perennial plants. You are to type this in your computer using the Microsoft word.

Note that:the treatment flowchart for week 2, Computer-Assisted Instruction is given below.

Put on your laptop computer by pressing the On bottom and allow it to boot
↓
Navigate to the ICON biology software through the power point and right-click
↓
Lesson Presentation Step 1: Students attention is drawn to the Microsoft slides on the topics: Agricultural classification of plants, classification of plants based on their life cycles.
↓
Step 2: Discussion Session, students were asked to learn individually using the biology software on power point.
↓
Step 3: Teacher right-clicked on his own laptop computer to guide the students in individualized learning.
↓
Step 4: Students right-clicked the learning software topic by topic on their own using the computer laptop to learn.
↓
Individualized Discussion with the teacher: 10 minutes (depending on the nature of the topics and the difficulties encountered by the students. Class Discussion: 15 minutes (depending also on the nature of topics and the difficulty faced by the students.
↓
Evaluation of the lesson taught by the teacher
↓
Conclusion of the lesson

Treatment Flowchart for week 2, CAI.

WEEK: 3

Name of study school: Government Secondary School Sabon Tasha (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II

Gender: Male and female.

Level of Group: SS II

Gender: Male and female.

Number of students: 290

Average age: 17 years.

Topic: Mechanism of gaseous exchange in plants.

Duration: 2-4 pm

Behavioural objectives: by the end of the lesson, the students should be able to use the biology courseware through the Microsoft power point presentation using the slides in their computers to:

a. Learn about the stomata and also study their functions.
b. Learn about the mechanism of stomata opening and closing.
c. Learn about the mechanism of gaseous exchange in plants.
d. Learn about transpiration and study the factors that affect the rate of transpiration.

Presentation:using Microsoft power point slides

Step 1:

Slide 11(Mechanism of gaseous exchange in plants).

- mechanism of gaseous exchange in plants.
- Aquatic plants obtain Carbon (iv) oxide from the surrounding water in form of carbonic acid.
- Land plant obtain Carbon (iv) oxide from the atmosphere, it diffuses into the plant through the stomata.
- Carbon (iv) oxide is essential to green plants for photosynthesis.

Step 2:

Slide 12 (Stomata).

- Stomata are pores perforating the epidermis of the leaves and stems.

- Stomata are numerous in the lower epidermis of the leaf.
- There are fewer stomata in the upper epidermis and fewer still in the stem

Slide 13 (Functions of the stomata).

Functions of stomata are:

- Allow exchange of Carbon (iv) oxide and oxygen between the inside of leaf and the atmosphere.
- It controls the flow of water in the xylem vessel
- It allows transpiration to occur.

Slide 14 (Mechanism by which stomata open and close).

Mechanism by which stomata open and close:

- The stomata pore is surrounded by pair of guard cells.
- Stomata opening and closure depends on changes in turgor pressure of the guard cells.
- Absorption of water by osmosis makes the guard cells turgid.
- Turgidity of guard cells opens the stomata.
- Flaccidity of the guard cells closes the stomata.

Step 3:

Slide 15 (Transpiration).

- Transpiration.
- Stomata allow the evaporation of water from the plant, a process called transpiration.
- When transpiration takes place through the cuticle, it is called cuticular transpiration and when it occurs through the lenticels it is called lenticellular transpiration.

Slide 16 (Factors affecting the rate of transpiration).

- Temperature
- Relative humidity
- Air movement
- Atmospheric pressure

- Light
- Water supply

Evaluation/ class activities: the students were asked to review the Microsoft power point presentation slides 11-16 and use that to differentiate between the cuticle and lenticellular transpiration.

Assignment:using the Microsoft power point presentation slides 11-16, write short notes on all the factors that affect transpiration rate. You are to type this in your computer using the Microsoft word.

Note that: The treatment flowchart for week 3, Computer-Assisted Instruction is shown below.

Put on your laptop computer by pressing the On bottom and allow it to boot

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Navigate to the ICON biology software through the power point and right-click

↓

Lesson Presentation Step 1: Students attention is drawn to the Microsoft slides on the topics: Stomata and their functions, mechanism of stomata opening and closing, mechanism of gaseous exchange in plants, transpiration and the factors affecting it.

↓

Step 2: Discussion Session, students were asked to learn individually using the biology software on power point.

↓

Step 3: Teacher right-clicked on his own laptop computer to guide the students in individualized learning.

↓

Step 4: Students right-clicked the learning software topic by topic on their own using the computer laptop to learn.

↓

Individualized Discussion with the teacher: 10 minutes (depending on the nature of the topics and the difficulties encountered by the students.
Class Discussion: 15 minutes (depending also on the nature of topics and the difficulty faced by the students.

↓

Evaluation of the lesson taught by the teacher

↓

Conclusion of the lesson

Treatment Flowchart for week 3, CAI.

WEEK: 4

Name of study school: Government Secondary School Sabon Tasha (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II

Gender: Male and female.

Number of students: 290

Average age: 17 years.

Topic: pollination in flowering plants.

Duration: 2-4 pm

Behavioural objectives: by the end of the lesson, the students should be able to use the biology courseware through the Microsoft power point presentation using the slides in their computers to:

a. Learn about pollination and study the 2 types of pollination.
b. Study the characteristics of insects and wind pollinated flowers.
c. Learn about the agents of pollination.

Previous knowledge: the students have already learnt about pollination.

Presentation:

Step 1:

Slide 17 (Pollination).

- pollination
- An anther is the male reproductive structure in the flowering plant that produces the pollen grains.
- An ovary is the female reproductive structure in flowering plant that produces the ovules.
- Pollen grains must be transferred from the open anthers to the stigma, this process is called pollination.

Slide 18 (Types of pollination).

- Types of pollination:
- Self-pollination: sometimes pollen grains fall on the stigma of the same flower; this process is called self-pollination.

- Cross pollination: sometimes pollen grains are conveyed by agents of pollination to another flower but of the same species, this is called cross pollination.

Step 2:

Slide 19 (Characteristics of insects' pollinated flowers)

- characteristics of insects pollinated flowers;
- Brightly coloured sepals or petals.
- Scent production.
- Secretion of nectar
- Sticky pollen grains.
- E.g. of insect pollinated flower is the Caesalpiniapulcherima (pride of Barbados).

Slide 20 (Characteristics of wind pollinated flower)

Wind pollination: this is promoted by certain factors, these are:

- Massive production of pollen grains.
- Pollen grains are light.
- Pollen grains are feathery.
- Pollen grains are not sticky.
- Sepals or petals are not brightly coloured.

Step 3:

Slide 21 (Agents of pollination)

- agents of pollination are;
- Water
- Insects
- Wind
- Animals

Slide 22 (Fertilization in flowering plants)

- After pollination, a pollen tube is formed which moves to the ovary to fuse with the ovules, a process called fertilization.

- After fertilization, the ovules become the seeds while the ovary forms the fruit.

Evaluation/class activities: students were ask to review the Microsoft power point presentation slides 17-22 and use that to list and explain the agents of pollination.

Assignment: using the Microsoft power point presentation slides 17-22, explain the different characteristics of insect and wind pollinated flowers. You are to type the answer using the Microsoft word in your computer.

Note that: the treatment flowchart for week 4, Computer-Assisted Instruction is given below.

Put on your laptop computer by pressing the On bottom and allow it to boot

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Navigate to the ICON biology software through the power point and right-click

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Lesson Presentation Step 1: Students attention is drawn to the Microsoft slides on the topics: Pollination and its types, characteristics of insects and wind pollinated flowers, agents of pollination.

↓

Step 2: Discussion Session, students were asked to learn individually using the biology software on power point.

↓

Step 3: Teacher right-clicked on his own laptop computer to guide the students in individualized learning.

↓

Step 4: Students right-clicked the learning software topic by topic on their own using the computer laptop to learn.

↓

Individualized Discussion with the teacher: 10 minutes (depending on the nature of the topics and the difficulties encountered by the students.
Class Discussion: 15 minutes (depending also on the nature of topics and the difficulty faced by the students.

↓

Evaluation of the lesson taught by the teacher

↓

Conclusion of the lesson

Treatment flowchart for week 4, CAI.

WEEK: 5

Name of study schools: Government Secondary School Sabon Tasha (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II

Gender: Male and female.

Number of students: 290

Average age: 17 years.

Topic: autotrophic nutrition.

Duration: 2:00-4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to use the biology courseware through the Microsoft power point presentation using the slides in their computers to:

a. Learn about the term autotrophic nutrition and study the 2 types.
b. Learn about photosynthesis and study the factors that affect it.
c. Study the two reactions of photosynthesis.
d. Learn about translocation and study the form of food storage in plants.

Presentation:

Step 1:

Slide 23 (Autotrophic nutrition)

- Autotrophic nutrition occurs in plants that produce their own food, e.g. green plants.
- The 2 types of autotrophic nutrition are photosynthesis and chemosynthesis.

Step 2:

Slide 24 (Definition of photosynthesis).

- Photosynthesis is the synthesis of organic compound by the reduction of Carbon (iv) oxide, using sunlight absorbed by the chlorophyll. In green plants where water is the hydrogen donor and the source of release oxygen.

Slide 25 (Factors that affect the rate of photosynthesis)

- Factors affecting the rate of photosynthesis are grouped into 2 namely:
  i. Internal factors (water and chlorophyll).
  ii. External factors (light, temperature and Carbon (iv) oxide.

  Step 3:

Slide 26 (Reactions of photosynthesis)

- Two reactions of photosynthesis are: light and dark reaction.

Slide 27 (Light reaction)

Light reaction

- First reaction of photosynthesis that is light dependent.
- It occurs in the palisade layer of the leaf.
- In this reaction, light energy is used to split water into hydrogen ion and hydroxyl ion, a process called photolysis.
- Hydrogen ion is used to reduce Carbon (iv) oxide to form glucose while hydroxyl ion is reconverted to water with the release of oxygen.

Slide 28 (Dark reaction)

Dark reaction:

- Reaction of photosynthesis that is light independent.
- It can occur in the day or night but light is not important.
- During this reaction, Carbon (iv) oxide is reduced by hydrogen ion to produce glucose.

Step 4:

Slide 29 (Translocation)

- Translocation is the process where the excess product of photosynthesis is transferred from the production organ to the storage organ through the phloem vessels.
- The different types of storage organs are :

i. Root tuber, e.g. potato.

ii. Stem tuber, e.g. yam.

iii. Bulb, e.g. onion.

iv. Fruits e.g. orange.

Evaluation/class activities: students were asked to review the Microsoft power point presentation slides 23-29 and then use it to explain the different forms of food storage in plants.

Assignment: using the Microsoft power point presentation slides 23-29 in your computer; explain the two reactions of photosynthesis. You are to type the answer using the Microsoft word in your computer.

Note that: the treatment flowchart for week 5, Computer-Assisted Instruction is given below.

Put on your laptop computer by pressing the On bottom and allow it to boot

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Navigate to the ICON biology software through the power point and right-click

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Lesson Presentation Step 1: Students attention is drawn to the Microsoft slides on the topics: Autotrophic nutrition, photosynthesis and the factors affecting it, Light and Dark reactions of photosynthesis, translocation.

↓

Step 2: Discussion Session, students were asked to learn individually using the biology software on power point.

↓

Step 3: Teacher right-clicked on his own laptop computer to guide the students in individualized learning.

↓

Step 4: Students right-clicked the learning software topic by topic on their own using the computer laptop to learn.

↓

Individualized Discussion with the teacher: 10 minutes (depending on the nature of the topics and the difficulties encountered by the students.
Class Discussion: 15 minutes (depending also on the nature of topics and the difficulty faced by the students.

↓

Evaluation of the lesson taught by the teacher

↓

Conclusion of the lesson

Treatment flowchart for week 5, CAI.

WEEK: 6

This week was dedicated for revision and the administration of the research instrument Biology Performance Test (BPT).

Note that: the treatment flowchart for week 6, Computer-Assisted Instruction is given below.

Put on your laptop Computer by pressing the On bottom and allow it to boot.

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Navigate to the ICON biology software through the power point and right-click on it.

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Class Discussion: 40 minutes were used for students revision. The students were asked to go through the previous lessons and ask questions where they have difficulties.

↓

The teacher answered their questions and also laid some emphasis on the key areas.

Treatment flowchart for week 6, CAI

APPENDIX IV

LESSON PLAN FOR EXPERIMENTAL GROUP 2, (SPA).

WEEK: 1

Name of study schools: Government Secondary School Kakuri (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 240

Average age: 17 years.

Topic: taxonomy of plants.

Duration: 2:00-4:00 pm.

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about the taxonomy of plants using Specimens A, B, C and D.
b. Use illustrations to classify plant Specimens A, B, C and D.

Note that:

1. Specimen A: Thallophyte (Spirogyra/green alga).
2. Specimen B: Bryophte (Moss).
3. Specimen C: Pteridophyte (Fern).
4. Specimen D: Spermatophyte (Water leaf plant).

Process skills for this lesson: observation, classification, drawing, labeling, naming.

Apparatus: microscope, hand lens, blank slide, cover slide, petri-dish.

Presentation:

Step 1:

Specimen A is mounted on the high power microscope.

Specimen B is put in the petri-dish.

Specimen C is on the table.

Specimen D is on the table.

Class activities: the students were asked to observe Specimen A mounted on the microscope, give reasons and then name it.

Specimen A:

- It is greenish in color.
- It is thread-like in nature.
- It is slimy in nature.

  Therefore Specimen A is the green alga (Spirogyra).

Specimen B (Observation using the hand lense).

- It has a long filament (seta).
- At the anterior end of the seta is the sporangium.
- At the posterior ends of the seta are: leaf-like structure, short stalk and rhizoid roots.

  Therefore Specimen is the Bryophyte (moss).

Specimen C (Observation using the hand lense).

- It has leaf with serrated/rough margin.
- In the middle of the leaf is the rachis.
- It has rhizome (underground stem).
- It has adventitious root.
- It has root hairs.

  Therefore Specimen C is the Pteridophyte (Fern).

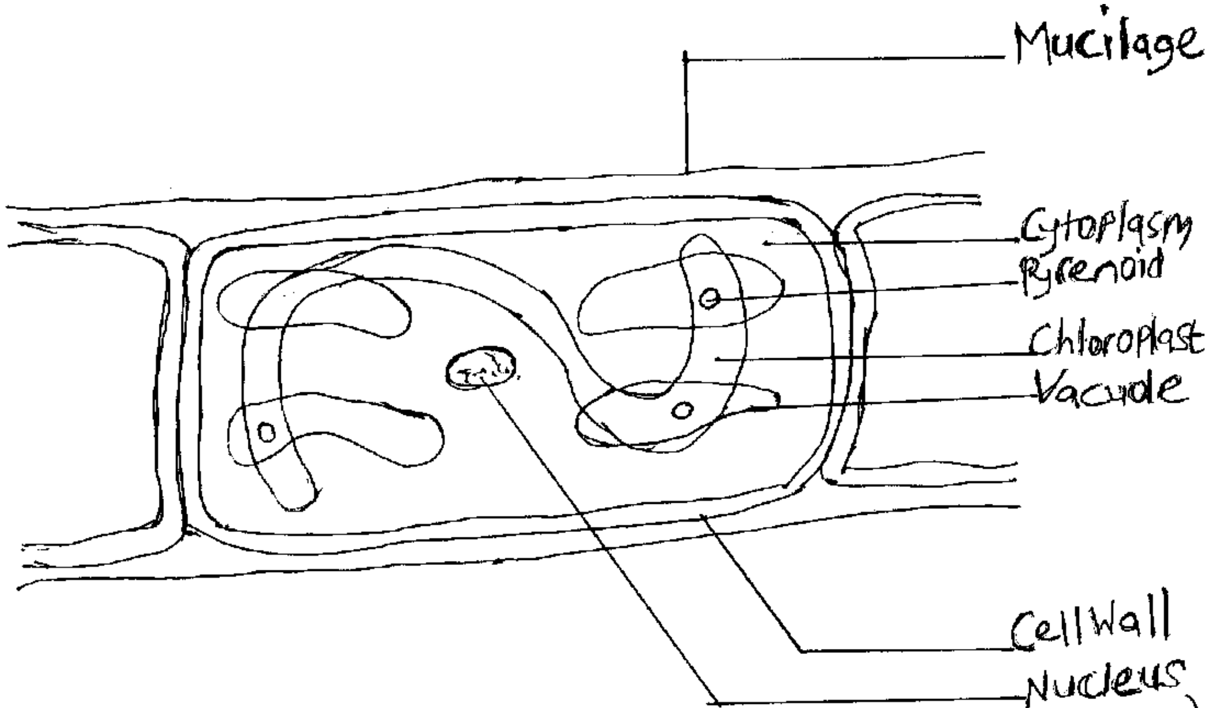
Specimen D (Observation using the hand lense).

- It is clearly differentiated into leaf, stem and root.
- The stem bears the leaves and the flower bud.
- It has the main root, secondary root and the root hairs.

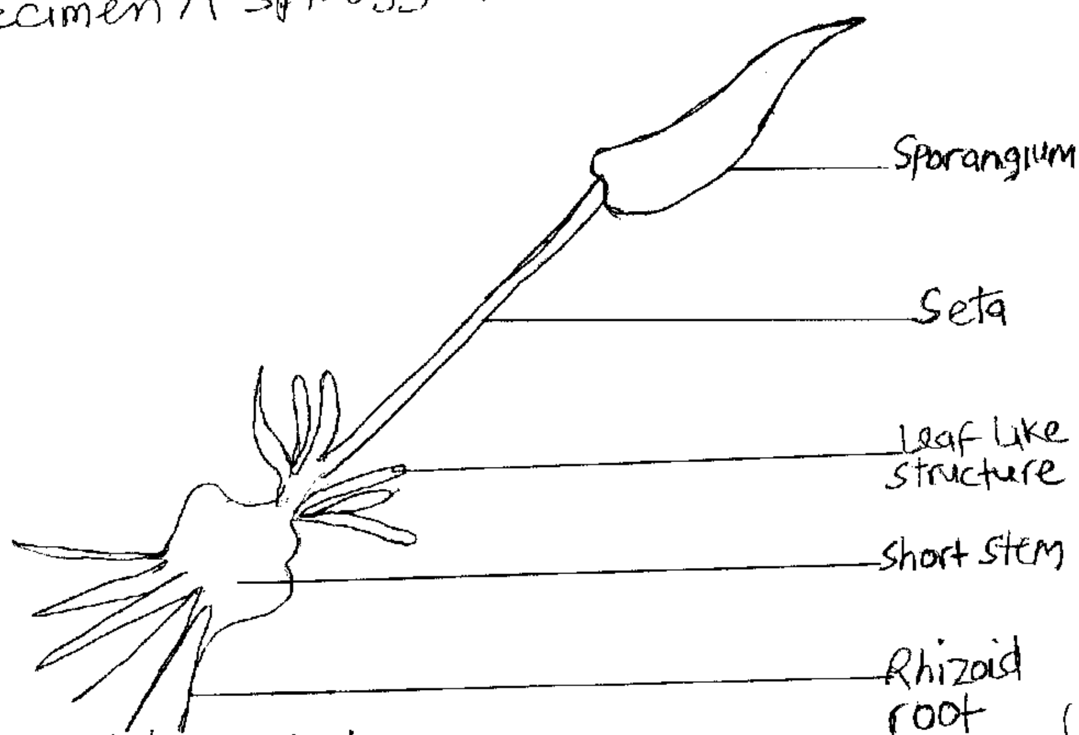
  Therefore Specimen D is the water leaf (Talinumtriangulare).

Step 2:

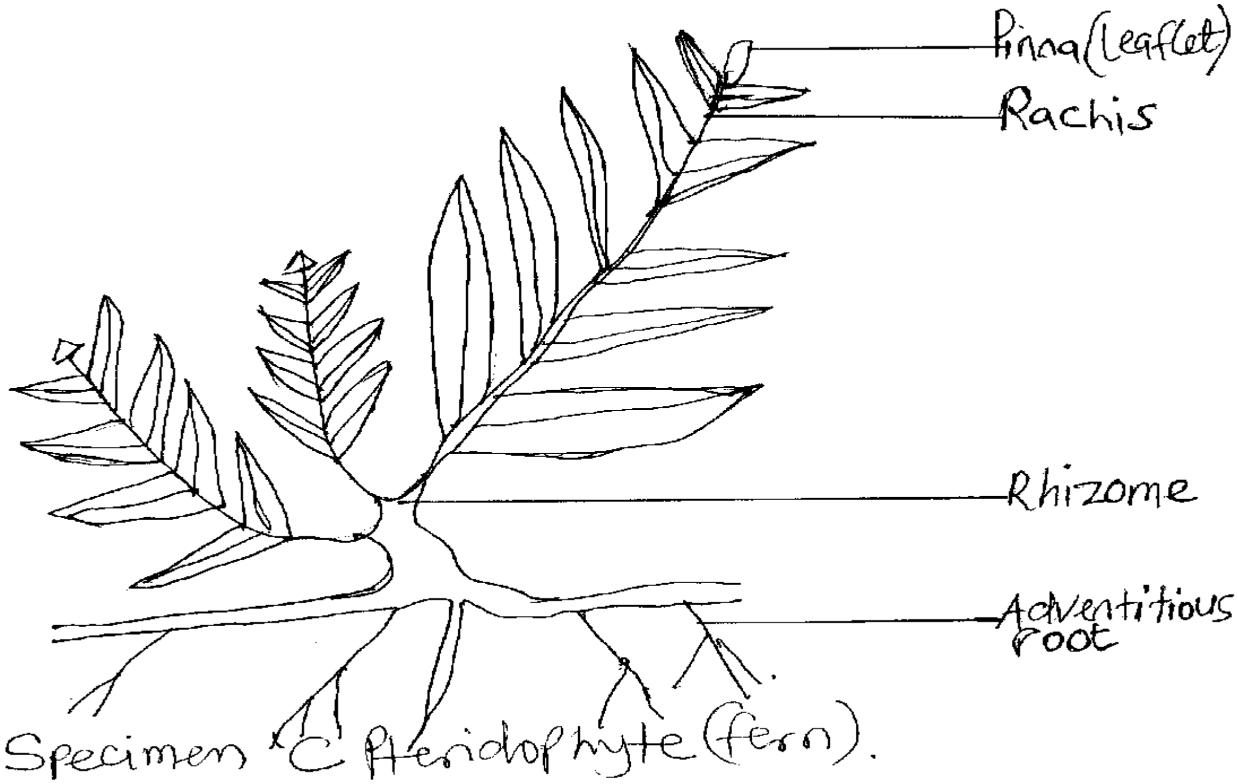
Class activities: the students were asked to draw a large, neat and well-labeled diagrams of Specimens A, B, C and D.

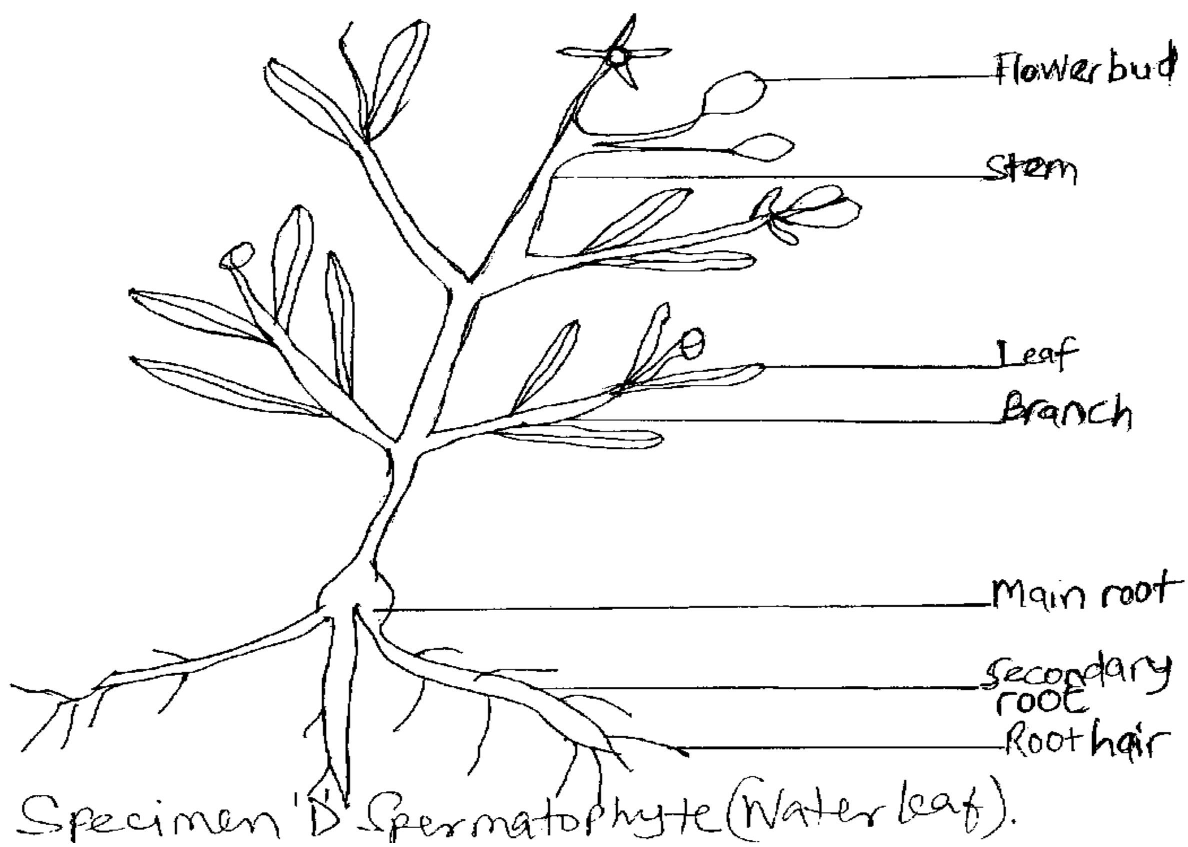


Specimen 'A' Spirogyra Cell (under high power microscope)



Specimen 'B' Bryophyte (Moss)


Pinna (Leaflet)
Rachis
Rhizome
Adventitious root
Specimen 'C' Pteridophyte (fern).


Flowerbud
Stem
Leaf
Branch
Main root
Secondary root
Root hair
Specimen 'D' Spermatophyte (Water leaf).

Step 3:

Comment on the Biological importance of Specimen A to aquatic food chain.

Spirogyra is an autotrophic species. It is the producer in the aquatic food chain because it has the chloroplast which produces the chlorophyll. With the help of the chlorophyll, the spirogyra produces its own food through the process of photosynthesis.

Evaluation:the teacher instructed the students to cross-check their diagrams and make sure that the labels are correct.

Conclusion:the teacher went over the lesson emphasizing on the distinctive features of the Thallophytes, Bryophytes, Pteridophytes and the Spermatophytes.

Note that: the treatment flowchart for week 1, Science Process Approach is given below.

The teacher reviewed the students Prior Knowledge on observation, classification, collection and recording, experimentation and the control of variables.

↓

Lesson Presentation Step 1: Students attention was drawn to the use of the following process skills; observation, classification, drawing, labeling and naming.

↓

Step 2: Students were instructed to use the process skills listed in step 1 to identify with reasons and also name and draw specimens A: Thallophyte (spirogyra), B: Bryophyte (moss), C: Pteridophyte (fern) and D: Spermatophyte (water leaf).

↓

Step 3: the teacher moved around the laboratory in order to guide the students individualized learning.

↓

Individualized-Discussion: 15 minutes (depending on the practical work and the difficulties faced by the students).

Class-Discussion: 25 minutes (depending on the nature of the practical work and difficulties encountered by the students).

↓

Evaluation of the laboratory activities

↓

Conclusion of the lesson

Treatment flowchart for week 1, SPA.

WEEK: 2

Name of study schools: Government Secondary School Kakuri (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 240

Average age: 17 years.

Topic: taxonomy of plants.

Duration: 2:00-4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Classify the given Specimens A-P, using the Agricultural techniques through grouping.
b. Classify the Specimen A-P into groups based on their life cycle.

Note that:

Specimen A: Maize	Specimen B: Rice
Specimen C: Millet	Specimen D: Palm-fruit
Specimen E: Beans	Specimen F: Potato
Specimen G: Cassava	Specimen H: Cabbage
Specimen I: Lettuce	Specimen J: Ginger
Specimen K: Orange	Specimen L: Banana
Specimen M: Pawpaw	Specimen N: Yam
Specimen O: Cotton	Specimen P: Pepper

Process skills for this lesson: observation, classification, placement, recording, grouping, tabulation, inferring, counting and naming.

Apparatus: hand lens.

Presentation:

Step 1:

Class activities: place the above mentioned Specimens into the following groups, Cereals, Legume, Root-tuber, Stem-tuber, Vegetables, Fruits, Spices, Oil, fibers based on their observable features.

CEREALS: Maize, Rice, Millet

LEGUME: Beans

ROOT-TUBER: Potato, Cassava

STEM-TUBER: Yam

VEGETABLES: Cabbage, Lettuce

FRUITS: Orange, Banana, Pawpaw

SPICES: Ginger, Pepper

OIL: Palm-fruits

FIBERS: Cotton

Evaluation: the teacher carried out the same grouping process and then asks the students to cross-check it with their own and make the necessary corrections where applicable.

Step 2:the teacher explained to the students that plants are classified based on their life cycle into the following groups:

- Ephemeral: plants that do complete their life cycles more than once in a year.
- Annual: plants that do complete their life cycle once in a year.
- Biennial: plants that do complete their life cycle once within two years.
- Perennial: plants that do complete their life cycle in many years before they die.

Class activities: the students were asked to place Specimens A-P into the 4 major groups based on their life-cycle.

GROUPING OF SPECIMENS BASED ON THEIR LIFE-CYCLE

EPHEMERAL: Maize, Cabbage, Lettuce, Pepper

ANNUAL: Rice, Millet, Beans, Potato, Yam, Cotton

BIENNIAL: Cassava, Ginger, Pawpaw

PERENNIAL: Palm-fruit, Orange, Banana.

Evaluation: the teacher carried out the same grouping process and he then asks the students to cross-check it with their own and make the necessary corrections where applicable.

Note that:thetreatment flowchart for week 2, Science Process Approach is given below.

The teacher reviewed the students Prior Knowledge on observation, classification, placement, recording, grouping, tabulation, inferring, counting and naming.

↓

Lesson Presentation Step 1: Students attention was drawn to the use of the following process skills: observation, classification, placement, recording, grouping, tabulation, counting and naming.

↓

Step 2: Students were instructed to use the process skills listed in step 1 to classify specimens A-P using the agricultural technique and also to classify them based on their life cycle. Specimen A: Maize, B: Rice, C: Millet, D: Palm fruit, E: Beans, F: Potato, G: Cassava, H: Cabbage, I: Lettuce, J: Ginger, K: Orange, L: Banana, M: Pawpaw, N: Yam, O: Cotton, P: Pepper.

↓

Step 3: Teacher moved around the laboratory in order to guide the students individualized learning.

↓

Individualized-Discussion: 15 minutes (depending on the practical work and difficulties faced by the students).

Class-Discussion: 20 minutes (depending on the nature of the practical work and difficulties encountered by the students).

↓

Evaluation of the laboratory activities

↓

Conclusion of the lesson

Treatment flowchart for week 2, SPA.

WEEK: 3.

Name of study schools: Government Secondary School Kakuri (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 240

Average age: 17 years.

Topic: mechanism of gaseous exchange in plants.

Duration: 2-4pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about the stomata and also study their functions through an experiment on transpiration.
b. Using experiment on transpiration to learn about the mechanism of stomata opening and closing.
c. Experimentally determine the mechanism of gaseous exchange in plants.
d. Using experiment on transpiration to learn about the factors that affect it.

Process skills for this lesson: experiment,observation, inference, communication, raising questions, manipulating variables, manipulating apparatus.

Apparatus: bell jar, potted plant, source of light (sun), polythene bag.

Presentation:

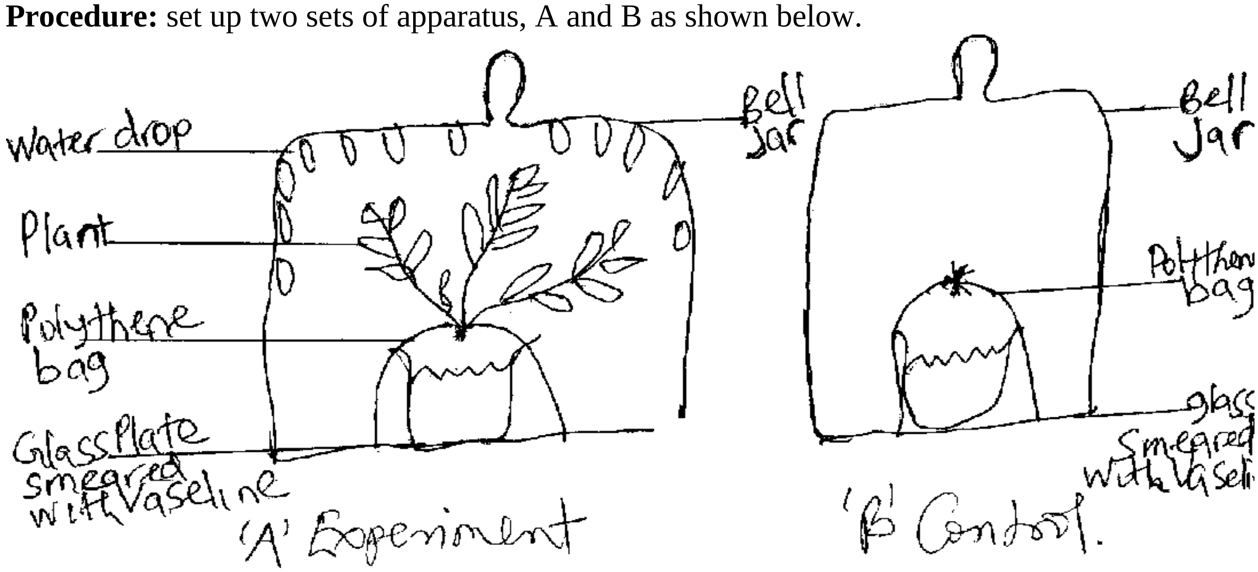
Step 1: transpiration is the process by which plants loose water in vapour form through their aerial parts (leaf) to the atmosphere.

Students' activities:

Experiment: to show the process of transpiration.

Apparatus: bell jar, potted-plant, polythene bag, light (sun), glass plate.

Procedure: set up two sets of apparatus, A and B as shown below.



In A tie a piece of polythene bag around a pot containing a growing plant so that no water can be lost from the pot or the soil.

Place the pot under a bell jar. Place both bell jar and pot stand on a glass plate. Smear Vaseline at the rim of the bell jar where it makes contact with the glass plate. This prevents the passage of vapour into or out of the space covered by the bell jar.

Set up B but in B there is no growing plant. B is the control. Leave both sets of apparatus for about 4 hours under the sun.

Results: drops of liquid are seen on the walls of the bell jar in A but none in B. The liquid is shown to be water because it turns anhydrous copper sulphate blue.

Conclusion:this shows that a plant transpires.

Step 2: based on the observation made through the experiment above, the students would be instructed to list the factors that affect the rate of transpiration. These factors are:

- Temperature.
- Relative humidity.
- Air movement.
- Atmospheric pressure.
- Light.
- Water supply.

Evaluation: at every stage of this experiment, questions will be asked in order to ascertain the level of students understanding.

Note that: the treatment flowchart for week 3, Science Process Approach is given below.

The teacher reviewed the students Prior Knowledge on: experimentation, observation, inference, communication, raising questions, manipulating variables and apparatus.

↓

Lesson Presentation Step 1: Students attention is drawn on how to use the basic and integrated process skills to carry out an experiment on transpiration.

↓

Step 2: Students were instructed to use the basic and integrated process skills to carry out an experiment to show the process of transpiration and also to identify the factors that affect the rate of transpiration.

↓

Step 3: Using the experiment above, the students learnt how to control variables like temperature, relative humidity, light, water uptake by plants, use of reagents among others.

↓

Step 4: Teacher moved around the laboratory in order to guide the students practical activities.

↓

Group-Discussion: 20 minutes (depending on the nature of the practical work and the difficulties faced by the students).
Class-Discussion: 25 minutes (depending on the nature of the practical work and difficulties encountered by the students).

↓

Evaluation of the laboratory activities

↓

Conclusion of the lesson

Treatment flowchart for week 3, SPA.

WEEK: 4

Name of study schools: Government Secondary School Kakuri (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 240

Average age: 17 years.

Topic: pollination in plants.

Duration: 2-4 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about pollination and use Specimen A (Pride of Barbados) and Specimen B (Maize plant) to study about the 2 types of pollination.
b. Use Specimens A and B to study the characteristics of insect and wind pollinated flowers.
c. Learn about the agents of pollination based on the observed features from Specimens A and B.

Note that:

Specimen A is Caesalpiniapulcherima (Pride of Barbados) flower.

Specimen B is Zea mays (Maize plant with male and female inflorescence).

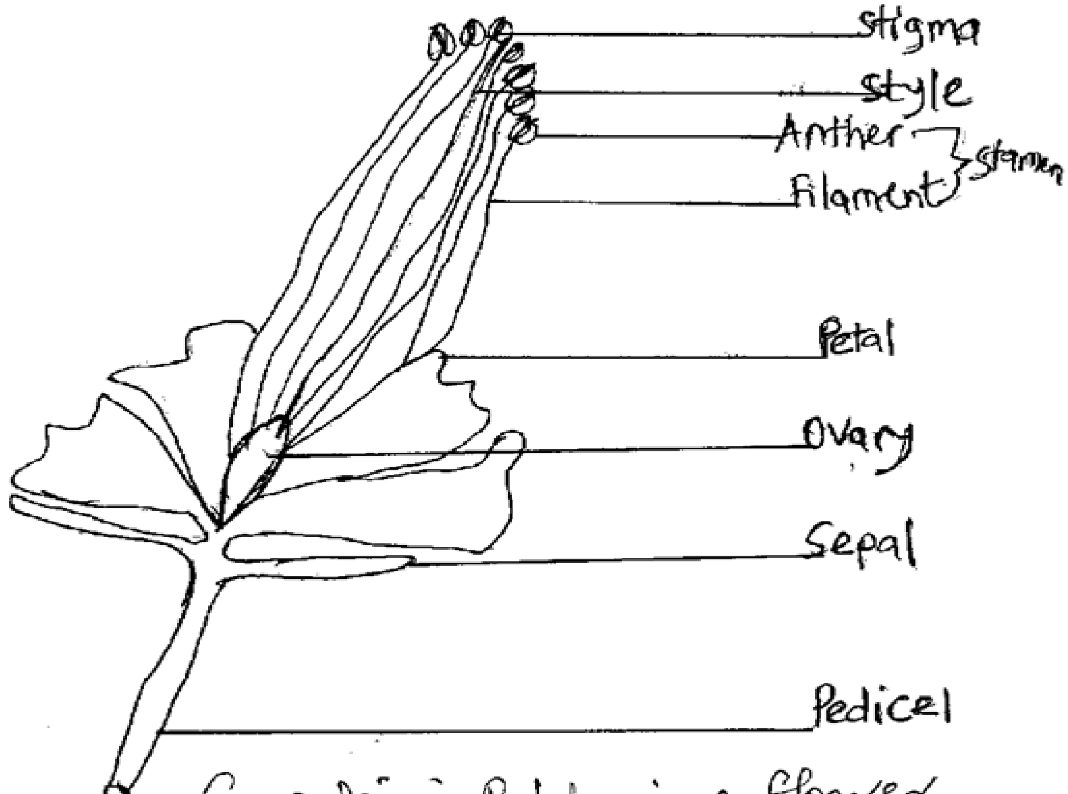
Process skills for this lesson: observation, classification, recording, counting, drawing.

Instructional materials: Zea mays (maize plant with female and male inflorescence). Caesalpiniapulcherima (pride of Barbados flower), hand lens and recording paper.

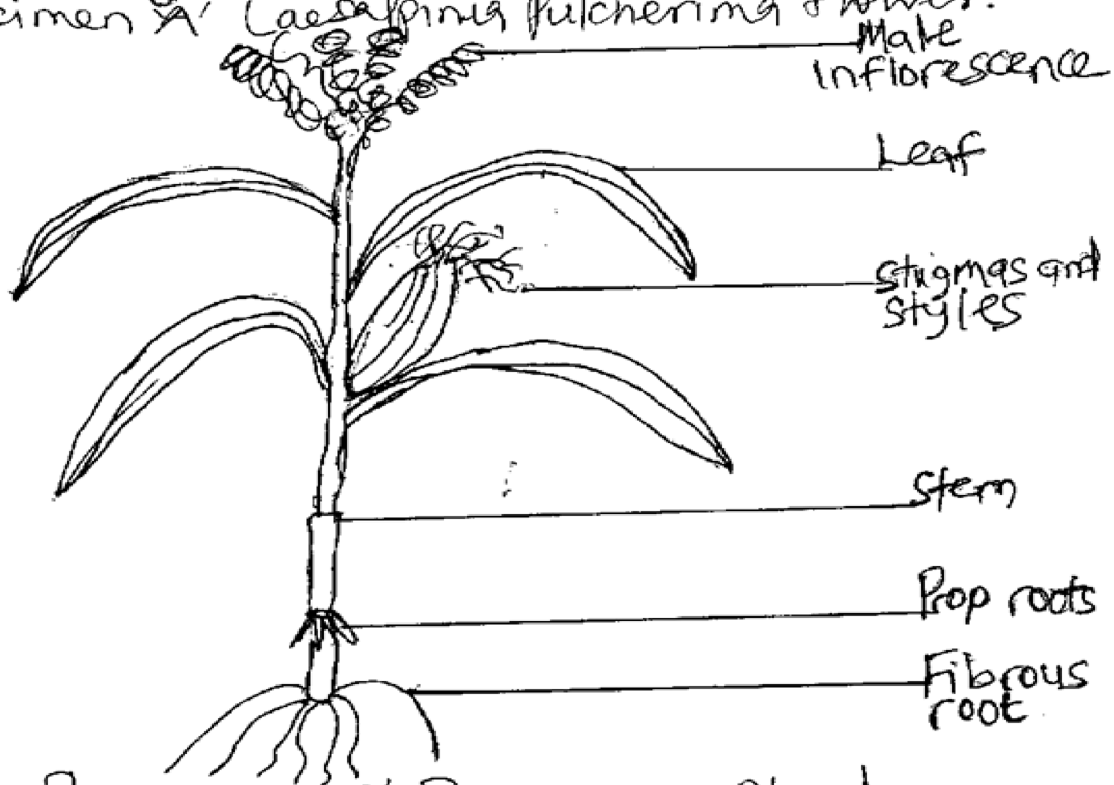
Presentation:

Step 1:

Class activities:the students were asked to draw a large, neat and well-labeled diagrams of Specimens A and B.



Specimen 'A' Caesalpinia Pulcherima flower.



Specimen 'B' Zea mays Plant.

Step 2:

Pollination is the transfer of the pollen grain from the anther to the stigma of the same flower or of a different flower but of the same species.

Specimen A is an insect pollinated flower because of the following reasons:

- It has brightly coloured petals/corolla.
- It has sticky pollen grains.
- It produces sugary substances/nectar.
- It has a good scent.
- It has few pollen grains

Specimen B is a wind pollinated flower because of the following reasons:

- The petals are not brightly coloured.
- The pollen grains are not sticky.
- It has no nectar.
- It has no scent.
- It produces many pollen grains.

Step 3: the agents of pollination based on the observed features from Specimens A and B are:

- Water.
- Insects.
- Wind.
- Animals.

Evaluation: on the spot evaluation strategy was employed in order to correct the students' error.

Note that: the treatment flowchart for week 4, Science Process Approach is given below.

The teacher reviewed the students Prior Knowledge on: observation, classification, recording, counting, drawing among others.

↓

Lesson Presentation Step 1: Students attention was drawn to use specimen A (Pride of Barbados) and B (Zea mays) to learn about pollination.

↓

Step 2: the students were asked to use specimens A and B above to study the characteristics of insect and wind pollinated flower.

↓

Step 3: the students were instructed to study and learn about the agents of pollination based on the observed features from specimens A and B.

↓

Step 4: teacher moved around the laboratory in order to guide the students practical activities.

↓

Group-Discussion: 15 minutes (depending on the nature of the practical work and the difficulties faced by the students.

Class-Discussion: 20 minutes (depending on the nature of the practical work and difficulties encountered by students).

↓

Evaluation of the laboratory activities

↓

Conclusion of the lesson

Treatment flowchart for week 4, SPA.

WEEK: 5

Name of study schools: Government Secondary School Kakuri (Senior) Kaduna.

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 240

Average age: 17 years.

Topic: autotrophic nutrition.

Duration: 2:00-4:00 pm

Behavioural objectives: by the end of the lesson, the students would be able to:

a. Learn about the term autotrophic nutrition experimentally using a starch test from a leaf.
b. Learn about photosynthesis and study the factors that affect it experimentally.
c. Experimentally study the two reactions of photosynthesis.
d. Learn about translocation and study the form of food storage in plants using bulb, corm, yam, cassava, mango, and cashew.

Process skills for this lesson: experiment, observation, inference, Smanipulating variables, manipulating apparatus and recording.

Apparatus: leaf from plant exposed to sun, Bunsen burner, iodine solution, beaker, water, lighter/matches, source of light (sun), watch glass, tripod stand, alcohol, cotton wool.

Presentation:

Step 1:

If Sunlight, Carbon (iv) Oxide, Water and Chlorophyll are present, green plants can build up Carbohydrates. This process, which takes place mainly in the leaves of green plants is called photosynthesis. It is often represented by the following equation:

$6CO_2 + 6H_2O - C_6H_{12}O_6 + 6O_2$

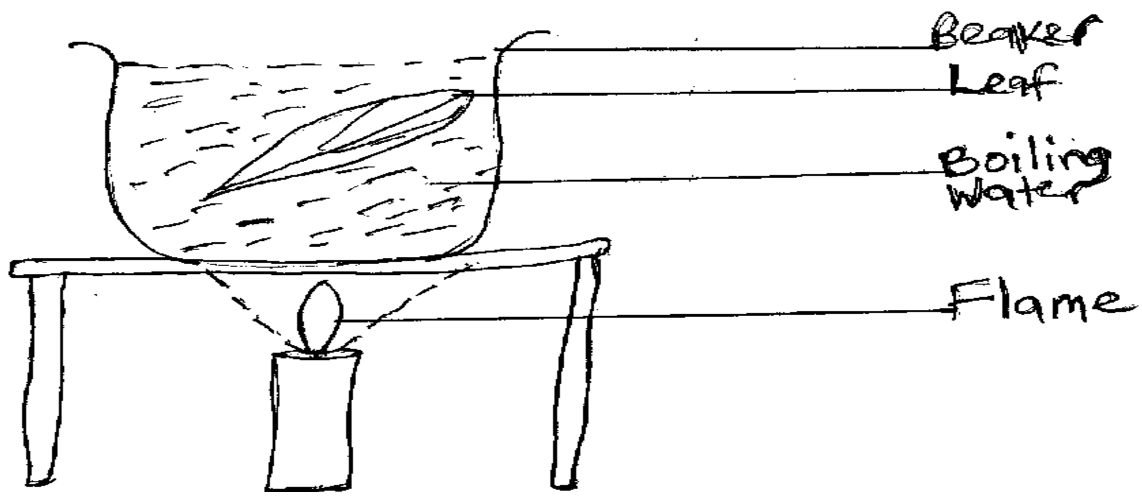
The simple sugar (glucose), which is the first product of photosynthesis is rapidly converted to starch and stored.

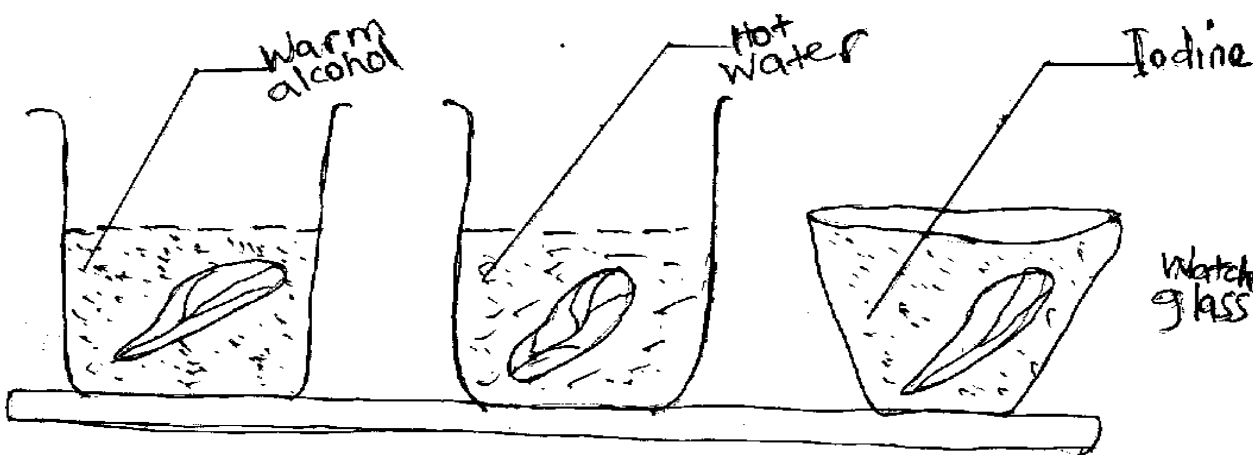
Activities:

Experiment: to test a leaf for starch produced during photosynthesis.

Apparatus:leaf from plant exposed to sun, Bunsen burner, iodine solution, beaker, water, matches, alcohol, watch glass, cotton wool.

Procedure: take a leaf from a green plant which has been in the sun for several hours and boil the leaf in water. Place the boiled leaf in warm alcohol until the colour comes out. It should be placed in a test tube. The tube is plugged with cotton wool so that excessive fumes do not escape. The tube is then placed in a beaker containing water. The water is warned slowly until the alcohol begins to simmer. Alcohol boils at 78.3 degree Celsius. Wash the leaf in hot water to remove the alcohol and prevent the leaf from becoming stiff. Spread the leaf out in a watch glass. Pour iodine solution over it, enough to completely cover it.





Result:the leaf turns blue-black in colour.

Conclusion: this indicates the presence of starch in the leaf.

Step 2: based on their experience during this experiment, the students would be asked to suggest the factors responsible for photosynthesis. These factors are:

- Carbon (iv) oxide.
- Light.
- Temperature.
- Water.
- Chlorophyll.

Evaluation: on the spot evaluation strategy was employed in order to correct the students' error.

Note that: the treatment flowchart for week 5, Science Process Approach is given below.

The teacher reviewed the students Prior Knowledge on: experiment, observation, inference, manipulating variables and apparatus, recording among others.

↓

Lesson Presentation Step 1: Students attention was drawn on how to use the basic and integrated process skills to carry out an experiment on how to test a leaf for starch.

↓

Step 2: Students were instructed to use the basic and integrated process skills to carry out an experiment to test a leaf for starch and also state the factors that affect the rate of photosynthesis

↓

Step 3: Using the experiment above, the students learnt how to control variables like light, reagents, apparatus among others.

↓

Step 4: Teacher moved around the laboratory in order to guide the students practical activities.

↓

Group-Discussion: 20 minutes (depending on the nature of the practical work and the difficulties faced by the students).

Class-Discussion: 25 minutes (depending on the nature of the practical work and difficulties encountered by the students.

↓

Evaluation of the laboratory activities

↓

Conclusion of the lesson

Treatment flowchart for week 5, SPA.

WEEK: 6.

This week was dedicated for revision and the administration of the instrument Biology Performance Test (BPT).

Note that: the treatment flowchart for week 6, Science Process Approach is given below.

The teacher reviewed the students Prior Knowledge on: observation, classification, collection and recording, experimentation, control of variables among others.

↓

The students were asked to go through all their practical works from week 1 – 5 and ask questions where they need some clarification.

↓

Class-Discussion: 30 minutes were used by the teacher for class discussion based on the activities covered with the students from week 1-5.

↓

Administration of the BPT: The Biology Performance Test (BPT) was administered to the students by the teacher.

Treatment flowchart for week 6, SPA.

APPENDIX V

LESSON PLAN FOR CONTROL GROUP, (LM).

WEEK: 1

Name of study School: Government Secondary School, Narayi (Senior).

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 280.

Average age: 17 years.

Topic: taxonomy of plants.

Duration:2:00-4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about the taxonomy of plants.
b. Learn about the biology classification of plants.

Previous knowledge: the students have already learnt in the previous Biology lesson that living things are classified based on their similarities and differences.

Presentation:

Step 1: the teacher introduces his lesson by teaching the students that taxonomy is the act of classifying living things based on their similarities and differences. In taxonomy, each species usually end up with two names. These are the Generic name and Specific name. The first letter of the Generic name starts with a capital letter while the first letter of the specific name starts with small letter. The Generic and Specific names form the Binomial nomenclature.

Step 2: the teacher explains to the students that in botany, plants are classified into four major groups called the Division or Phylum. These divisions are:

- Thallophyta .
- Bryophyte.
- Pteridophyta.
- Spermatophyta.

Step 3: the teacher discusses each of the division in detail to the students.

Thallophyta:

- Thallophyte is the common name for a group of plants that are placed in the Division Thallophyta of the plant kingdom.
- Thallophytes are characterized by the simple nature of their structure, an undifferentiated thallus that has no root, stem or leaves.
- Example of thallophyte is the green alga (spirogyra).

Bryophyta:

- Bryophyte is a collective term applied to about 22, 000 species of small plants that usually grow in moist areas, on soil, tree trunks and rocks.
- Bryophytes lie between the green algae from which they most likely have evolved.
- They lack true conducting tissues (vascular bundles) that is found in higher plants.
- Some species of bryophytes are aquatic and some can survive in dry, arid areas.
- Bryophytes are non-vascular embryo bearing plants of three plants groups namely:

  i. Bryophyta e.g. mosses.

  ii. Hepatophyta e.g. liverwort.

  iii. Anthocerophyta e.g. hornworts.

Step 4: **pteridophyta .**

- Pteridophyte is the common name for any genus of ferns, especially the common bracken.
- Distinguished from other ferns in part by their spores' cases which are situated near the margin of the back of the leaf.
- Pteridophytes grow in open woodlands.
- The leaves (frond) arise singly from a thick underground root stalk and are divided into several pinnate.
- Bracken is from the genus Pteridium of the family Polypodiaceae.

Spermatophyte:

- Spermatophyte is the advanced form of plant kingdom.
- Has body divided into leaf, stem and root.
- Has a well-developed vascular bundles (xylem and phloem).
- Seeds producing plant such as angiosperm or gymnosperm.
- Angiosperm group comprising of flowering plants that produced enclosed seeds.
- Gymnosperm group comprising of flowering plants that produced naked seeds e.g. ponderosapine.

Students' activity: students were asked to explain briefly the biological classification of plants.

Conclusion: teacher went over the lesson emphasizing the key concepts taught to the students.

Assignment:classify plant using your knowledge in biology.

WEEK: 2.

Name of study school: Government Secondary School, Narayi (Senior).

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 280.

Average age: 17 years.

Topic: taxonomy of plants.

Duration: 2:00- 4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about the classification of plants using the Agricultural technique.
b. Learn about the classification of plants based on their life cycles.

Previous knowledge: the students have already learnt about the botanical classification of plants.

Presentation:

Step 1: the teacher explains to the students that in Agriculture, plants are classified based on their uses to man. Examples:

- Cereals are seeds use as food to man, examples maize, rice, millet.
- Legumes are single chambered flattened seed pod with two sutures e.g. groundnuts. Legume may be indehiscent or dehiscent. Legumes renew the soil nitrogen.
- Root crops are crops grown for its edible roots, e.g. potato, cassava.
- Vegetables are edible products of herbaceous plants with soft stem, e.g. cabbage, lettuce.
- Fruits are seeds bearing structure of flowering plants. It is a fertilized ovary e.g. banana, pawpaw, oranges.
- Beverages and drugs, beverage is a plant which extract is used as drink, e.g. coffee while drug like tobacco is grown for commercial use.
- Spices are aromatic flavoring made from plant parts. The term spice is applied to pungent plant product like ginger and pepper.

- Oil plants are plants that their fruits/products can be processed to produce oil, e.g. palm fruits, coconuts.
- Latex are plants with milky fluid found in specialized cells e.g. rubber plant.
- Fibres are plants that produce a long slender thread or filament e.g. cotton. Cotton is used in the textile industry to produce clothing materials.

Step 2: plants are classified based on their life cycle into:

- Ephemeral plants.
- Annual plants.
- Biennial plants.
- Perennials plants.

Ephemeral plants are plants that do complete their life cycle more than once in a year. Example is Zea mays (maize).

Annual plants are plants that do grow, flower and produce seeds/fruits within one year e.g. yam, ginger.

Biennial plants are plants that grow, flower and produce seeds/fruits within two years; example is Carica papaya (pawpaw).

Perennials plants are plants that grow flower and produce seeds/fruits in many years before they die, examples mango, orange plants.

Evaluation: on the spot evaluation strategy was employed. That is to say those questions were asked to the students at the end of every stage of the lesson, e.g. differentiate between biennial and perennial plants.

Summary and conclusion: at this stage, the students were asked to summarize what they have learnt on their note books.

Assignment: classify plants using the Agricultural technique.

WEEK: 3.

Name of study school: Government Secondary School, Narayi (Senior).

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 280.

Average age: 17 years.

Topic: mechanism of gaseous exchange in plants.

Duration: 2:00- 4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about the stomata and also study their functions.

b. Learn about the mechanism of stomata opening and closing.

c. Learn about the mechanism of gaseous exchange in plants.

d. Learn about transpiration and study the factors that affect it.

Presentation:

Step 1: the teacher explains the mechanism of gaseous exchange in plants.

Aquatic plants obtain Carbon (iv) oxide from the surrounding water in form of carbonic acid.

Land plant obtain Carbon (iv) oxide from the atmosphere, it diffuses into the plant through the stomata.

Carbon (iv) oxide is essential to green plants for photosynthesis.

Step 2: the stomata.

Stomata are pores perforating the epidermis of the leaves and stems.

Stomata are numerous in the lower epidermis of the leaf.

There are fewer stomata in the upper epidermis and fewer still on the stem.

Functions of the stomata are:

Allow exchange of Carbon (iv) oxide and oxygen between the inside of leaf and the atmosphere.

It controls the flow of water in the xylem vessel.

It allows transpiration to occur.

Mechanism by which stomata open and close:

The stomatal pore is surrounded by pair of guard cells.

Stomatal opening and closure depends on changes in turgor pressure of the guard cells,

Absorption of water by osmosis makes the guard cells turgid.

Turgidity of the guard cells opens the stomata.

Flaccidity of the guard cells closes the stomata.

Step 3: transpiration.

Stomata allow the evaporation of water from the plant, a process known as transpiration.

When transpiration takes place through the cuticle, it is cuticular transpiration and when it occurs through the lenticels, it is lenticellular transpiration.

Factors that affect the rate of transpiration are:

Temperature.

Relative humidity.

Air movement.

Atmospheric pressure.

Light.

Water supply.

Evaluation:at every stage of the lesson, questions were asked in order to ascertain whether or not the students have understood the lesson.

Assignment: explain the mechanism of gaseous exchange in plants.

WEEK: 4.

Name of study school: Government Secondary School, Narayi (Senior).

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: Male and female.

Number of students: 280.

Average age: 17 years.

Topic: pollination.

Duration: 2:00- 4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about pollination and explain the 2 types of pollination.

b. Study and explain the characteristics of insects and wind pollinated flowers.

c. Learn about the agents of pollination.

Previous knowledge: the students have already learnt about pollination.

Presentation:

Step 1: the teacher explains the term pollination.

Anther is the male reproductive structure in the flowering plant that produces the pollen grains.

Ovary is the female reproductive structure in plant that produces the ovules.

Pollen grains must be transferred from the open anthers to the stigma, this is called pollination.

Types of pollination are:

Self-pollination where pollen grains fall on the stigma of the same flower.

Cross pollination where pollen grains are conveyed by agents of pollination to another flower but of the same species.

Step 2: the teacher explains the characteristics of insects and wind pollinated flowers.

Characteristics of insect pollinated flower:

Brightly coloured sepals and petals.

Scent production.

Secretion of nectar.

Sticky pollen grains

Example of insect pollinated flower is Caesalpiniapulcherima (pride of Barbados)

Characteristics of wind pollinated flower:

Massive production of pollen grains.

Pollen grains are light.

Pollen grains are feathery.

Pollen grains are not sticky.

Flowers are not brightly coloured.

Step 3: the teacher explains the agents of pollination to the students. These are:

Water.

Insects.

Wind.

Animals.

Note that: after pollination, the pollen tube is formed which moves to the ovary to fuse with the ovules, a process known as fertilization. After fertilization, the ovules become seeds while the entire ovary becomes the fruit.

Evaluation: at each stage, questions were asked to the students in order to assess their understanding.

Summary/conclusion: students were asked to form their notes based on the learnt concepts.

Assignment: list and explain the characteristics of insect and wind pollinated flowers.

WEEK: 5.

Name of study school: Government Secondary School, Narayi (Senior).

Name of researcher: Maikano Stanley.

Level of Group: SS II.

Gender: male and female.

Number of students: 280.

Average age: 17 years.

Topic: autotrophic nutrition.

Duration: 2:00- 4:00 pm

Behavioural objectives: by the end of the lesson, the students should be able to:

a. Learn about the term autotrophic nutrition and study the 2 types.

b. Learn about photosynthesis and study the factors that affect it.

c. Study and explain the two reactions of photosynthesis.

d. Learn about translocation and study the form of food storage in plants.

Previous knowledge: the students have already learnt about the elementary aspect of photosynthesis.

Presentation:

Step 1: the teacher explains the term autotrophic nutrition to the students:

Autotrophic nutrition occurs in living species that produce their own food, e.g. green plants.

The two types of autotrophic nutrition are; photosynthesis and chemosynthesis.

Step 2: the teacher explains photosynthesis to the students:

Photosynthesis is the synthesis of organic compound by the reduction of Carbon (iv) oxide using sunlight absorbed by the chlorophyll. In green plants where water is the hydrogen donor and the source of released oxygen.

Factors affecting the rate of photosynthesis are grouped into two, these are:

Internal factors; water and chlorophyll.

External factors; light, Carbon (iv) oxide and temperature.

Step 3: the teacher explains the two reactions of photosynthesis to the students; these are the light and the dark reactions.

Light reaction:

First reaction of photosynthesis that is light dependent which takes place at the palisade layer of the leaf.

In this reaction, light energy is used to split water molecule into hydrogen ion and hydroxyl ion, a process known as photolysis of water molecule.

The hydrogen ion is transferred to the dark reaction while the hydroxyl ion is reconverted back to water with the release of oxygen.

Dark reaction:

Second reaction of photosynthesis that is light independent that is it occurs either in the day or night but light is not important.

In this reaction, hydrogen ion is used to reduce Carbon (iv) oxide to form glucose (monosaccharide).

Hydroxyl ion is reconverted back to water with the release of oxygen.

Step 4: the teacher explains the term translocation to the students:

Translocation is the process where excess product of photosynthesis is transfer from the organ where it is produced to the storage organ through the phloem tissues.

The different types of storage organs in plants are:

Root tuber e.g. potato.

Stem tuber e.g. yams.

Bulb e.g. onions.

Fruits e.g. oranges.

Evaluation: at each stage, questions were asked to the students in order to assess their level of understanding.

Summary/conclusion: students were asked to write comprehensive notes, using the notes taken on their jotters.

Assignment: explain the two reactions of photosynthesis.

WEEK: 6.

This week was dedicated for revision and the administration of the test instrument; Biology Performance Test (BPT).

APPENDIX VI RELIABILITY COEFFICIENT OF INSTRUMENT (BPT) USING PPMC.

	A	B	C	D	E	F	G	H
1	**Rank Correlations**							
2		Var_A	Rank	Var_A	Rank	Difference	**Spearman R**	**0.8469**
3	1	32	39.5	34	40	-0.5	*Rank Difference Squares Sum*	1,615.5
4	2	11	2.5	18	4.5	-2	*t-test value for hypothesis r = 0*	9.8182
5	3	17	19.5	20	16	3.5	*p-level*	0
6	4	16	16	17	2.5	13.5	**Kendall Tau**	**0.6792**
7	5	23	30	30	36.5	-6.5	*Inversions Count*	92
8	6	17	19.5	25	25	-5.5	Z	6.1725
9	7	19	24	21	20	4	*p-level*	0
10	8	15	12	18	4.5	7.5	**Gamma**	**0.7302**
11	9	19	24	20	16	8	*Pearson Correlation Coefficient*	0.8453
12	10	20	26.5	25	25	1.5		
13	11	16	16	19	9	7		
14	12	24	32.5	27	28.5	4		
15	13	14	9	17	2.5	6.5		
16	14	12	4.5	16	1	3.5		
17	15	23	30	24	22	8		
18	16	23	30	30	36.5	-6.5		
19	17	11	2.5	19	9	-6.5		
20	18	9	1	20	16	-15		
21	19	18	21.5	23	21	0.5		
22	20	14	9	19	9	0		
23	21	28	35.5	30	36.5	-1		
24	22	16	16	19	9	7		
25	23	28	35.5	29	32.5	3		
26	24	13	6.5	19	9	-2.5		
27	25	13	6.5	20	16	-9.5		
28	26	20	26.5	25	25	1.5		
29	27	12	4.5	19	9	-4.5		
30	28	14	9	19	9	0		
31	29	15	12	20	16	-4		
32	30	25	34	30	36.5	-2.5		
33	31	15	12	20	16	-4		
34	32	32	39.5	27	28.5	11		
35	33	18	21.5	20	16	5.5		
36	34	19	24	28	30.5	-6.5		
37	35	29	37	30	36.5	0.5		
38	36	24	32.5	29	32.5	0		
39	37	16	16	28	30.5	-14.5		

	A	B	C	D	E	F	G	H
40	38	21	28	25	25	3		
41	39	31	38	30	36.5	1.5		
42	40	16	16	25	25	-9		

APPENDIX VII

RAW SCORES FOR TESTING HYPOTHESES 1 - 4

HYPOTHESIS ONE

There is no significant difference in the academic performance of Secondary School Students taught biology using the Computer Assisted Instruction and their counterparts taught the same concepts using Science Process Approach teaching strategy and Lecture Method.

Total sampled = 153 ÷3 (CAI, SPA, LM) =51.

CAI=51

SPA=51

LM=51

One way ANOVA should be used to analyze this hypothesis.

S/N	CAI (not significant)	SPA (not significant)	LM (significant)
1.	36	40	30
2.	41	33	34
3.	33	41	27
4.	30	38	28
5.	40	33	30
6.	44	30	31
7.	42	35	29
8.	38	41	29
9.	37	40	30
10.	40	41	30
11.	40	38	26
12.	43	35	25
13.	3839	28	
14.	3936	30	
15.	40	41	22
16.	42	40	25
17.	34	37	27
18.	41	33	30
19.	38	41	22
20.	36	39	26
21.	43	41	28
22.	36	37	30

23.	41	35	29
24.	37	40	27
25.	35	38	26
26.	40	41	23
27.	38	37	30
28.	40	33	29
29.	38	35	27
30.	45	40	23
31.	32	41	19
32.	40	33	20
33.	36	40	30
34.	41	37	19
35.	37	36	27
36.	40	40	30
37.	39	38	19
38.	41	41	22
39.	37	35	25
40.	43	41	29
41.	40	30	21
42.	36	34	30
43.	41	41	19
44.	38	42	21
45.	33	37	18
46.	40	35	22
47.	39	35	29
48.	37	38	19
49.	40	36	20
50.	43	40	19
51.	36	41	27

HYPOTHESIS TWO

There is no significant difference in the mean academic performance scores of Secondary School Students taught biology s with a). Low ability b). Medium ability and c). High ability using the Computer Assisted Instructional teaching strategy, Science Process Approach and the Lecture Method.

CAI 51 (H 17, M17, L17).

SPA 51 (H 17, M17, L 17).

LM 51 (H 17, M17, L17).

Two ways ANOVA will be used to test this hypothesis.

CAI

S/N	HIGH (not sig)		MEDIUM (not sig)		LOW (not sig)
1.	40		36		35
2.	39		40		39
3.	40		37		40
4.	35		40		37
5.	40	36		36	
6.	43	39		33	
7.	45	42		30	
8.	44		38		30
9.	39		41		40
10.	40		37		37
11.	40		40		36
12.	41		39	41	

13.	38	42	35
14.	40	40	37
15.	38	39	33
16.	41	39	36
17.	40	40	40

SPA

S/N	HIGH (Not sig)	MEDIUM (Not sig)	LOW (Not sig)
1.	39	35	37
2.	36	40	35
3.	40	36	33
4.	38	40	40
5.	40	39	38
6.	40	36	36
7.	39	35	37
8.	37	40	40
9.	40	41	39
10.	43	40	35
11.	40	39	37
12.	39	40	40
13.	40	33	37
14.	38	37	38
15.	39	39	35
16.	40	38	39

17.	37	40	35

	LM		
	HIGH (Sig)	MEDIUM (Sig)	LOW (Sig)
S/N			
1.	40	33	29
2.	39	39	30
3.	40	40	26
4.	41	31	17
5.	38	29	20
6.	40	32	22
7.	37	41	28
8.	41	35	30
9.	41	30	19
10.	39	30	25
11.	35	32	28
12.	40	31	26
13.	41	36	19
14.	40	32	22
15.	36	33	24
16.	39	36	30
17.	40	35	23

HYPOTHESIS THREE

There is no significant difference in the retention ability of Secondary School Students taught biology using Computer-Assisted Instructional strategy, Science Process Approach and Lecture Method.

Total sampled =153 ÷3 (CAI, SPA, LM) = 51.

CAI =51

SPA = 51

LM = 51

One way ANOVA will be used to analyze this hypothesis.

SN	CAI (Not sig)	SPA (Not sig)	LM (Sig)
1.	43	40	29
2.	35	39	30
3.	41	41	27
4.	38	33	25
5.	37	37	30
6.	40	39	26
7.	42	35	28
8.	40	41	30
9.	39	40	30
10.	35	38	31
11.	30	33	29
12.	33	37	27
13.	30	40	30
14.	40	41	30

15.	43	43	28
16.	37	38	30
17.	40	33	27
18.	39	36	30
19.	33	40	28
20.	40	39	30
21.	41	35	26
22.	44	38	29
23.	37	40	30
24.	35	36	25
25.	33	39	24
26.	38	41	28
27.	41	36	27
28.	39	33	30
29.	35	37	25
30.	37	40	25
31.	40	38	30
32.	35	33	26
33.	37	36	28
34.	33	35	28
35.	41	39	25
36.	39	37	29
37.	40	40	30
38.	37	42	31
39.	40	33	27

40.	38	37	24
41.	35	39	26
42.	39	36	30
43.	40	40	27
44.	33	40	29
45.	38	37	26
46.	40	39	30
47.	41	36	24
48.	36	38	27
49.	33	40	24
50.	40	39	28
51.	35	37	29

HYPOTHESIS FOUR

There is no significant difference in the academic performance between male and female Secondary School Students taught biology using Computer-Assisted Instructional strategy, Science Process Approach and Lecture Method.

Sampled size 138 (69 male & 69 female).

CAI (Male 23, Female 23), SPA (Male 23, Female 23), LM (Male 23, Female 23).

Two ways ANOVA will be used to test this hypothesis.

CAI

S/N	Male	Female
1.	38	40
2.	40	38
3.	37	30
4.	42	37
5.	39	36
6.	37	38
7.	40	40
8.	36	41
9.	39	37
10.	41	40
11.	38	39
12.	41	37
13.	33	40
14.	36	39
15.	39	36
16.	40	33
17.	40	40
18.	38	37
19.	36	39
20.	40	36
21.	39	40
22.	40	37

23.	37	40

SPA

S/N	Male	Female
1.	40	40
2.	40	38
3.	36	41
4.	40	37
5.	38	39
6.	39	35
7.	40	40
8.	35	41
9.	40	41
10.	40	37
11.	39	32
12.	35	39
13.	33	40
14.	36	40
15.	40	33
16.	41	39
17.	39	37
18.	37	40
19.	40	38
20.	36	40

21.	33	36
22.	40	38
23.	39	40

LM

S/N	Male	Female
1.	36	38
2.	39	40
3.	40	33
4.	33	38
5.	30	37
6.	37	35
7.	30	30
8.	32	34
9.	37	36
10.	39	37
11.	36	40
12.	37	33
13.	33	36
14.	38	39
15.	40	38
16.	38	33
17.	34	36
18.	36	33

19.	39	34
20.	33	40
21.	34	36
22.	35	39
23.	37	33

No significant difference existed in the academic achievement of male and female using CAI, SPA and LM. CAI, SPA and LM are gender friendly.