EFFECTS OF CONCEPT MAPPING AND EXPERIMENTAL TECHNIQUES IN TEACHING BIOLOGY IN SECONDARY SCHOOLS IN FEDERAL CAPITAL TERRITORY ABUJA, NIGERIA

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A DISERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN CURRICULUM AND INSTRUCTION, AHMADU BELLO UNIVERSITY, ZARIA

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AUGUST, 2015

DECLARATION

I hereby declare that this Dissertation tilted "EFFECTS OF CONCEPT MAPPING AND EXPERIMENTAL TECHNIQUES IN TEACHING BIOLOGY IN SECONDARY SCHOOLS IN FEDERAL CAPITAL TERRITORY ABUJA" is a collection of my original research work and has not been produced for any other qualification anywhere. This work was undertaken by me in the Department of Educational Foundations and Curriculum under the supervision of Dr (Mrs) H.O. Yusuf, Dr A. Guga and Dr S. Mohammed. The information derived from literatures (published or unpublished) has been duly acknowledged.

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CERTIFICATION

This Dissertation entitled "EFFECTS OF CONCEPT MAPPING AND EXPERIMENTAL TECHNIQUES IN TEACHING BIOLOGY IN SECONDARY SCHOOLS IN FEDERAL CAPITAL TERRITORY ABUJA" by Martins-Omole Mojirola Ibitomola meets the regulations governing the Award of Philosophy of Education Degree in Curriculum and Instruction of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

Dr. (Mrs) H. O. Yusuf _____ _____

Chairman, Supervisory Signature Date

Dr. A. Guga _____ _____

Member, Supervisory Committee Signature Date

Dr. S. Mohammed _____ _____

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Head of Department Signature Date

Prof. A. Z.Hassan _____ _____

Dean School of Postgraduate Studies Signature Date

DEDICATION

This work is dedicated to the Almighty God the fulfiller of dreams and to my husband for being a motivator to the fulfillment of my dream.

ACKNOWLEDGEMENTS

A work of this magnitude and scope would not have been made possible without the help, sacrifice and co-operation of some individuals. I want to appreciate God for His wisdom, strength and courage He bestowed on me to be able to start this PhD programme and to come to this far to Him be the glory.

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ABSTRACT

The study was aimed at determining the Effect of Using Concept Mapping and Experimental Techniques in Teaching Biology in Senior Secondary Schools in Federal Capital Territory. The design of the study was quasi experimental pretest posttest control group design. The population consisted of 6,208 SS2 Biology students of the Federal Capital Territory, from which 192 were selected from three schools within Karshi zone of Abuja Municipal Area Council. Intact classes of 64 students each of SS2A & SS2B students of Government Secondary School Nyanya were used for the experimental group which consisted of students taught Biology using concept maps and experiments and 64 SS2A students of Government Day Secondary School Karu were used for the control group respectively. The choice of the schools were because they shared similar characteristics like student types (co-educational), number of students per class and presence of competent and experienced Biology teachers. To guide the study, five research questions were raised and five hypotheses stated and test at 0.05 level of significance. The major instruments used for data collection were Biology Achievement Test pretest and posttest (BAT), Biology Achievement Retention Test (BART) used after 2 weeks of instruction and Concept Mapping Attitude Scale Towards Biology Questionnaire (CMASTBQ) and Experiment Attitude Scale Towards Biology Questionnaire (EASTBQ).The treatment package included Concept Mapping Instructional Package (CMIP), Lesson Plan for Experiments and Lesson Plan for Control Group. The items used for the pretest, posttest and retention test were adopted from Educational Resource Centre (ERC) Abuja. The items were lifted based on the topics used for the study. The reliability of these instruments used was 0.65 for concept mapping and 0.78 for experimental techniques. The data collected was analyzed using comparative mean and standard deviation for research questions while the null hypotheses were analyzed using Two sample t-test, Covariance Analysis(ANCOVA) and Pairwise comparison tested at 0.05 alpha level of significance. The findings of the study showed a significantly better academic performance of students who were taught using experiments than those taught using concept mapping; students taught using experiments performed significantly higher in retention of Biology knowledge than those taught using concept mapping and lecture method, no significant difference was observed between students taught using concept mapping and lecture method on retention of these concepts; Students showed positive attitude towards the use of concept mapping over the use of experiments Based on the findings, experiments are indispensable if the teaching and learning of Biology is be effective and meaningful. Recommendations were made to this effect that Science Teachers Association of Nigeria in conjunction with the Federal Ministry of Education should liaise with stakeholders in the FCT and the Nation in general to provide well equipped Biology laboratory in all senior secondary schools. Teachers should also be encouraged to use Concept mapping alongside lecture method in teaching Biology in Senior Secondary Schools.

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OPERATIONAL DEFINITION OF TERMS

Concept Maps: These are derived from a method of teaching called concept mapping. Which is a process of teaching topics or concepts by representing them with maps .These maps helps to give meaning and insight into every part of the concept. These maps begin with the main topic to the sub-topics within the main topic. These maps are connected with links which connects the concepts and also give meaning to the concepts as they join them together.

Experiment in Biology: It is a process of learning Biology concepts by performing experiments in an orderly procedure with the goal of verifying, refuting or establishing the validity of a hypothesis and making systems of organisms that have been taught to the students real to them.

Lecture Method: This refers to an oral presentation of lesson given to a class by the teacher. The teacher usually dispenses facts and opinions about contents, while students listen passively and sometimes make their own contributions when they are familiar with the topic(s).

Retention: In this study retention is the ability of students to remember or recall Biology concepts they have been taught 2 weeks and 5 weeks after the study respectively.

Attitude: This concept defines students' response either positively or negatively to the use of a teaching method in giving instruction.

Technique: These are principles and methods used in instruction.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The subjects at the Senior Secondary Schools in Nigeria are divided into Arts, Social Sciences and Sciences depending on the course each individual intends to offer after the secondary education. In Nigeria, the sciences are taught in subjects such as Physics, Chemistry and Biology. As a biology teacher of many years, experience has shown that even though a large populace of students show interest in offering biology as a subject and think it to be the simplest of the sciences, there have been a consistent poor achievement in both internal and external examinations. On the order hand even though biology lessons are supposed to be taught with practical lessons I have observed over the years that most biology teachers do not teach their lessons with praticals. The National Curriculum for Senior Secondary Schools Volume Three (3) Science in (Ajaja 2009) stated the specific objectives to be achieved by each subject (curriculum).

The cardinal objectives for biology include:

> Adequate laboratory and field skills in Biology;
> Meaningful and relevant knowledge in Biology;
> Ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture; and
> Reasonable and functional scientific attitudes. (Ajaja, 2009)

Biology occupies a unique position in the school curriculum; this is because Biology is central to many sciences related professional courses such as Medicine, Pharmacy, Agriculture, Nursing, Biochemistry, Dentistry, Microbiology, Laboratory Technology and all other related courses. It therefore becomes binding on anyone wishing to offer any of the courses listed above or any related to such to offer Biology as one of the prerequisite subjects in the secondary school to gain admission into the University.

Although Biology is a prerequisite to these courses, poor achievement in Biology is alarming according to reports from Okebukola (1998), Ajaja (2002), Ahmed (2008) and randomly collated WAEC results by the researcher from 10 schools in six area councils of Federal Capital Territory, between 2006 – 2010 in 2011 and also my experience in students poor performance in biology internal examinations. These consistent poor performances in Biology external examinations among Senior Secondary Schools students have given a lot of concern to educators, curriculum planners and students themselves Okoye (2004). Various teaching methods are used for instruction in the teaching of Biology. These teaching methods have been summarized into Expository, Practical or Activity Oriented and Constructivism. Okoye and Okechukwu (2006), Nwokenna (2010). Expository methods according to Nwokenna (2010) which include lecture method, demonstration, project, field trip and discussion methods. They concentrate on presentation of concepts, facts and principles by the teacher while the students are merely asked to listen and take notes.

These facts and principles are drawn from textbooks based on stipulated contents and cognitive levels within the unit of instruction. The foregoing presents a picture of the use of poor teaching methods used during Biology instruction, which according to Nwokenna (2010), may not improve the performance of students in their academic pursuit. The above scenario tends to suggest that the conventional teaching methods used among others have accounted for the persistent poor performance of students in internal and external examinations.

Scientists and science educators have however come to a conclusive agreement as many researches have been on going on how to involve students in the learning process and science educators have come up with concept maps as one of such teaching learning techniques. Okoye and Okechukwu (2006), Kinechin (2000a,b), Markow and Lenning (1998). According to Canas and Novak (IHMC 2009) concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclossed in circles or boxes of some type and relationships between concepts are indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases specify the relationship between two concepts. Wikipedia, the free encyclopedia defined concept map as a diagram that depicts suggested relationships between concepts. It is a graphical tool that designers, engineers, technical writers and others use to organize and structure knowledge. Giving an overview, the Wikipedia encyclopedia describes concept map as a way of representing relationship between ideas, images or words in the same way that a sentence diagram represents the grammar of a sentence, a road map represents the locations of highways and towns and a circuit diagram represents the workings of an electrical appliance. In concept map, each word or phrase connects to another, and links back to the original idea, word or phrase. Concept maps are means of developing logical thinking and study skills by revealing connections and helping students see how individual ideas form a larger whole.

The technique of concept mapping according to Wikipedia encyclopedia was developed by Joseph D. Novak as a means of representing the emerging science of knowledge of student by his research team at Cornell University in the 1970s s. It has subsequently been used as a tool to increase meaningful learning in the sciences and other subjects as well as to represent the expert knowledge of individuals and teams in education,

government and business. Concept maps have their origin in the learning movement called constructivism. In particular, constructivists hold that learners should actively construct knowledge.

Novak & Canas (2006) believes that one of the reasons concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks.

Biology experiments and investigations are keys to enhanced learning, clarification and consolidation of theory. Practical activities are not just motivational and fun: they also enable students to apply and extend their knowledge and understanding of Biology in novel investigative situations which can stimulate interest and aid learning and retention. Crucially, practical work gives students an understanding of how biological knowledge is generated by experiment and observation. (www.societyofbiology.org, 2009-2013). Nwagbo & Chukelu (2011) believe that practical activities in Biology provide opportunities for students to actually do science as opposed to learning about science. Nzewi (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more realistic to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matter. Nzewi maintained that practical activities should engage the students in hands-on, mind-on activities, using varieties of instructional materials/equipments to drive the lesson home. Nwagbo (2008:4) stated that the use of practical activities (approach) tin the teaching of Biological concepts should therefore be a rule rather than an option to Biology teachers. If we hope to produce students that would be able to

acquire the necessary knowledge, skills and competence needed to meet the scientific and technological demands of the nation .Nwosu in Ibe (2004) asserted that science process skills are abilities which can be developed by experience and used in carrying out mental and physical operations.

Practical work is a central theme of lessons in the natural sciences (Galton and Eggleston, 1979: Holstein and Lunelta, 1982) in Abimbola(1994) . Laboratory work is seen as an integral part of most science courses and offers students a learning environment that differs in many ways from the "traditional" classroom setting (Fisher ,Harrison, Henderson & Hofstein 1998). It is hard according to Ozay, Ocak and Ocak (2009) to imagine learning about science, without doing laboratory work or fieldwork. Student experimentation underlies all scientific knowledge and understanding. They provide students with opportunities to think about, discuss and solve real problems. No science can be properly taught without students' experiments. The student experiment should be the central part of science teaching. It serves many purposes. Students' experiments are performed to find relations among concepts or to verify hypothesis. Studies from (Mandor, 2002; Ibe, 2004; and Nwagbo and Chukelu, 2011) have also indicated that active participation of students give rise to more meaningful and effective learning. The Biology teacher should therefore make Biology a student based learning by making experiments part of Biology teaching so as to improve students' performance.

One of the key factors in learning science is students' attitude, and development of positive attitudes toward science can motivate students' interest in science and science related careers. George, (2006) in Nasr & Asghar, (2011), Simpson and Oliver (1990) in Nasr & Asghar (2011) sees the concept of attitude towards science as vague and

ambiguous. They opined that attitude is a concept that defines emotional trends in response to affairs, persons, locations, events or ideas. They concluded that such phrases as 'I like science or I enjoy science' courses enumerate as attitude. According to Yara (2009) in Omirin and Oladosu (2010) attitude of the teacher and his teaching method can influence students' attitude. And attitude as they say is the key to success. Franseca (2010) opined that one of the factors that affect students' learning performance is the way they face knowledge, namely their attitude to the subject. Such attitudes as profound feelings, relatively stable are derived from positive or negative experiences across time on learning a subject (Estrad, 2002 in Franseca 2010). Buttressing this, studies from Markow and Lonning, (1998), Simpson, (1978), Wilson, (1983) and Soyibo, (1985), in Adesoji (2008) reported that students' positive attitude to science correlate highly with science achievement.

Learning according to Angelo and Howard (2007) is a complex cognitive process that occurs in individual ages. The learner may have a variable degree of understanding of the new information, at one end of the spectrum and the learner may have virtually no understanding of the new information, this condition is called rote learning. In such a condition the learner acquires information primarily through verbatim memorization. Because the conceptional meaning of the knowledge being memorized is not addressed, the new information cannot be linked to relevant concepts the learner already knows. According to the authors, the outcome of rote learning is that little or no information is transferred into the long-term memory. Citing Novak and Gowin,(1984)& Novak (1991b), they opined that the outcome of meaningful learning is that the new information is transferred into long term memory (retained) in a relevant linkage with prior knowledge. As such, meaningful learning leads to long term information retention.

The foregoing therefore underscores the need to look into the effect of concept mapping and experimental techniques in teaching Biology

1.2 Statement of the Problem

This study was inspired in response to the deteriorating performance of students in internal and external Biology examinations. Chief WAEC examiner's report 2004, 2005, 2006,2007 and randomly selected WAEC results from ten schools within the six Area councils of FCT Abuja and the researcher's experience as a biology of many years experience of attest to this . These poor performances according to Ajaja (2011) were occasioned by the very poor state of resources for teaching and learning Biology and the unchallenging environment under which the teaching of Biology takes place. The state of the Biology laboratories Ajaja (2011) opines range from total absence to ill-equipped ones. (Nwagbo 2001 in Nwagbo and Chukelu, 2011) among other researchers identified the teacher variable, that is the teacher's teaching strategy as being responsible for students' poor performance in science and Biology in particular. WAEC chief examiner's report (2002 &2003) in Egolum &Nwafor (2012) showed that the traditional teaching methods have not yielded expected results.

Researchers like Nwagbo and Chikelu (2011), Nwagbo (2008) and Nzewi (2008) have also observed that experimental techniques help students to acquire basic scientific skills which helps to improve performance because students are involved in process skills and not only the theories behind them. This is because, the acquisitions of science process skills are the basis for scientific inquiry and the development of intellectual skills and attitudes that are needed to learn concepts. It therefore becomes necessary in a quest to finding a solution to the persistent poor performance of students in biology to substantiate these claims empirically. This situation therefore calls for a search for

alternative teaching methods or a combination of methods that will guarantee effective learning by students. The notion that concept mapping makes students to remember information longer and enables them to use this knowledge effectively because it is moved to a long term memory Novak & Canas (2006),makes it a possible alternative. Also the use of experiments have been shown to give rise to effective learning .The statement of the problem therefore is to determine the effects of using concept mapping and experimental(experiments in Biology) techniques for the teaching of selected topics in Biology in Senior Secondary Schools in Karshi zone of the federal Capital Territory Abuja.

1.3 Objectives of the Study

This study sought to achieve the following objectives:

1. Compare the mean performance of students taught biology using concept maps and experiments in the Federal Capital Territory.

2. Compare the mean performance of students taught biology using concept map, experiments and lecture method Federal Capital Territory.

3. Determine the level of retention of biology knowledge between students taught using concept maps and experiments in the Federal Capital Territory.

4. Determine the level of retention of biology knowledge between students taught using concept maps, experiments and lecture method in the Federal Capital Territory.

5. Compare the attitude of students to the teaching of biology when concept maps and experiments are used in the teaching of biology in the Federal Capital Territory.

1.4 Research Questions

1. What is the difference in the mean scores of students taught biology using concept map and experiments in the Federal Capital Territory?
2. What is the difference in the mean scores of students taught biology using concept maps, experiments and lecture method in the Federal Capital Territory?
3. What is the mean score of students taught using concept maps and experiments in the retention of biology concepts used for the study in the Federal Capital Territory?
4. What are the mean scores of students taught using concept maps, experiments and lecture method in the retention of biology concepts used for the study in the Federal Capital Territory?
5. What is the difference in attitude of students towards Biology when concept maps and experiments are used for teaching biology in the Federal Capital Territory?

1.5 Hypotheses Testing

$H0_1$: There is no significant difference in the mean scores of students taught biology using concept map and those taught using experiments in the Federal Capital Territory.

$H0_2$: There is no significant difference in the mean scores of students taught biology using concept map, experiments and those taught using lecture method in the Federal Capital Territory.

$H0_3$: There is no significant difference in the mean scores of students taught using concept map and those taught using experiments in the test of retention of selected biology concepts in the Federal Capital Territory.

$H0_4$: There is no significant difference in the mean scores of students taught using concept map and experimental techniques and those taught with lecture method in the test of retention of selected biology concepts in the Federal Capital Territory.

$H0_5$: There is no significant difference in students' attitude towards biology when concept map and experiments are used for teaching in the Federal Capital Territory.

1.6 Basic Assumptions

The study is based on the following assumptions:

1. That most biology teachers are not conversant with learning theories that are best suited for biology teaching and learning.
2. That in schools where laboratories are well equipped biology teachers do not make out time to teach their students using experiments.
3. That most biology teachers do not take time to analyze their teaching methods to find out how appropriate it is to the topics they teach at a particular time, as not all topics in biology can be taught using only one particular teaching method.
4. That most biology teachers do not make attempt at finding out if other methods can be added to the lecture method for effective teaching.
5. That most biology teachers are not concerned about students' negative attitude towards the teaching and learning Biology as a result of their teaching method.

1.7 Significance of the Study

The findings of this study will be of benefit to biology students, teachers, curriculum planners/ developers, textbook writers, ministry of education and future researchers. Biology students will benefit from the findings of this study as the use of concept maps and the use of experiments in the teaching of biology will boost their achievement and

help to increase their retention of biology concepts. It will also help them to develop more interest in Biology and acquire and develop scientific skills which will help them in their career choice particularly those careers geared towards Biological sciences.

The findings of this study will be of benefit to biology teachers as it will help teachers in choosing appropriate instructional methods and materials capable of releasing students' tension toward the subject. It will motivate teachers to develop interest in utilizing modern instructional material like using experiments in teaching topics that are experimental in nature and selecting suitable teaching methods that will be a possible means towards reducing failure in the teaching and learning of biology. The findings of this study will also sensitize Biology teachers on the benefits of the use of concept maps and experimental techniques for teaching as it will have a great effect on the academic achievement and retention of the students. The research will also form another dimension of innovations in the teaching and learning of Biology.

The findings of this study will also benefit curriculum planners in curriculum planning, as using concept maps in planning a curriculum on a specific topic helps to make the instruction conceptually "transparent" to students. (Bascones and Novak 1985 ; Novak 1991, 1998). Concept mapping can be utilized in appropriate strategies of curriculum planning such as modification and revision.

The Federal Ministry of Education can also benefit by using the findings of this study to engage teachers and administrators in training programmes that can model this new educational approaches.

1.8 Scope of the Study

The study was on effects of concept mapping and experimental techniques in the teaching of Biology. The study covered two (2) schools in the Karshi Zone of the Abuja Municipal Council Area.

The senior secondary two (SS2) students were used. The reason, been that they are more exposed to the teaching of biology and can be used as a research sample because they are not preparing for any external examination. The study focused on using concept mapping and experiments in the teaching of selected Biology topics. The content of these topics include.

- Classification of Living Things – Classification of Plants
- Classification of Food – Food Test
- Skeletal System – Vertebrae Bones
- Digestive system –Alimentary canal of bird
- Cell's reaction to its environment- osmosis and diffusion

The choice of this selected classes make room for the use of concept maps and experiments for teaching the selected topics. It also enables the students to get adjusted to the new class. The choice of SS 2 is to ensure that concept learned from SS1, been a foundation class can be properly integrated into the ones been learnt in SS2, and makes understanding better for SS3 topics so as to improve their performance in senior secondary school for their external examination.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

In this chapter, previous research woks and other related literature that assessed effects of concept maps and experimental techniques in teaching of biology in secondary schools are reviewed. The review is carried out to provide a frame work for some basic concepts and theoretical explanation of concepts that are fundamental to the study. Moreover, the review explored different researches on the field of study with the hope of determining the gap this will fill in terms of its contribution to knowledge. The review is therefore organized under the following sub-headings for easy referencing- Introduction, conceptual framework which is further discussed under concept maps, using concept maps in instruction, the use of concept maps and experiments in the teaching of Biology, origin of experimental science, importance of science practical work, experimentation in Biology teaching, Biology as a subject in Senior Secondary School, Biology curriculum for Senior Secondary School, Conventional teaching methods for Biology in Senior Secondary School, influence of teaching methods on students' attitude towards Biology, influence of lecture method on students' achievement in Biology, influence of concept mapping on students' attitude towards Biology, influence of concept mapping on students' achievement in Biology, meaningful learning and retention, the need for a change in teaching strategy, theoretical framework, review of related empirical studies and summary of review of related literature.

2.2 Conceptual Framework

2.2.1 Concept Maps

Metacognitive strategies, as explained by Novak (1987) are strategies that empower the learners to take charge of his/her learning in a highly meaningful fashion. Concept mapping as a metacognitive instructional strategy based on Ausubel – Novak – Gowin theory of meaningful learning. (Ausubel, Novak and Hanesian, 1978; Novak, 1987; Novak and Gowin, 1984). It relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognitive bridging and integrative reconciliation. Concept mapping is based upon a major psychological theory in science education and is designed to help students learn how to learn science. Udeani and Okafor (2006). Concept maps were developed in 1972 in the course of Novak's research program at Cornell where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991).

Concept maps are graphical tools for organizing and representing knowledge, they include concepts usually enclosed in circles or boxes of some types, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or phrases and these specify the relationships between the two concepts. Novak and Canas (2006); they defined a concept as a perceived regularity in events or objects, or record of events or objects designated by a label. Concept maps are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. Concept maps were developed to enhance meaningful learning in sciences. They serve to clarify links between old and new knowledge and force the learner to externalize those links. Concept maps are useful tools to help

students learn about their knowledge structure and the process of knowledge construction (Meta knowledge). In this way, concept maps also help students to learn how to learn (Meta learning).

Qarareh (2010) outlines the advantages of concept maps to include the following:

- They can be used as advance organizers to improve learner's achievement (Kommer 2004).
- Provide teachers with meaningful and practical structured approach.
- Aid the development of deep meaningful teaching, moving towards critical thinking rather than surface approaches.
- It allows students to reflect on their own misunderstanding and take ownership of their learning (Fitzgerald, 2004).
- Organize their thoughts and visualize the relationship between the key concepts in a semantic way (Pill, 2005).

Okunlola and Wahab (2011) asserted that concept mapping is very useful in the teaching and learning process for systematizing and organizing not only the concepts under study, but also the already learned concepts. They believe it is used for building a new system for the measuring of our external world. The approach they concluded if properly adopted will:

- Promote better retention and understanding of the subject matter, also concept details are easily reconstructed from a map; this reduces the burden on memory and thus reduces memorization errors.
- It shows the organizational structure of content as a compact source of information.
- It is a versatile teaching tool that can be used to present and reinforce content or assess its understanding.

- It supports students in making connection between known information and new information.
- By creating maps, students clarify their understanding of the topic and integrate new ideas into their thinking.
- It aids students in summarizing texts and identifying main ideas as well as provide a useful way to assess students' understanding of a topic.

Novak (1998) stressed that the process of concept mapping can reduce the need for rote memory and make learning more meaningful. Johnson and Otis (2006) suggested that concept mapping should be treated as a very personal learning tool. According to whitehead (2008) in Young (2008) one of the primary goals in the use of concept map is to promote meaningful learning. In order for this to occur the following points need to be considered:

- The learner must have relevant background knowledge.
- Materials to be learned must be conceptually clear and presented with simple language and examples that will relate to the learner's prior knowledge.
- The learner must make the choice to learn meaningfully. Students must be motivated to incorporate new meanings into their prior knowledge, rather than just memorizing concept definitions. The creation of concept maps supports the incorporation of new meanings into prior knowledge.

2.2.2 Using Concepts Mapping in Instruction

The use of concept maps in instruction on a specific topic helps to make the instruction "conceptually transparent" to students. Many students have difficulty identifying the important concepts in a text, lecture or other forms of presentation. Part of the problem stems from a pattern of learning that simply requires memorization of information, and

no evaluation of the information is required. Such students fail to construct powerful concept and prepositional frameworks, teaching them to see learning as a blur or myriad facts, dates, names, equations or procedural rules to be memorized. For these students, the subject matter of most disciplines, and especially science, mathematics, and history is a cacophony of information to memorize, and they usually find this boring. Many feel they cannot master knowledge in the field. If concept maps are used in planning instruction and students are required to construct maps as they are learning, previously unsuccessful students can become successful in making sense out of science and any other discipline acquiring by a feeling of control over the subject matter. (Bascones & Novak, 1985; Novak, 1991, 1998); Jegede et al 1990; Trowbridge and Bybee (1996).

According to the "dual-coding" Theory of Information Storage, Paino (1991), information is processed and stored in memory in two forms: a linguistic form (words or statements) and a non-linguistic form (mental pictures or physical sensations). The way knowledge is coded in a brain has significant implication for teaching and particularly for the way we help students acquire and retain knowledge. As Marzano, Pickering and Pollock (2001) point out, "the primary way we present new knowledge to students is linguistic. We either talk to them about the new content or read about it" (p.73). The fact that education gives weight to the verbal processing of knowledge means that students are left to generate their own visual representations. Yet, it is a well established that showing students how to present information using the Imagery Form not only stimulates but also increases activity in the brain (Marzano 1998). As students try to convey what they know and understand in non-linear, visual ways, they are forced to draw together what they have learned, see how ideas, information and concepts are connected; develop higher-order thinking skills (e.g. analytical thinking); and makes

sense to others. Visual representation also helps students remember and recall information more easily.

Visual representations can be created and supported by tools such as graphic organizers, physical models, pictographs (i.e. symbolic pictures) and engaging students in Kinesthetic activities that involve physical movement (Marzano, Pickering & Pollock, 2001). From those, perhaps the most commonly used visual learning tool is graphic organizers which include diagrams depicting hierarchical information (e.g. concept maps). Graphic organizers not only help students not to "read" and comprehend more easily complex information and relationships but also generate ideas, structure their thought and learn how to make visible in an easy-to-read way, what they know. The latter requires that students understand the topic under study, be able to discern relationship between concepts and prioritize information. Birbili (2006).

2.2.3 The Use of Concept Mapping and Experiments in the Teaching of Biology

Concept maps are constructed to represent visually "meaningful relationships among concept in the form of propositions" (Novak and Gowin, 1984, p.15). As Novak and Canas (2006) explain propositions are statements about some objects or events in the universe, either naturally occurring or constructed. According to Birbili (2006) concept maps are the spatial representations of concept and their interrelationships that are intended to represent the knowledge structure that humans store in their minds" (Jonassen, Reeves, Hong, Harvey and Peter's as cited in McAleese, 1998, p.258). Concept maps can facilitate teaching and learning in several ways. First, as their inspirers note, they can help both teachers and students to identify the key concepts and principles that they must focus on for any specific task (Novak & Gowin 1984, p.15) in Birbili (2006). Second, a concept map can provide "a kind of visual road map"

indicating some of the pathway that teachers may take "to connect meanings of concepts in propositions" (Novak & Gowin 1984, p.15). Third, concept maps can provide a graphical summary of what students have learned, which in turn can help teacher detect and eventually break down students' misconceptions and misunderstandings.

Concept maps are also effective in helping teachers identify students' prior knowledge and understanding and organize teaching and learning in a way that is meaningful to them. In fact, identifying students' pre-existing knowledge was the aim that leads Novak and his team to the construction of the first concept map (Novak, 1998). Novak & Gowin 1984, p.15-16) argue that "because meaningful learning proceeds most easily when new concept or concept meanings are subsumed under broader, more inclusive concepts, concept maps should be organized in a hierarchical way; that is the more general, more inclusive concepts should be at the top of the map, with progressively more specific, less inclusive concepts arranged below them".

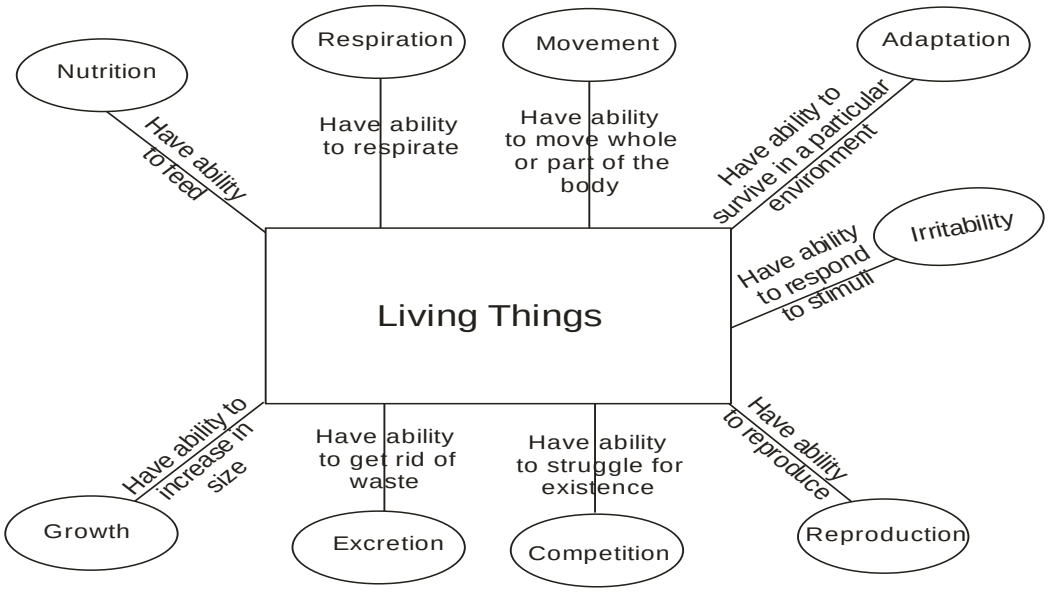

Figure 2.1: Concept Maps on Characteristics of Living Things.

Source: STAN biology workshop journal 2011

Both simple and more complex concept maps consist of two things: concepts are usually represented as labeled circles or boxes, which are called “needs”. Relationships, on the other hand are represented as lines or arrows connecting the concepts, while arrows are used to show the direction of the relationship. As concepts are connected through links, they form the statements that Novak & Gowin refer to as propositions.

Birbili (2006) proposed that if concept maps arc to fulfill their potential as a teaching tool, children’s need and cognitive abilities need to be taken into consideration. More specifically, Birbili said educators interested in using concept maps should keep in mind the following:

1. Young children need to be taught the technique of concept mapping, Sparks Linfield and Warwick (2003). They should be taught the technique over of a period of direct instruction before they can successfully construct their own concept maps (Ferry, 1997). The process should start by having children observe their teacher creating concept maps.

2. When modeling the process of concept map creation, teachers should give particular emphasis to the linking or joining words and help children understand that “they are what makes the whole thing have meaning” (Sparks Linfield & Warwick, 2003, p.126). Those words help create the propositions, the main characteristic of concept maps.

3. Concept maps should be introduced after children have had many opportunities to manipulate real objects, observe what is going on around them, record their observations, and communicate their findings and impressions in different ways. Having those experiences is important because it is through these experiences that concepts and generalizations are formed (Mancinelli, Gentih, Priori & Valitutti, 2004). Concrete experiences are also crucial for the development of representative thinking.

For example, children must have observed plants needing to be watered and seen for themselves what happens to be able to represent graphically the relationship "plants need water". It is also better to introduce concept maps after children have had some experience with simple, less-structured graphic organizers such as webs as a way of summarizing and presenting information.

4. Children's first attempt to create a concept map should be done within the context of a simple familiar topic (e.g. animals or plants) and using a small number of concepts, for example a concept with two to four links. Figures 4 and 5 show two examples of the kind of concept map that sparks Linfield and Warwick are referring to:

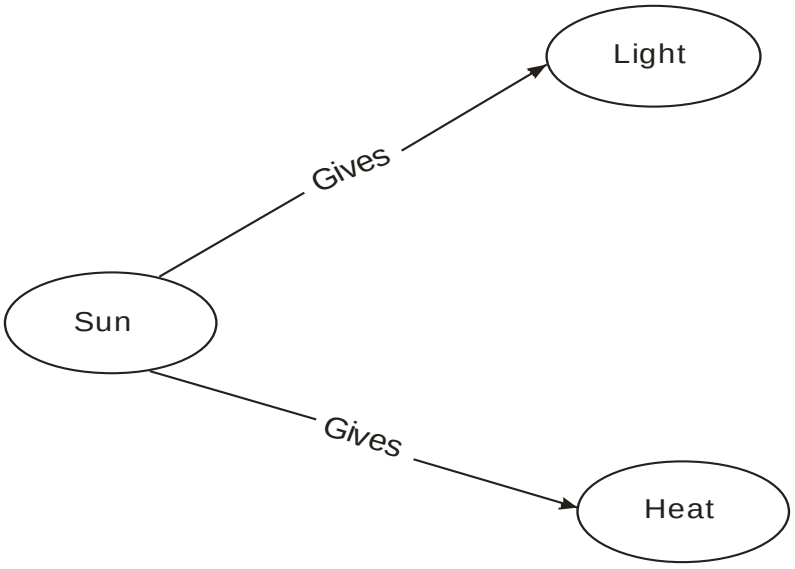

Figure 2.2: Example of a simple concept.

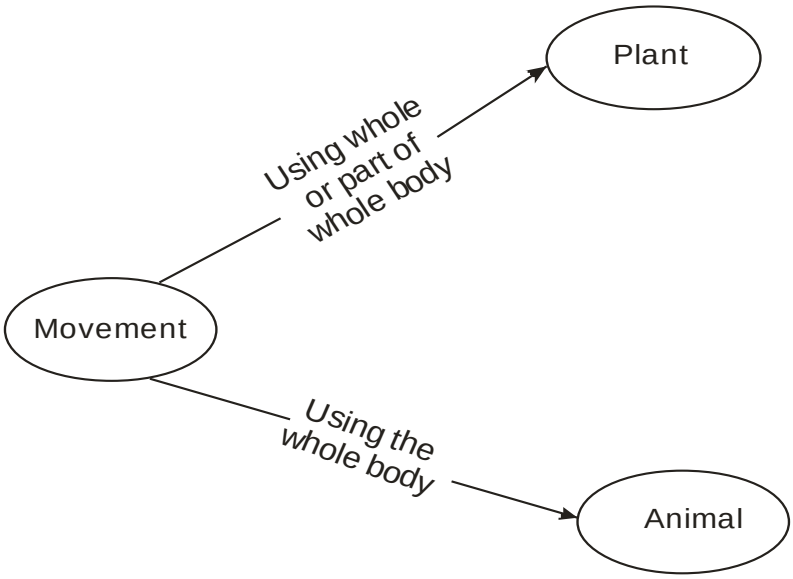

Figure 2.3: Another example of a simple concept.

Source: Sparks and Warwick (2003)

Kinechin (2000a,b) discussed the positive import of using concept maps on instruction and learning in secondary biology education. Building on the researches conducted, Kinechin (2000b) demonstrated the relevance of concept mapping for a teacher planning and preparing a lesson and creating an opportunity for meaningful learning on behalf of students.

Kinechin (2000b) found a positive effect on students' who used concept maps to revise and summarize materials using experiments or practical activities in the teaching of biology to provide opportunities for students to actually do science as opposed to learning about science. Nwezi (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matter. Nwezi maintained that practical activities should engage the students in hands on, minds on, activities using varieties of instructional materials/equipments to drive the lesson home.

Shulmen and Tamir's (1973) in Abimbola (1994) review of research in science teaching,dentified three rationale generally advanced by those that supported the use of the laboratory in science teaching. They included:

(1) The subject matter is highly complex and abstract.

(2) Students need to participate in enquiry to appreciate the spirit and methods of science.

(3) Practical work is intrinsically interesting to students.

Shulman and Tamir also compiled a list of objectives of using laboratory work in science teaching. The list included the teaching and learning of skills, concepts, attitudes, cognitive abilities, and understanding the nature of science.

2.3 Origin of Experimental Science

The use of laboratory method in science teaching originated from the ideas of early scientist (Abimbola, 1996). The 17th century is very significant in this respect. Mendelson (1982) has characterized the century as the century of "The Scientific Revolution". This characterization is so because, according to Westfill (1971). "It was in the 17th centur that the experimental method became a widely employed tool of scientific investigation" (p.115). The general feeling of disillusionment among scientist with earlier methods precipitated this trend (Butterfield 1957; Westfall 1971). The feeling of disillusionment had to do with results of scientific investigations that did not match the efforts put into them. The scientists of the time blamed the method of conducting science for low output.

Taylor (1963) claimed that "the idea of experimental science began to have influence about 1590" (p.90) when scientists started basing their work on deliberately contrived experiments. According to him, "Galileo Galilei (1564 – 1643) in Abimbola (1996)

was the first to employ the modern scientific method in the fullness" (p.91) in physics and astronomy. Before then, Westfall (1971) stated that Gaten's writing on physiology contained examples of experimental investigation. Westfall also claimed that Robert Grosseteste of the medieval school and the logicians based at the University of Padua, Italy in the 11th century, also discussed the precursors of hypothetico-deductive method.

However, it was in the 17th century that scientists paid the greatest attention to the scientific method that led to a revolution in science. The sheer number of persons that attended to the method then, indicated the need for an acceptable method of conducting science. Francis Bacon (1961 – 1626) was perhaps the first in the 17th century to formulate a series of steps to account for the scientific method in his book Novum organum (The New Instructments, 1620), Taylor (1963). The book was a reaction to Aristotle's treatise in logic referred to as organum. Bacon based his method on inductive method of objective observation and experimentation without any preconceptions. Rene Descartes' (1569 – 1650) Discourse on method based on mathematical reasoning and deduction closely followed Bacon's book. Westfall (1971) has credited Robert Boyle with perhaps the best statement of the experimental method that focused on "the activity of investigation that distinguishes the experimental method of modern science from" (p.115). Pascal, Gassende and Newton also wrote on scientific method (Westfall 1971).

The emphasis on method during this period paid off with the several discoveries and inventions in the 17th century and beyond thereby giving the impression, albeit unintentionally, that science is synonymous with its method.

2.3.1 Importance of Science Practical Work

Shulman and Tamir's (1973) review of research on science teaching identified three rationales generally advanced by those that supported the use of the laboratory in science teaching. The rationales included: (1) The subject matter of science is highly complex and abstract, (2) Students need to participate in enquiry to appreciate the spirit and methods of science, and (3) Practical work is intrinsically interesting to students. Shulman and Tamir also compiled a list of objectives of using laboratory work in science teaching. The list included the teaching and learning of skills, concepts, attitudes, cognitive abilities, and understanding the nature of science. Also, there is hardly any science method's book that does not usually list the objectives of science laboratory work (Abdullahi, 1982; Collette & Chiappetta, 1984). All science curricula in Nigeria list practical activities that should go with each curriculum item listed. The current West African Examinations Council (WAEC) syllabus and the National Educational Research council (2009),Federal Ministry of Education for Senior Schools, recommended that the teaching of all science subjects listed in the syllabus should be practical based, perhaps, to demonstrate the importance it attached to practical work in science. Thus, several decades of emphasizing the assumed importance of laboratory work in science teaching have elevated the importance to the level of a dogma. Thomas (1972) and White and Tisher (1986) are of this opinion. This position perhaps, is why Yager (1981) thought that science educators should treat laboratory work as the 'meal'- the main course" (p. 201) rather than an "extra" or "the desert after a meal" (p.201). Also, Bajah (1984) said, "All science teachers and students know that practical work is the 'gem' of science teaching" (p.44).

This dogma about the importance of laboratory work originated from the views of a few American educationists in the early sixties that extolled the importance of laboratory work in science teaching. Notable among these personalities according to Abimola(1996) are Bruner (1961), Gagne' (1963), and Schwab (1960), they all extolled the virtues of teaching science as a process of inquiry or discovery. Before them, Dewey (1938) advocated learning by doing through his "project method" that he considered as a method of organizing the school curriculum on a scientific basis. Another American, Charles Pierce (Peirce, 1877, 1958) who advocated the use of the method of science as a mode of inquiry to satisfy our doubts, in turn, influenced him. The ultimate goal of these advocates of practical work was to train students in the ways of practicing scientists so that students could become good scientists in the future. The surprise by which the former Soviet Union took the Americans, and, perhaps, the world, in launching the Sputnik into space in 1957, motivated their positions. Emphasis in science teaching at this time shifted from the products of science, what science to teach and learn, to the processes of science, i.e., how we teach and learn science (Bates, 1978). According to Shulman and Tamir (1973), this shift in emphasis lacked empirical evidence because the influence of the educationists mentioned above formed the basis of the shift. As a result of this influence, and the need to match the Soviet feat, the Americans commissioned and executed several curriculum development projects. Such curriculum development projects included the Biological Science Curriculum Study, which started in 1959-, Chemical Bond Approach, began in 1958, Physical Sciences Study Committee, was initiated 1956, and Science: A Process Approach which started in 1967, etc. They were all laboratory based. These curriculum development activities, with emphasis on laboratory work, spread to Nigeria, and elsewhere in the world.

2.3.2. Experimentation in Biology Teaching

Experimentation is a method of learning science concepts not through what the teacher told the students, but through what is involved in the process of investigation, carrying out experiments as well as other practical activities. The experimental teaching technique also referred to as discovery in STAN (1998) involves observing, classifying, measuring, predicting, describing, hypothesizing, experimenting and inferring. Experimentation involves activity-oriented learning; in this case, the emphasis is on doing. Most time the activities are carried out in the biology laboratory. A laboratory is a room or building set aside for scientific investigations.

Practical activities in biology provide opportunities for students to actually do sciences as opposed to learning about science. Nzewi (2008) in Nwagbo and Chikelu (2011) asserted that practical activities can be regarded as a strategy that could be adopted to abstract or theoretical presentation of facts, principles and concepts of subject matters. Nzewi maintained that practical activities should engage the students in hands-on, mind-on activities, using varieties of instructional materials/equipment to drive the lesson home. Nwagbo (2008:41) in Nwagbo and Chikelu (2011) stated that:

> "The use of practical activities (approach) to the teaching of biological concepts should therefore be rule rather than an option to biology teachers. If we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the scientific and technological demands of the nation".

Experimentation is a means by which students acquire meaningful learning of science concepts to the point of achieving transfer and application of knowledge. Hence, it exposes them to acquire attitudes and skills of a scientist. This method of teaching

science has proved to be one of the most effective ways of learning. (Nigerian Open University Edu 636: Biology methods).

The laboratory work involved in the process of experimentation can be broken down into different phases:

1. Pre-laboratory session: This involves assembling in advance by the teacher all the equipment and materials needed for the exercise, so as to ensure that they are all in good working condition. The teacher also trial tests the chemicals to be used to ensure that they are active and this session reduces the errors which the teacher may have committed in the actual laboratory session.
2. Laboratory session: In this session, the teacher interacts with the students by telling them what to do, the teacher oversees by walking round the laboratory to ensure students follow instructions they are given carefully and also clarifies any doubt or problem.
3. Post laboratory session: In this session, the teacher discusses the result of the investigation in order to clarify students' doubt. The teacher also summarizes the result of the investigation and assign marks to the work done by students.

The advantages of experimental in the teaching of biology include:

1. It enables students to have direct sensory experience of scientific knowledge, e.g. working with living organism; it enables the learner not only to acquire knowledge but also to appreciate life.
2. It fosters opportunities for the acquisition of science process e.g. manipulation, measuring, classifying etc.
3. It helps in the retention of information as the students interact with the scientific process.

4. The use of experiments helps students to develop scientific altitudes such as enquiry, curiosity, carefulness, objectivity, honesty etc.
5. Experimental work helps to stimulate and sustain student's interest in science.
6. It aids students in problem solving and arriving at conclusions.
7. It helps to increase student's ability towards critical thinking and acquisition of better understanding of scientific knowledge.

Realizing the importance of science process skills as a solution to scientific problems, the Federal Government among other things states as one of the national goals of education in Nigeria that "Education should aim at helping the child in the acquisition of appropriate skills abilities and competencies, both mental and physical as equipment for the individual to live in and contribute to the development of the society" (Federal Republic of Nigeria (FRN), 2004:29).

2.4 Biology as a Subject in Senior Secondary School.

Biology according to Nwagbo and Chukelu (2011) as a branch of science and the prerequisite subject for many fields of learning contributes immensely to the technological growth of nature. This includes medicine, pharmacy, forestry, agriculture, biotechnology and nursing. The authors further stated that the study of Biology in senior secondary school can equip students with useful concepts, principles and theories that will enable them face the challenges before and after graduation. Biology in senior secondary school is offered for the three-year senior secondary school. It involves mainly the study of plants and animals. In most schools, Biology is compulsory for all science students and optional for Arts and Humanity classes. The topics offered in the course of these 3years prepare the students for higher education in any of the biological related course.

The Senior Secondary School according to the National Policy of Education (2004) shall be comprehensive with a core-curriculum designated to broaden pupils' knowledge and outlook. The senior secondary school Biology curriculum is one of such curriculum materials. The Biology curriculum at the directives of the Federal Government is for the societal and individual development and has its cardinal objectives. The preparation of pupils to acquire:

1. Adequate laboratory and field skills in Biology.
2. Meaningful and relevant knowledge in Biology.
3. Ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture.
4. Reasonable and functional scientific altitude FRN (2004)

In pursuance of the stated objectives, the contents and context of the curriculum place emphasizes on field studies, guided discovery, laboratory techniques and skills along with conceptual thinking. The curriculum is intended to provide a modern Biology course as well as meet the needs of the learner and the society through relevant and functional contents, methods, processes and applications. It covers the major themes of:

1. Organization of life
2. Organisms at work
3. The organisms and its environment
4. Continuity of life.

These themes are of direct relevance to the society and the learner.

In planning the new Biology curriculum, the spiral approach to sequencing a science course was adopted. In the approach, the concepts to be taught are arranged in such a

way that they run throughout the three-year post basic course, with the concepts being discussed in greater depth as the course progresses. (NERDC, 2009).

2.5 Conventional Teaching Method for Biology in Senior Secondary School

Teaching has been defined in many ways by different authors. Akudolu (1994) in Onuigbo (2011) defined teaching as a deliberate effort by a mature or experienced person to impart information, knowledge, skills and so on to an immature or less experienced person through a person that is morally and pedagogically acceptable. Fadare (2004) defined teaching as the action of someone who is trying to assist others to reach their fullest potentials in all aspects of development. Lyop and Mangut (2001), defines teaching as a process that facilitates learning. Owoso (2005) stated that the aim of teaching is to facilitate learning, stressing that there are many teaching methods and techniques used by teachers in teaching students. Various authors have listed many teaching methods used in teaching, but specifically, the Biology methods of National Open University has specified the lecture method, discovery, discussion methods, demonstration, project method, and field trip as conventional methods of teaching Biology.

For a teacher to communicate the knowledge in a topic to the pupils, the teacher needs to decide what teaching method or technique to use. Teaching method is defined as an overall plan for the orderly presentation of content or learning material, and usually a method is driven by a philosophy about how children learn. Lecture method according to Lyop and Mangut (2001) is characterized by a steady flow of information from teacher to the students, the teacher dispenses facts and opinions about procedures or contents, expressing his own ideas or citing an authority. Oyetunde and Famwang (1996) stated that the philosophy behind a lecture method is that the knowledge the

teacher has can be passed on to students. Ogwa (2002), states that lecture method of instruction is the process of speaking to students, while they sit and listen to the teacher. Ogwa further emphasized that in lecturing method, the teacher acts as a conference organizer while the students listen as the audience. The lecture method is the most common of these traditional teaching methods.

Bligh (1993) observed that originally, lecturing was the only way that knowledge stored in the books could be transmitted to a large number of students. The word lecture is derived from the Latin legere meaning to read. Bligh states that many centuries after the invention of movable type and other significant advances in technology, learning continues to be the primary mode of instruction in secondary schools as well as in higher education. According to the author, reasons for lecture method are because lectures are cheap since teachers can lecture in auditorium full of students. Lectures are easily changed and updated and they are efficient in covering material quickly. Finally and perhaps most importantly, the method is familiar to students and teachers alike and their roles are clearly defined.

Lyop and Mangut (2001) points out the inherent setbacks of lecturing method. They affirm that it does not promote meaningful learning as it appeals only to the sense of hearing. According to them more effective learning goes on only when many senses are involved. They opined that schools consist of many ability groups in each class, the abilities of student they believed vary considerably therefore, and they conclude the lecture method cannot meet the different needs of the students. They believe that some students learn better through the manipulation of objects while others will learn easily through hearing and seeing objects and events. Lecture method they opined encourages rote learning and regurgitation of information without necessarily aiding understanding.

The lecture method they stated is unsuitable for teaching science in secondary school and is better suited for teaching in higher institutions of learning.

A survey carried out at Dorset House school of occupational Therapy, Oxford into the perceived effectiveness of different teaching methods used within the lecture format in the human biology course of year 1 & 2 by Butler (1992) showed that the traditional didactic lecture method was perceived by students as the least effective method used, yet by involving the students actively within the lecture time, the format was enhanced and was regarded as a more effective teaching and learning tool. Experimental tasks and learning package used within the lecture format were also perceived by students as effective.

A similar study by Ozay, Ocak and Ocak (2009) on sequential teaching methods on Biology showed that evidence from a number of disciples suggests that oral presentation to a large group of passive students contributes very little to real learning. In Physics, they opine that standard oral lecture does not help most students develop conceptual understanding of fundamental processes in electricity and in mechanics. Similarly, student grades in a large general chemistry oral lecture do not correlate with the lecturing skills and experience of the instructor. Despite the limitations of traditional oral-lectures, introductory science courses in biology are forced to offer high-enrolment introductory science courses many professors who teach these courses feel that lecturing is their only option.

The study by Ozay, Ocak and Ocak (2009) came to the conclusion that academic achievement of students taught using experiment and slide demonstration was higher than beginning with lecture method. They agreed that using only oral lecture bores

students and looses their attention. They concluded that people remember 10% of what they read, 20% of what they heard, 30% of what they saw and 90% of what they had a hands-on-experience. Laboratory work is a hands-on experience (Beydogan, 2001). And since Biology and other science courses are practical oriented it consequentially means that oral lecture method may not be completely avoided but should not be solely used in any science instruction.

The increasing effect of globalization and the rapid rate of technological changes in the world have informed the recommendation of UNESCO and ILO (2002) that all systems in the 21st century should be geared towards life-long learning. This requires that schools should in addition to academic skills, inculcate values to citizen such as problem solving collaborative skills and higher order thinking skills. Okoye and Okechukwu (2006) opines that science educators have been focusing attention on how to improve science instruction in schools by going beyond the stereotype methods of obtaining knowledge in science. There has been emphasis, they said in science teaching and on students' active involvement in doing science. Concept mapping teaching strategy they stated is designed to help students acquire basic scientific skills and improve performance.

Another teaching method is the demonstration method. Lyop and Mangut (2001) define it as the act of showing, displaying something, according to them, it involves showing something for the students to see. They stated that demonstration method is normally done by teachers but sometimes demonstrations can be performed by students individually or in small groups. According to Alfred (1973) in Lyop and Mangut (2001) the demonstration method serves various purposes in teaching. These purposes include setting a problem, illustrating a point (which is the most popular use of demonstration

or to serve as a climax) – performing on exciting students which is an excellent way to end a lesson.

Lyop and Mangut list the following reasons as justification for the use of demonstration method:

a) It gives opportunity for use sophisticated apparatus and difficult experiments.
b) Hazardous and dangerous experiments can be carried out.
c) It is effective for teaching manipulative and applied practical skills.
d) It guides students' thinking along the same channel.

In using demonstration method for instruction, Okoro (1999) pointed out that for demonstration to be effective, the teacher should:

1. Plan the demonstration
2. Prepare students for demonstration
3. Carry out the demonstration process and re-state the important point connected with it.

Demonstration can be carried out in the class or done in groups as group demonstration can also be an individual demonstration. It is possible for students to learn how to perform manipulative operations by reading or being told how to do them. However, they can learn faster and more effectively when they are shown how the work is done. Demonstration enhances students' rate of comprehension of specific objectives.

Another method used for instruction is field trips. Lyop and Mangut (2001) define it as an excursion taken outside the classroom for the purpose of making relevant observations and also for obtaining some specific information. The experience they said provide direct, primary and concrete evidences to the learner. When field trips are

properly planned Lyop and Mangut opines it offers the students opportunities for observing, collecting, classifying, studying relationships and manipulation of objects.

Field work is very important in any effective science instruction. It is one of the most enjoyable and exciting experiences of students studying science. It plays the same role as laboratory experiments and demonstrations because through the process one can gain first hand-experiences.

Lyop and Mangut list the advantages of field trips to include:

i. Speedy contributions to science programme
ii. These are related to the out of school or real life experiences of the student than the classroom experiences.
iii. It creates meaningful learning and allows easier application of learning to real life.
iv. Likely to arouse varied type of interest in students' work with actual objects which are likely to generate curiosity than ideas do
v. Helps to add reality to, and verification of scientific laws.

The project method according to Lyop and Mangut (2001) is employed by teachers for individual instruction. This method is meant to provide for the needs of individual students, or sometimes small groups so that those with special abilities have opportunities to fulfill themselves. The project work is one of the teaching methods for the teaching of biology. Project method is suitable for large groups, small group and individual instruction (Okoro 1999, Ukoha and Eneogwe (1996). Ukoha and Eneogwe (1996) explained that the project method of teaching originated in the early twelfth century. It was greatly influenced by Dewey's problem method of teaching and it is an original work of W.H Kill Patrick who advocated purposeful activity, problem solving

and the needs and interest of the individual child in action, learning and conduct. The underlying principle of the method according to them is that learning takes place through direct contact with materials. A project method implies a practical problem which a student and the teacher plan to execute.

The planning and the execution must be concrete in nature. It should involve the design, arrangement of materials, availability of equipment and tools and a good environment for the activity. On the part of the teacher he/she must have an excellent understanding of the individual after learning has taken place. The execution should meet the following objectives to encourage the individual, to assist the individual for specific changes. It is a learning activity selected, planned, designed and executed by learners collectively or individually to clarify facts, acquire knowledge, skills, appreciation and to solve identified problems under the teacher's guidance and supervision. Therefore the role of the teacher in providing guidance and direction to students should not be completely eliminated. This is because students tends to exaggerate their power of execution and to select projects that are beyond them leading to production of crude projects which defeat the purpose of project work. According to Lyop and Mangut (2001) topics from project works can be obtained from interaction with their colleagues, reading from Journals and classroom experience on a particular topic.

In summary, conventional teaching methods are teacher-centered approaches of learning. They are methods used in teaching many subjects including Biology, but to meet the globalization demands, modern teaching methods such as concept mapping amongst others should be explored for use in teaching Biology if it will yield a good effect.

2.6 Influence of Teaching Method on Students' Attitude towards Biology

Attitude according to Macmillan English Dictionary for Advanced Learners (2007) is someone's opinion or feelings about something especially as shown in their behaviour. Nasr & Asghar (2011) opines that definition or concept of attitude towards science is vague and ambiguous, but sees attitude as a concept that defines emotional trends in response to affairs, person, locations, events or ideas. Simpson and Oliver (1990) believe that phrases as "I like science enjoy science courses" conveys attitude e of the learner.

Nasr & Asghar (2011) outlined that many factors influence attitude and achievement motivation among adolescents. Some of these factors are associated with parental background and family environment, individual characteristics such as self concept, locus of control and achievement motivation, school influence such as class climate, teachers and administrative styles. According to Osbome, Simon & Collins (2003), studies have incorporated a range of components in their measures of attitude to science including: the perception of teachers; anxiety towards science; the value of science; self esteem at science; motivation towards science, enjoyment of science; attitude of peers and friends towards science; attitude of parents towards science; the nature of the classroom environment, achievement in science and fear of failure on course. According to Yara (2009), attitude of the teacher and his method of teaching can influence students' attitude. Simpson and Oliver (1990) in Alebiosu and Micheal (2011) identified factors of teachers' attitude, teaching methods and personality, attitude of parents and peers, nature and perception of the subject among components influencing attitude to school subject. This is because attitude is key to success as people used to say, Fansceca (2010) opined that one of the factors affecting students' learning

performance is the way they face knowledge, namely their attitude to the subject. Such attitude as profound feelings, relatively stable attitudes are derived from positive or negative experiences across time on learning the subject (Estrad, 2002 in Fonseca, 2010). This experience according to Omirin and Oladosun (2010) includes teachers' method of teaching.

Goodykoonz (2009) citing Pophama (2005) opined that in education, research suggests that students' attitude towards a subject leads to academic success. This is why the research seeks to find out the attitude of students to the use of experiments and concept map in the teaching of Biology.

2.6.1 Influence of Lecture Methods on Students' Attitude towards Biology

Biology teaching must reflect the exciting nature of the subject and its surrounding. Students' work in Biology lessons should be practical and visual in nature whenever possible. Yok (1996) in Egitimbilim (2009). Ericson (1960) in Egitimbilim (2009) stated that the lecture method is the method of teaching outside of manipulation work. Teachers are comfortable with traditional method because they remain in control of content and time (Havice, 1999).

According to Armbruster, Patel, Johnson and Weiss (2009) the traditional lecture format of most large introductory science courses present many challenges to both teaching and learning. Although the traditional lecture course may be effective for effectively disseminating a large body of content to a large number of students. This one way exchange often promote passive and superficial learning (Bransford et al 2000) and fails to stimulate student motivation, confidence and enthusiasm (Wieimer 2002). A study conducted by Egitimbilim (2009) showed that lessons with lecture method bores student and makes them lose their attention. Supporting the above result National

Research Council (2007) and wright and Boggs (2002) opines that the traditional lecture method can often lead to students completing their undergraduate education without skills that are important for professional success. Armbruster et al (2009) in their study observed that the perceived deficiencies common to traditional lecture based introductory courses was poor student attitudes. These attitudes were reflected by poor attendance, limited participation in class and sub-optimal student performance. In conclusion, when an active-learning and student-centered pedagogy was incorporated into a previously traditional lecture-based introductory biology course. The changes led to sustainable improvements in students' attitudes and performances. The lecture method should therefore not be a main method of teaching and learning in Biology.

2.6.2 Influence of Lecture Method on Students' Achievement in Biology

Methodology is very vital in any teaching-learning situation. The method adopted by the teacher may promote or hinder learning. The adoption of lecture methods by most teachers according to Ameh and Dantani (2012) in order to overcome the bulky syllabus before the SSCE affects students' performance. According to the authors, researchers believe that in the lecture method, theory is taught as an absolute knowledge, hence pupil-centered activities for developing scientific reasoning skills and processes are lacking. The lecture method is also known to cause lack of interest and poor performance in science as opined by Njoku (2007) in Ameh and Dantani (2012). Aghadindno (1987) in Ameh and Dantani (2012) contented that science teaching limited exclusively to telling, reciting and testing of information is sterile as it does not convey either the meaning or intent of science. Derek (2007) in supporting this view in Ameh & Dantani (2012) reported the seriousness of the deplorable performance of secondary school students in science subjects and identified persistent use of the

traditional mode of instruction as one of the major short-coming affecting the learning and higher achievement in science subjects.

In studies carried out by Ameh & Dantani (2012), McAdmins (2001), Osuafor & Okigbo (2013), they believe that the use of lecture methods of teaching has been found not to be appropriate with respect to achievement in the learning of science.

2.6.3 Influence of Concept Mapping on Students' Attitude towards Biology

The attitude formed by a child towards any subject will go a long way to decide and determine the child's choice and achievement in that subject as well as his or her career choice (Woolnough, Guo, Leite, de Almeida, Ryu, Womg and Young, (1997) in Alebiosu et al (2011 . Simpson and Oliver (1990) in Alebiosu et al (2011) identified factors of teacher attitude, teaching methods among others, as factors that influence attitude of students to school subject. The above, according to Alebiosu et al (2011) explains that teachers are very important dominants of enrolment, achievement and essentially attitude towards school subject. The teacher is a consultant, guide, mentor, inspirator and moderator (Krejster, 2004) in Alebiosu et al (2011). His/Her use of innovative instructional strategy stands a higher change of positively influencing the attitude of the learner to the subject. Guzel,(2004) in Nasr & Asghar (2001)believes that negative attitude towards a subject makes learning or future learning difficult, hence when students are positively inclined towards a subject they tend to do well in that subject.

Consequently Grober and Jodl (2010) in Alebiosu et al (2011) suggested the use of self study; problem oriented learning and remote lab/web experiments, while Adeoye and Okpala (2005) in Alebiosu (2011) advanced the systematic assessment procedure. Alebiosu et al (2011) opines that invariable, instructional strategy and teaching methods

are important determinants of attitude to science (Orji, 1998; Meltzer, 2002; and Alebiosu,(2006). One of such is the concept mapping instructional strategy. Concept mapping relates with the meaningful learning theory whose advantage lies on the fact that learning a new knowledge is dependent on what is already known. By using concept maps, the learning process becomes active rather than passive. Kempa and Dude (1974) in Adesoji (2008) worked on the influence of science instruction; the result was that attitude becomes more positive after instruction. Also Studies from Long, 1981; Atwood, 1978; and Wasik, 1978 in Adesoji (2008) suggest that there is relationship between attitude and methods of instruction and also between attitudes and achievement.

Reviews of concept mapping studies have shown that the technique has been generally perceived as having a positive effect on learning Horton et al, 1993; lawless et al, 1998 in Kinchin, 1992.

2.6.4 Influence of Concept Mapping on Students' Achievement in Biology

Metacognitive strategies, as explained by Novak (1987) are strategies that empower the learner to take charge of his or her own learning in a highly meaningful fashion. Concept mapping as a megacognitive instructional strategy is based on Ausubel Novak-Godwin theory of meaningful learning. (Ausubel, Novak & Hanesien, 1978). It relates directly to such theoretical principles as prior knowledge, subsumption progressive differentiation, cognitive bridging and integrative reconciliation. Concept mapping is based upon a major psychological theory in science education and designed to help students learn how to learn science. Studies on the influence of concept maps on students' achievement has shown that students taught using concept map achieved significantly higher than taught using lecture method. Boujaound & Altieh (2008), Candan, Turkmen & Candak (2006), Egolum & Nwafor (2012), Karakuyu (2010),

Okoye and Okechukwu (2006). Studies from Okoye & Okechukwu, 2006; Ige, 1998; and Wandersee 1990, shows that when incorporated into teaching, it helps to improve students' performance.

Meaningful learning is the learning that is well anchored and integrated in the cognitive structure. It occurs when the learner can find meaning in the information presented. Meaningful learning will not occur unless the new ideas are presented in a clear way that enables them relate with other ideas unless the learner already possesses those other ideas he can relate the new ideas with and unless the learner actually makes a conscious attempt to do so. As a result of meaningful teaching, the new idea will remain anchored to a so called subsumer (anchoring site of the ideas)Novak & Gowin(1984),Novak (1991b) Young (2008). According to Novak and Canas (2006) meaningful learning requires three conditions:

1. The materials to be learned must be conceptually clear and presented with language and examples related to the learner's prior knowledge
2. The learners must possess relevant prior knowledge
3. The learners must choose to learn meaningfully. The one condition over which the teacher or mentor has only indirect control is the motivation of students to incorporate new meanings into their prior knowledge, rather than simply memorizing concept definition or propositional statements or computational procedures

According to Ausubel "the most important single factor influencing learning is what the learner already knows" (Novak, 1998, p.71). Relationships between concepts are formed when two concepts overlap on some level. As learning progresses, this network of concepts and relationships becomes increasingly complex. Ausubel's compare meaningful to rote learning which refer to when a student simply memorizes

information without relating that information to previously learned knowledge. As a result, new information is easily forgotten and not readily applied to problem-solving situations because it was not connected with concepts already learned. However, meaningful learning requires more effort; as the learner must choose to relate new information to relevant knowledge that already exist in the learner's cognitive structure. This requires effort initially. However after knowledge frame-work are developed, definitions and the meanings for concept become easier to acquire. Further, concepts learned meaningfully are retained much longer, sometimes for a life time. Knowledge creation is viewed as a special form of meaningful learning.

According to Momoh-Oke (1997) retention is viewed as the repeat performance by a learner of the behavior than an acquired piece of knowledge which is always intended to elicit in the learner (without practice) after an interval of time. Retention simply refers to how much a person remembers after an interval of time without practice and this is the difference between what is initially learnt and what is later forgotten. Haynie (2003) defines retention as learning which lasts beyond the testing and is assessed with tests administered two or more weeks after the information has been taught and tested. Haynie further explained that retention of learning is measured with two tests: The initial test and the delayed retention test. The initial test is the test employed at the time of instruction or immediately thereafter while the delayed retention tests are those tests administered two or more weeks after instruction and initial testing to measure retained knowledge.

Oloyede (2010) in his research work examined the effect of guided discovery and concept mapping teaching strategies on SSS students' chemistry achievement. The result showed that there was a significant difference in the retention of the two groups

used for the research in favour of the group taught using concept mapping. This finding according to Oloyede is in agreement with those of Okebukola (1990) and Udeani (1993). Altin (2002) in his work on the study of computer assisted experimental method and concept mapping method with regards to some cognitive processes and level of Retention observed that the use of concept mapping in teaching physics courses had positive and significant effect on the level of retention of students.

2.7 The Need for a Change in Teaching Strategy in Biology

A lot of factors have necessitated the need for a change in the teaching strategy or technique in Biology. Among these are the effects of globalization and the rapid rate of technology changes and the need to address individual differences more seriously in the classroom .In addition to these is the persistent failure in both internal and external examinations of biology students Teaching and learning process should be student centered and one way to bring about a change of emphasis in teaching from the teacher centered approach to a facilitated approach is to change the method of instruction (Kearsley, 2010). This shows that Biology education needs a total overhaul in terms of its medium of instruction. Teachers should utilize appropriate strategy to pass across knowledge and enhance achievement, interest and retention. That is the teachers should consider every topic and select the correct method that will convey the knowledge at a particular time to the students.

According to Neekpoa (2007) in Onugbo (2011) ,Nigeria is saddled with educational problems of great magnitude, which the traditional methods of teaching and learning alone cannot solve. Roegge, Wenthing and Bragg (1996) stressed that the traditional approach of delivery of knowledge and skill through lecture must be improved or even abandoned and replaced with methodologies which allow students to learn needed skill

in the context within which the skill are suited in the real world. There must be a change in the conventional lecture methods adopted in teaching students to a more fascinating strategy that could enhance good performance. This study therefore adopted the use of experiments and concept mapping strategies as alternative techniques in the teaching of Biology in senior secondary schools.

2.8 Theoretical Framework of the Study

This research is hinged on the following theories of learning.

a. The operant conditioning models and stimulus Response (SR), Association theory

b. Jean Piaget's development theory

c. Bruner's theory of cognitive learning

d. John Dewey's theory on experience, reflection and learning

e. Ausubel's subsumption theory

2.8.1 The Operant Conditioning Model and Stimulus Response Association Theory

In a school setting, the frequency of various behaviors can be seen as depending on the immediate consequences of those behaviors. For example, if a biology student perform well in an examination and the student is rewarded with praise or gift or any other motivating factors, the student will tend to repeat the performance. According to Stoner (1982) the operant conditioning process may be expressed as stimulus- response-consequences – future response. The above means that individual's own voluntary behavior (Response) to a situation or event (Stimulus) is the course of specific consequences or outcomes. If a teacher uses a technique or strategy that gives the student proper understanding, the student will tend to have interest and retain more of

what is been taught in that subject. If the teaching techniques or strategy is difficult or abstract for the student, the student tends to loose interest and avoid such subjects.

This suggests that if a Biology teacher intends to arouse students' interest in the subject, the teacher must use a teaching technique or strategy that aids in retention of concept which invariably improves students' performance, thereby making learning attractive and interesting one of such techniques is the use of concept maps and experiments in the teaching of biology.. The operant conditioning theory by B.F Skinner was highly acclaimed to be affective in training of lower animals.

2.8.2 Jean Piaget's Development Theory

Piaget's theory is based on the idea that the developing child actively and adaptively builds cognitive structures, in other words mental "maps" schemes or networked concepts for understanding and responding to physical experience within his or her environment. Through successive stages of intellectual development children develop intellectual structures that enable them to have a greater understanding not only of the world, but also themselves. Piaget considered intellectual activity to be a biological function. In his theory; Piaget describes the development and adaptation of mental operations or thought structures for example counting, classification etc which progress through rich interactions with the world. Concept maps and experiments in Biology help students to progress through such interactions. Piaget's theory of conceptual change involves four stages of intellectual development.

Sensorimotor stage (birth – 2years old), pre-operational stage (age 2-7), Concrete operation (age 7-11) and formal operations (Beginning at age 11-15). Reasoning is freed from the concrete. Adolescents begin to construct whole systems of belief and can engage in more reflective reasoning such as thinking about other's thoughts or engaging

in self reflection. In scientific problems solving, formal thinking enables adolescents to systematically manipulate variables and reason about unknowns such as algebraic variables. This stage of intellectual development can be of use to the students in the construction of concept maps as concept maps help learners to make evidence the key concepts or propositions to be learned and suggest connections between new and previous knowledge.

2.8.3 Bruner's Theory of Cognitive Learning

Bruner's theory states; "To perceive is to categorize, to conceptualize, to learn is to form categories, to make decisions is to categorize"(p:25), He maintained that people interpret the word in terms of similarities and differences and suggested a coding system in which people have a hierarchical arrangement of related categories. Each successively higher level of categories becomes more specific. The major variable in his theory of learning is the coding system into which learners organize, this coding system. He believes that the system facilities transfer; enhance retention and increase problem solving and motivation. He also advocated the discovery oriented learning method in schools which he believed helped students discover the relationship between categories.

2.8.4 John Dewey's Theory

John Dewey's theory emphasizes the experiential aspects of learning. In his theory learning results from our reflections on our previous experiences, as one strive to make sense of learning task. Dewey believed that the role of education is neither to cater completely to a learner's inclinations nor to attempt to force upon a child a pre-ordained curriculum which takes no account of the learner. This is what the conventional techniques in teaching of biology does. He saw children's mind as flexible, expansive

and unformed. Educators should structure learning environment that engage children in inquiries, which he believes will guide then towards broader knowledge.

2.8.5. Ausubel's Theory of Subsumption

This is also referred to as Assimilation theory or Theory of Advanced organization. The theoretical framework for this study is based on this cognitive learning theory. Concept mapping is grounded in Ausubel's Assimilation Theory (Ausubel, 1968; Ausubel, Novak & Hanesian, 1978 in Bamidele ,Adetunji,Awodele&Irinoye 2013). Assimilation theory posits that new knowledge can be learned most effectively by relating it to previously existing knowledge. Concept Maps may be viewed as a methodological tool of assimilation theory that displays fundamental elements of the theory such as subsumption, integrative reconciliation and progressive differentiation. Concept Maps allow for the representation of non-hierarchical relationships or cross-links, as well as other types of non-hierarchical arrangements. Over the past decades, Ausubel (1963) has been concerned with the problem of how meaningful verbal learning and retention can be facilitated through the use of extrinsic organizing devices that modify the learner's cognitive structure. He stressed that if existing cognitive structure is clear, stable, and suitably organized, it facilitates the learning and retention of new subject matter. However, if it is unstable, ambiguous, disorganized, or chaotically organized, it inhibits learning and retention. In order to describe the importance of classification in learning and retention and the strategy for deliberately manipulating cognitive structure so as to enhance proactive facilitation and to minimize proactive interference, Ausubel (1963) coined the phrase "advance organizer" this involves the use of appropriately relevant Inclusive introductory materials that are maximally clear and stable in a learning situation. These organizers are normally introduced in advance of the learning material itself and are used to and establish a meaningful learning set. The advance

organizers help the learner to recognize that elements of new learning materials can be meaningfully learned by relating them to specifically relevant aspects of existing cognitive structures. The rationale for using organizer is based primarily on the importance of having relevant and otherwise appropriatly established ideas already available in cognitive structure. It is also to make logically meaningful new ideas potentially meaningful and to give them stable anchorage. The organizer functions to 'bridge the gap' between what the learners already knows and what he needs to know before he can meaningfully learn the task at hand. It is to provide ideational scaffolding for the stable incorporation and retention of the more detailed and differentiated material that follows. This is the basis of this research study. The concept maps were introduced in advance of the learning materials to facilitate the establishment of meaningful learning set.

The central propositions in Ausubel's cognitive assimilation (subsumption) theory (Ausubel, 1968; Ausubel,Novak and Henesain (1978) ,the main basis for concept mapping,are:

(1) Concepts derive their meanings through their inter-connections with other concepts; and

(2) Meaningful learning occurs when fresh knowledge is consciously anchored to relevant concepts in the Cognitive structure of the learner.

According to Wandersee (1990), concept mapping relates directly to such theoretical principles as prior knowledge, Subsumption, progressive differentiation, cognitive bridging and integrative reconciliation. This theory involves the learner linking new specialized concepts to more generalized, more inclusive concepts in the learner's existing structure of Knowledge (schema). The result of subsumption is that the Schema

of the learner becomes progressively more differentiated leading to assimilation of newer information. This theory, therefore, asserts that cognitive structure is hierarchically organized and more inclusive, broad concepts are super-ordinate to less inclusive and more specific concepts. Furthermore concepts in the learner's cognitive structure undergo progressive differentiation in which greater inclusiveness and specificity of concepts are discerned, resulting in recognition of more prepositional linkages with other related concepts (Canas et. al. 2003).

A student may not remember a name he learnt previously but when the bearer of the name is physically present, he may recall. Idialu (1998) and Ughamadu (1998) are in agreement with the above explanation. They identified the roles that instructional strategy can play in learning and teaching of subjects. This situation mostly applied to factual knowledge where recognition is much more difficult to recall. The theory stipulates that an experience gained in one situation may be incompatible in another situation because of the absence of vital clues.

Implication of the theories to the study

The present study on effects of concept mapping and experimental techniques in teaching Biology is based on John Dewey's theory on experience, reflection and learning and also on Ausubel's theory of subsumption.

John Dewey's theory emphasized the experiential aspect of learning .He suggested a learning environment that would provide ample" time, talk and tools". He suggested learning environments that engaged children in inquiries. The students used in the present study were taught Biology and allowed to learn through inquiry and also were allowed to handle tools/materials/equipments needed for the experiments they

performed. Thus this study was basically anchored on John Dewey's theory of experience, reflection and learning.

Ausubel's theory of subsumption also called assimilation theory or theory of advanced organizer posits that knowledge can be learned most effectively by relating it to previously existing knowledge. This existing knowledge Ausubel emphasize can be brought to bear by helping the learner through the introduction of an advance organizer to recognize that element of new learning materials can be learned meaningfully by relating them to specifically relevant aspects of their cognitive structures. The students used for the study were tutored on how concept mapping works and on commencement of treatment were presented with concept mapping instructional package (CMIP) ahead of the lesson to help them organize their cognitive structure to the prior knowledge they have on the topic under consideration so as to enable them connect the new knowledge to what they already know. Thus this study is also basically anchored on Ausubel's theory of subsumption.

2.9 Empirical Studies

The following related literatures were reviewed, the purpose of the review was to determine what gap this present study will fill and its contribution to knowledge.

Okoye and Okechukwu (2006) they examined the effect of concept mapping and problem solving teaching strategies on achievement in genetics among Nigeria secondary school students. The method used for the study was a quasi-experimental pre-test and post-test treatment design one hundred and thirteen senior secondary three (SS III) students were selected from three mixed secondary schools located in Delta North Senatorial District in Delta State as subjects for the study.

The experimental group was taught using selected topics in genetics using concept mapping and problem-solving strategies while the control group was taught using the traditional lecture method. The instrument used for data collection was the Genetic

Achievement Test (GAT) consisting of 40 multiple choice items and 20 short answer questions on Genetics. The reliability index of this instrument was 0.82. To answer the research questions, analysis of covariance was used. The result revealed that students exposed to concept mapping strategy while studying genetics achieved significantly higher than those exposed to the traditional lecture method. The reviewed work is closely related to the present study in that both are tackling how to improve the problem of poor performance in Biology. The population of the research will be a little higher than the present study been reviewed. The research under review took into consideration only a single topic while this present research used five topics in the course of this study.

Udeani and Okafor (2012) carried out a research on the effect of concept mapping instructional strategy on the Biology achievement of senior secondary school learners. One hundred and twenty four biology slow learners were identified and randomly assigned to the expository group (n = 62) and concept mapping group (n = 62) respectively were taught the concept of photosynthesis. From the purpose of the hypothesis concept mapping instructional technique could produce significant (<P 0.05) gain over the expository instructional technique in Biology attainment of slow learners amongst others. The groups were post-tested after two weeks of teaching for any significant difference in their Biology achievement. A 30 –item multiple pretest and posttest were used to collect the data and a t-test was used to test the hypotheses. Analysis of the post-test scores indicated that the group taught by the concept mapping instructional strategy performed significantly ($p < 0.05$) better than their expository group counterparts. The result of data analyzed for the study, provided support for the potency of the concept mapping technique in bringing about meaningful learning of

biological concepts in slow learners. The present study sought to find out the potency of concept mapping not only on slow learners, but on a generality of all types of learners. A retention test was conducted two (2) weeks after treatment to test the level of students' retention of concepts taught after two (2) weeks of lesson.

In a study carried out by Boujaoude and Attieh (2007) on the effect of using concept maps as study tools on achievement in Chemistry had the following objectives to (1) examine whether or not the construction of concept maps by students improves their achievement and ability to solve higher order question in chemistry (2) investigate the differential effect of the treatment by gender and achievement level and (3) explore the relationship between performance on concept and achievement level. The participant for the study were sixty grade 10 chemistry students in Lebanon who were randomly divided into two sections based on achievement to experimental and control groups. The materials covered were acid-base titration and equilibrium in weak acids. The instrument used for data collection was a chemistry achievement test which measured a pre and a post test. The study spanned a period of eight weeks in a class that met four times a week. The data obtained was analyzed using means, standard deviations and Analysis of variance (ANOVA) .The Result showed that while there were no significant differences on the achievement total score, there were significant differences favoring the experimental group for scores on the knowledge level question. The study is similar to the present study as a pre and post tests was also administered but unlike the former, the present study this study has a higher population, and also tested for retention and attitude. It also taught five topics in to the students in five weeks using experiments and concept mapping for instruction.

Ajaja (2011) examined if the use of concept mapping as study skill can influence students' achievement in Biology. The design of the study was quasi experimental pre-test, post-test control group design. The population consisted of 100 SSII from Delta state were used for the study. To guide the study five research questions were raised and three hypotheses stated and tested at 0.05 level of significance. The major instrument used for data collection was Biology achievement test and an interview scheduled to determine the students' perception of the usefulness of concept mapping in their studies. The study spanned a period of six weeks. The data was analyzed using Analysis of covariance (ANCOVA) and paired sample t-test. The major findings of this study include, a non significant difference in immediate post achievement test scores between students who used concept mapping as a study skill and those who reviewed and summarized in their studies. It was concluded that concept mapping could serve as an appropriate alternative for studying Biology. The population used for the present study is similar to that of this study under consideration, as SS II students will also be used in the study. The instrument used was the pre-test and post-test Biology achievement test. This study did not consider if concept map helps in retention of Biology concepts. This study opted for this.

Akeju, Rotimi and Kenni (2011) investigated the effects of teaching with concept mapping strategy on learning achievement in Nigeria secondary schools. The research study adopted the Quasi-experimental Research Design. The population comprised of a sample of 168 senior secondary school class two physics students purposively selected from senior secondary school across Ekiti state. There were two activity groups, the experimental and control groups. The research study were two types, namely uncompleted MCM (Motion Concept Map) which the experimental group were

required to complete, and used as pre-test and post-test respectively and printed materials which comprised of two parts. 20 simple structured sample questions relating to the knowledge of the presented concept was used to measure level of cognition and part B consisted of 10 structured questions administered as post-test to the experimental group only. The post-test for both groups was administered two weeks after the treatment mean, standard deviation and t-test were used to calculate students' achievement. The major findings of the study were that:

i. There is a significant effect of the instructional strategy on students' learning achievement
ii. Experimental group was able to recall a higher percentage of learned materials.

Akeku,Rotimi &kenni (2011) used a population similar to that used by the present researcher, however the researcher did not use students' across FCT. The present research used five (5) weeks for the study after which a post-test was given, unlike the research under consideration which gave a post-test after two weeks only. The researcher used twenty-five (25) multiple questions for the pre-test and post-test.

Karakuyu (2010) investigated the effect of students' concept mapping on their physics achievement and attitudes towards physics lesson. The design for the study was comparative research that employed an experimental group and a second group that was taught in a more traditional teacher-centered manner called the control group. Subjects were 58 ninth grade students from the two classes enrolled into general physics in a high school in Turkey. The data were collected via a pre and post administration of the physics Achievement Electricity test (PAET) and concept maps attitude scale towards physics (CMASTP). One of the classes was randomly chosen as experimental group (28), which constructed electricity concept and the other was control group (30) which

did not receive any presentation on concept mapping. The study conducted in six weeks in a class that met two times a week. The material covered was about electricity. The data was analyzed using mean, standard deviation, independent sample t-test and a two –way ANOVA. The result from the study using t-test showed that while there were no difference in the attitude and achievement between the experimental and control groups, however, the experimental group students were observed to have a tendency of more positive attitude than the control group students. Results also showed that drawing concept map instruction was more effective than traditional instruction in improving physics achievement of the participating students. This study under consideration did not research the effects of concept maps on students' retention which the study considered. The research was conducted for five (5) weeks unlike this present study which was conducted for six (6) weeks, the class also met two (2) times a week like the study under consideration.

Rao (2004) carried out a study on the Effect of Concept Mapping in Science on Science Achievement, Cognitive Skills and Attitude of Students. The objective of the study included among others to develop and implement concept mapping as a strategy in the selected few units of science standard VIII students and its effect on the achievement, concept attainment and process skills of students belonging to different intelligent groups. The study was quasi-experimental in nature where non-randomized pre and post test design was used. The intact classes of eight standard as a whole were considered as experimental (47) and control group (42) for the study from two local schools of Mysore City. The instruments used to collect data were achievement test, a process skill test and a concept attainment test. The data obtained was analyzed using percentages, mean, standard deviation, t-values and ANOVA. The major finding of the

study revealed that the experimental group student had performed better when compared to the control group.

The present study did not take into consideration the cognitive skills of students' to concept mapping, but only on its achievement in Biology and not in science. The study is similar to that of the researcher because intact classes of SS2 students were used in schools. However the population of the researcher was larger than that of the study under consideration.

Candan, Turkmen and Cardak (2006) carried out a study on Effects of Concept Mapping on Primary School Students' Understanding of the Concept of Force and Motion in Turkey. The purpose of the study was to reveal fifth-grade school students' misconceptions about the concepts of force and motion and to compare the Effect of Traditional Teaching Methods and Concept Maps in remedying these Conceptions. The research was designed as a quasi-experimental approach that concept maps and traditional teaching methods were applied to the experimental and control groups, respectively. The study approximately took six weeks. A thirty-item was constructed for the purpose of identifying the students' understanding and misconceptions concerning the concepts of force and motion. The study indicated that the students in the experimental group, taught with concept maps, showed greater achievement in the unit than the students in the control group training with the traditional method.

The study under discourse is similar to the study the researcher is undertaking because both sought to compare the effectiveness of concept maps with traditional teaching method. The researcher will also be using intact classes like the study under discourse and will equally use experimental and control group. The study is however different from the researcher's in that the research will be carried out using secondary school

students, using five (5) concepts instead of the two used and last for five weeks instead of six weeks used in the study above. The research compares the Effects of Concept Maps alone with Traditional Methods, while the present research used specifically, compared concept maps and experiments with the traditional lecture method.

Egolum (2012) investigated the Effects of Concept Mapping and Cognitive Styles on Achievement of Students in Chemistry. A quasi-experimental design was used. The focus of the study was to compare the mean achievement scores of field dependent(FD) and field independent(FI) students taught chemistry using concept mapping(CM)instructional strategy and those taught using conventional lecture method(CLM) amongst others. Two research questions and two hypotheses were posed to guide the study. The quasi-experimental design was used. One hundred and ninety three (193) chemistry students were selected from four co-educational schools in Onitsha. Two instruments: Group embedded figure test (GEFT) and Chemistry Achievement Test(CAT) were used. The data were analyzed using mean, standard deviation and analysis of covariance (ANOVA). The results revealed that Field Dependent (FD) and Field Independent (FI) cognitive styles students taught chemistry using concept mapping achieved better than those taught using conventional lecture method. The population for this study is similar to the researchers' population and unlike the study; the researcher is using intact classes and not students selected like the present study. The research is similar to this study, because the researcher will also use the lecture method for its control group. This present study sought to find out what effects concept mapping has on students' achieivement and retention. The study also covered more than one topic hence was similar to the present study.

A study on attitude of Nigerian Secondary School chemistry students towards concept mapping strategies in learning Mole Concept was administered by Bamidele, Adetunji, Awodele and Irinonye (2013). It compared the effectiveness of the use of different concept mapping strategies used as advance organizers on students' performance and examined attitudes of students towards the use of concept mapping strategies in the teaching of five topics. The treatment lasted five weeks of two periods per week. The study adopted the pretest-post test-control group quasi experimental design. The population for the study was 132 SSII chemistry students randomly selected from three (3) secondary schools in Osun state. Two research instruments were used for the study, Problem Solving Achievement test in Chemistry (PSATC) and Questionnaire on attitude of student towards concept mapping (QACSCM).The data collected were analyzed using one way analysis of variance (ANOVA). The result of the study showed that students had a positive attitude to concept mapping strategy. The research is similar to this study, in that the researcher also used five weeks for treatment and equally met for two periods in a week and also adapted the quasi experimental method study also considered the change in the attitude of students towards Biology; however instead of one topic used in the research been examined, the researcher used five (5) topics and also had a higher population.

A study on the Attitude towards Biology and its effects on student's achievement was conducted by Nasr & Asghar (2011) using a total of 185 grade 12 students in Isfahen. A 30 item questionnaire provided by authors based on STAQ_R inventory was used for the research and the research questions among others included: Is there any relationship between attitude towards Biology and students' achievement in Biology courses at the following dimension (a) motivating Biology class;(b) self directed efforts;(c) family

models;(d) biology is fun for me (e) peer models. The data was analyzed using the statistical software SPSS version 16.0 t-test The result showed that among attitude towards science dimensions only "biology is fun for me" had meaningful and positive relation with students achievement in biology. This study is similar to the one been carried out by the researcher in that the researcher sought to find out the attitude of students to Biology only this time, the research is using concept maps and experiments unlike the researcher under study who is not using any teaching method

2.10 Summary

So far, the review presented a moderate analysis of studies that relate to the framework for some basic concepts that are fundamental to the study. Moreover, the review explored different works on the field of study and some related field of study with a view to determining the gap which this study will fill in terms of contribution to knowledge. in the review, the theoretical framework used included operant conditioning model and stimulus response (SR).Association theory, Bruner's theory of cognitive learning, John Dewey's theory of cognitive, Ausubel's subsumption theory other review done covered the following concept maps, using concept maps in instruction, the use of concept maps and experiments in the teaching of Biology, origin of experimental science, importance of science practical work, experimentation in Biology teaching, Biology as a subject in Senior Secondary School, Biology curriculum for Senior Secondary School, conventional teaching methods for Biology in Senior Secondary School, influence of teaching methods on students' attitude towards Biology, influence of lecture method on students' achievement in Biology, influence of concept mapping on students' attitude towards Biology, influence of concept mapping on students' achievement in Biology, meaningful learning and retention, the need for a change in teaching strategy, review of related empirical studies. In the view of the

reviewed authors, it was revealed that students performed better when exposed to the use of concept mapping as an instructional strategy than when they are taught with conventional method alone. It was also showed attitudinal changes when concept maps were used for instruction In the review of empirical studies some result findings on the effectiveness of the use of concept mapping and academic achievement in Biology, Chemistry and Physics showed that students instructed with concept maps usually performed better and retained better.

However the effectiveness of using concept mapping and experimental teaching strategy in Biology is yet to be determined and ascertained it is clear from the review of literature that concept mapping has been used mostly in the teaching of a single topic in Biology or in the other two science subjects. It therefore become necessary that the present be embarked on to investigate the effectiveness of using concept mapping and experimental teaching techniques in teaching Biology.

CHAPTER THREE

RESREACH METHODOLOGY

3.1 Introduction

This chapter is presented and discussed under the following sub- headings. Research design, population for the study, sample and sampling techniques, method of data collection , instrumentation, validity of instrument, reliability of the instruments, collection, treatment of experimental group and method of data analysis/techniques.

3.2 Research Design

The study was conducted using the quasi- experimental design, specifically the pre-test and post-test; non equivalent control group design was used. This implies that, intact classes (non-randomized groups) were used for the study. According to Sambo(2005) and Offor(2000) quasi experimental research design permits the use of intact classes. Also Nwankwo(2007)defines quasi-experimental study as "a study in which some threats to validity cannot be properly controlled because of unavoidable situations associated with the study when human beings are used for experimental study"(p.49). Furthermore Ali (2006) in Nwankwo (2007) observed that, among other conditions when subjects for a study are selected and randomization of subjects are not feasible, rather intact classes are used such is quasi-experimental study. Quasi-experimental research design was adopted because it may not be possible for the researcher to randomly sample the subject and assign them to groups without disrupting the academic programme and the time table of the secondary schools involved in the study. Hence the design is considered quite suitable for conducting the study.

There were two experimental groups and one control group. The design is represented below:

E O_1 X_1 O_2

O_3 X_2 O_4

C O_5 X_3 O_6

Where

E- Stands for experimental groups

C- stands for control group

O_1 O_3 and O_5 represents the pretest in the three groups

X_1 X_2 X_3 represents treatment 1 (experiments), treatment 2 (concept mapping) and (lecture method) respectively.

Also O_2, O_4 and O_6 represents post test for three groups

Dotted lines separating E and C stands for intact classes of groups

3.3 Population

The population for the study comprised of the 6208 SS2 biology student of FCT Abuja from which 1116 were drawn from Karshi Zone of Abuja Municipal Area Council FCT. There are six (6) public senior secondary schools in Abuja Municipal Area Council of the Federal Capital Territory. The students' population is 1116 students. (see table 3.1 below).

Figure 3.1: Population of SSII Biology Students in the Public Senior Secondary Schools in Six Area Councils of the Federal Capital Territory.

S/N	Name of Area Council	Number of Schools	Population of Male Students	Population of Female Students	Total
1	Bwari	12	540	535	1075
2	Kuje	11	440	360	800
3	Gwagwalada	10	204	190	394
4	Abaji	8	187	174	361
5	Municipal	18	1764	1584	3348
6	Kwali	3	118	112	230
	TOTALS	**62**	**3253**	**2955**	**6208**

3.4 Sample and Sampling Technique.

Two co-educational senior secondary schools were purposely sampled for the study. The schools sampled include Government Secondary School (GSS) Nyanya and Government Day Secondary School (GDSS) karu. The choice of the schools were because they shared similar characteristics like student type (co-educational), and presence of competent and experienced Biology teachers. In each of the senior secondary schools SS2 students were used for the study. Two arms of SS 2 classes were randomly sampled and used for the study. SS 2A of Government Secondary School GSS (Nyanya) was used as the experimental class 1 (experiment) while SS 2B of the same school was used as experimental class 2 (concept mapping). Government Day Secondary School, Karu was used as the control school. SS 2A students were used for the study.

Table 3.2: Sample Size of Streams of Schools Used for the Study.

Groups	Name of School	Class	Female Population	Male Population	Total
Experimental Group (Taught using experiments)	Government Secondary School Nyanya	SS 2A	34	31	64
Experimental Group (Taught using concept maps)	Government Secondary School Nyanya	SS 2B	33	31	64
Control Group (Taught using lecture method)	Government Day Secondary School karu	SS 2A	32	33	64
Total			99	95	192

One hundred and twenty-eight (128) SS 2 students, constituted the students in the experimental group (of which 64 constituted students for concept map and 64 for experiments) and sixty-four (64) SS two students constituted the students in the control group. The sample size chosen above agrees with the view of Eboh (2009) who states that a common quasi-experimental design uses two or more groups which have not been randomly selected or allocated and the number in each group should be manageable. His view is in support of the small sample size. Akuezuilo (2002, p.58-59) noted that quasi-experimental studies allows small number of subjects for easy management of the variables involved in the studies.

3.5 Instrumentation

The Biology Achievement Test (BAT) was used in the study. The dependent variable in this study is the students' Biology achievement. Two tests were used to measure achievement, one a pretest which was used to test students' pre-requisite knowledge in topics related to the ones covered during the study (Appendix A presents sample of the questions used in the pre-test). The post test measured students' achievement at the conclusion of the study. Three of these topics are drawn from SS I syllabus and two (2) from SS II. (Appendix B) shows sample of the questions used in the post-test. According to Willerman and MacHarg (1991), a test must be at the comprehension level and above in order to measure meaningful learning. Consequently, many items on the achievement tests used in this study were at the comprehension level or above. The pre-test assessed students' achievement on the topics listed out for the research. The post test also assessed students' achievement on these topics.

The Biology Achievement test comprised of 25 test items of multiple choice questions. These questions were drawn from questions developed by Educational Resource Centre (ERC) for promotion examinations for 2009, 2010, 2011 and 2012. Each question had four options A – D, the multiple choice items were drawn from SS1 & SS2 topics using the table of specification covering topics selected for the study. Three (3) of these topics are from SS 1 and two (2) from SS 2. The questions used in the pre-test were re-numbered for the post-test and the questions relating to the two topics taught in the first two weeks were extracted for retention test. The students' Pre, Post and Retention test questions were scored. Each correct answer carried one mark and each wrong answer carried no mark. Students who scored twelve (12) marks were seen has having performed well.

The following instruments were used for data collection:

- Biology Achievement Test (BAT) for Pre-test and Post-test. Appendix A
- Biology Achievement Test for Retention (BATR) Appendix B
- Concept Mapping Instructional Package (CMIP). Appendix C
- Lesson Plan for Experiments Appendix D
- Lesson Plan for Control Group Appendix E
- Concept Map Attitude Scale Towards Biology Questionnaire (CMASTBQ) Appendix F
- Experiments Attitude Scale Towards Biology Questionnaire (EASTBQ) Appendix G

3.5.1 Validity of the Instrument

The BAT achievement tests were past questions developed by Educational Resource Centre (ERC) 2009 – 2012. Only the items on the syllabus were lifted. The lesson plans were face validated by two experts from the Department of Education of Ahmadu Bello University (ABU) Zaria, and the questionnaire was vetted by a psychologist from University of Abuja.

3.5.2 Pilot Study

Two topics each on concept map and experimentation laboratory work meant for the treatment group (experimental group) namely transport system, blood clotting and excretory system – urine formation, and identification of vertebral bones and experiment on Food Test was administered on a class of 65 students at Government Secondary School Karu in Abuja. The student were taught the two topics using concept map and were taught experiments on which they identified bones and carried out

experiment on Food Test each class was taught using a double period of 80mins each. After the lesson a post test was given on the topics taught.

3.5.3 Reliability of the Instrument

The reliability co-efficient for both teaching techniques concept map and experimental techniques was determined using the Kuder-Richardson Formula 21 which determined the suitability of the instruments for the study and they yielded a co-efficient value of 0.65. Brown (1983) has indicated that reliability co-efficient of 0.5 or more is considered reliable.

3.6 Method of Data Collection

The researcher and the trained biology teacher administered the pre-test to the experimental and control groups respectively. In the pre-test, the Biology Achievement Test (BAT) was administered to the groups. Objective question sheets (Appendix A) were provided for the students to mark the correct answers for the BAT. The researcher marked the sheets of the BAT to obtain the students' scores on cognitive achievement before the treatment. The exercise provided baseline data on students' performance in Biology before the treatment. The treatment commenced with the use of concept mapping techniques in giving instructions on Biology to one of the experimental group and experimental technique to teach the second experimental group. The researcher administered a retention test to the two experimental groups after two weeks of teaching, while the trained Biology teacher administered the retention test after two (2) weeks of teaching. The questionnaire to determine the attitude of students towards the use of concept maps and experiments in teaching was administered in the fifth week. The researcher administered the post-test to the experimental groups after five (5) weeks of lesson, while the trained Biology teacher administered the post-test to the

control group. The researcher marked the sheets for the BAT to obtain the students' scores in cognitive achievement after treatment, while the trained Biology teacher did the same for the control group.

Table 3.3: Topics Taught and Method of Teaching

S/N	TOPICS	METHOD OF TEACHING		
		EXPERIMENTAL GROUP	CONCEPT MAP	CONTROL GROUP
1	Classification of plants	Experiments	Concept Map	Lecture
2	Food Test	Experiments	Concept Map	Lecture
3	Bones of the vertebral column	Experiments	Concept Map	Lecture
4	Alimentary carnal of bird and function of parts	Experiments	Concept Map	Lecture
5	Osmosis and diffusion	Experiments	Concept Map	Lecture

See Appendices C, D and E for the lesson notes for experimental and control group.

3.6.1 Treatment of Experimental Group

The experimental Group was treated for five weeks. The double period of the Time Table was used for the lesson each to ensure that the lesson and experiments had ample time. Before the commencement of the treatment the researcher explained how the concept mapping operates to the subjects.

In the first week, the experimental classes were taught classification of living things using concept map and experiments respectively. In the class for experiments the teacher instructed the students on how to carry out the experiments by observing and classifying the plants, and in the concept mapping class, the teacher gave the students the concept mapping instructional package as an advance organizer before the explanation for the lesson and instructed them using the package.

In the second week, the teacher instructed the students on how to carry out food test on starch, sugar, protein and fats & oil using experiments while using the concept mapping package the teacher taught the other class. After the lesson, the teacher administers the Biology retention test.

In the third week, the teacher instructed the concept mapping class using the package, while the other class was taught by showing them the various vertebral bones namely cervical, thoracic, lumber, sacral, and caudal and the plants. Afterwards they are asked to identify, draw and label them.

Using the instructional package on digestive system of birds and their functions. The teacher instructed the students in the fourth week, while using a disserted chicken the teacher instructed the students in the experimental class and lists their functions. The students identified these parts.

In the fifth and final week, the teacher used the instructional package on concept map to teach students diffusion and its importance to man, while the teacher carried out the experiment on diffusion in the experimental class explaining its importance to man. After this the teacher administers the post-test.

3.7 Method of Data Analysis

The research questions were answered using mean and standard deviation while the two sample t-test, analysis of covariance and pairwise comparison was used for testing the hypotheses at 0.05 level of significance. The two sample t-test was used because of the two independent variables, while the covariance analysis procedure was used to because of the need to ensure that significant variability between scores is not attributed to chance or any exogenous factors, while the pairwise comparison was used to determine more specifically which method had a greater effect in terms of mean scores and retention scores.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Introduction

Students' performance in biology when exposed to concept mapping, experiments and Lecture method were compared in this study. The chapter presents the statistical significance of the variability in the performance of students when exposed to the three different methods of teaching biology at the senior secondary school level. Variables analyzed were the students' academic performances before and after their exposure to the methods, their retention levels and attitude towards the use of Concept mapping and experiments in the teaching of biology. Three classes of 64 students each were used for the different methods. Records of achievement were taken before and after the experiment. Performances on the three variables are presented along the research questions and hypotheses as follows:

4.2 Response to the Research questions

The following research questions were formulated to aid the identification of the efficacy of the two methods of instructing students on Biology over the existing conventional method.

Research Question one: What is the difference in the mean scores of students taught Biology using concept map and experiments?

The comparison of the performances of the students taught using concept maps and experiments was conducted by using the pre-test scores along with the post test scores in the two methods as summarized in Table 4.1. The mean scores are shown in Bar chart with error bar in Figure 1.

Table 4.1: Mean scores of students before and after exposure to the use of concept mapping and use of experiment in the teaching of Biology

Method	Status	N	Mean	Standard Deviation	Standard Error
Concept mapping	Pre-test	64	8.78	2.865	0.358
	Post test	64	13.53	3.578	0.466
Experimental Technique	Pre-test	64	11.17	4.135	0.517
	Post test	64	17.22	3.803	0.475

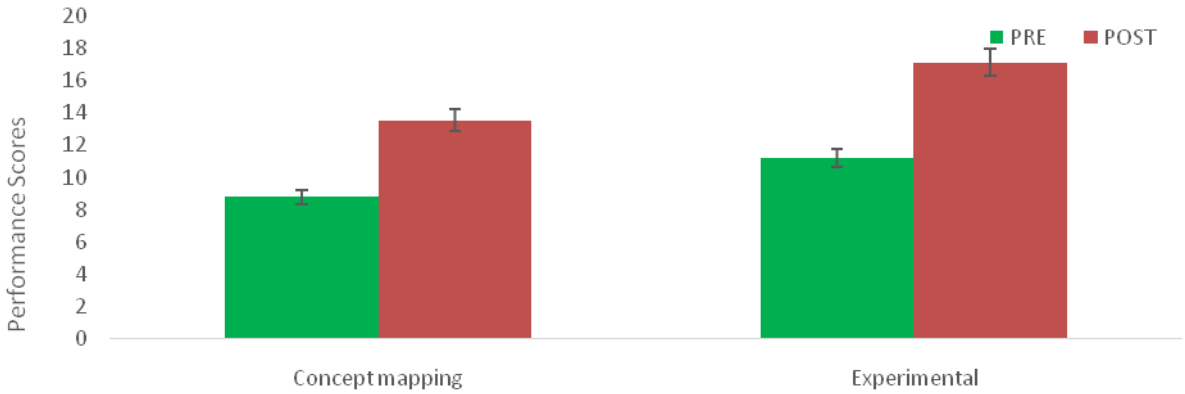

Fig. 1: Students' performance before and after exposure to Concept mapping and Experimental methods

The scores as shown in the table and the chart show that the students who were exposed to the use of experiments in the teaching of the Biology performed proportionately higher than those who were exposed to the use of Concept maps. The observed variability was reflected before and after the test but the proportionate increase among students who were exposed to the use of experiments is higher than that observed among students in the concept mapping method. This would imply that the use of experiments in the teaching of Biology has a relative edge over the use of concept mapping.

Research Question two: What is the difference in the mean scores of students taught Biology using concept maps, experiments and lecture method?

The performances of the students exposed to the three methods of teaching the subject were compared here. Table 4.2 shows the mean scores along with the standard deviation and standard errors. The mean scores for the different methods before and after the experimental techniques are graphically illustrated in Figure 2.

Table 4.2: Mean achievement scores of students exposed to the use of concept mapping, experiments and lecture method

Methods of teaching	N	Pre-test scores		Post test scores			
		Mean	Std. Dev.	Std. Error	Mean	Std. Dev	Std. Error
Concept mapping	64	8.78	2.865	0.358	13.53	3.578	0.466
Experiments	64	11.17	4.135	0.517	17.16	3.782	0.480
Lecture	64	8.33	1.952	0.244	14.29	4.700	0.570
Total	192	9.43	3.342	0.241	14.99	4.344	0.316

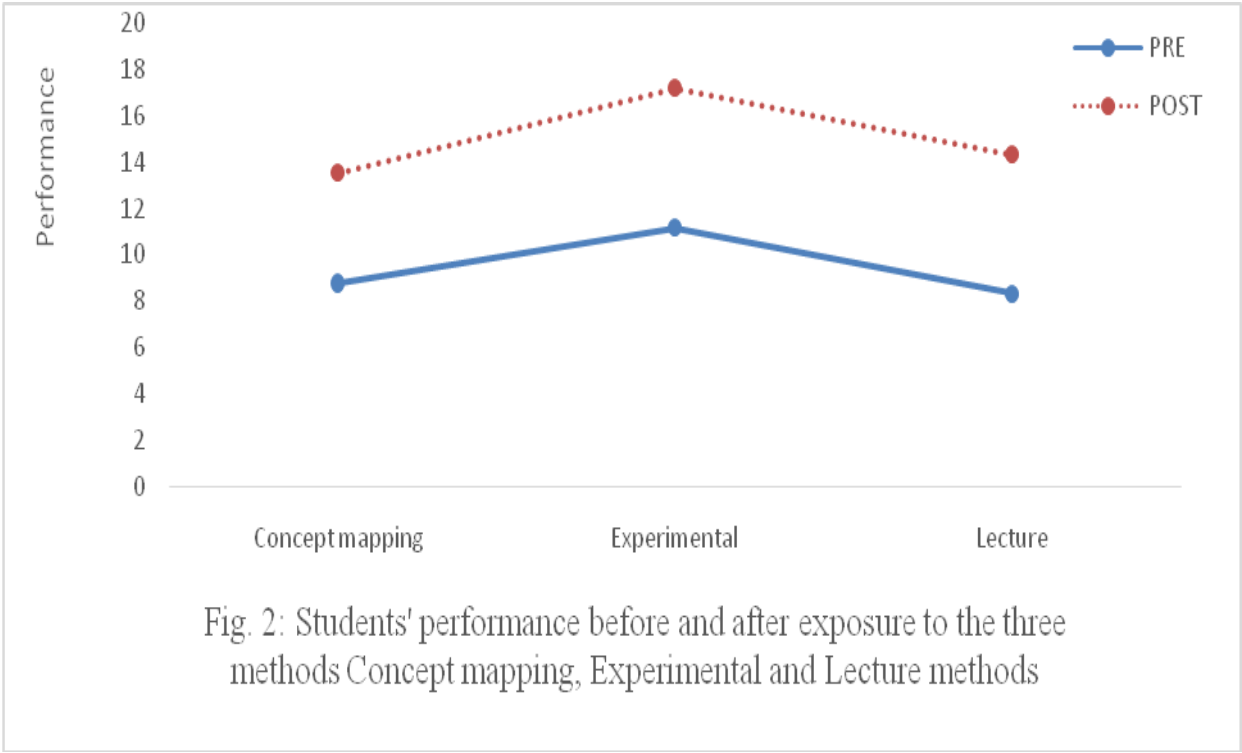

Fig. 2: Students' performance before and after exposure to the three methods Concept mapping, Experimental and Lecture methods

The mean scores were generally low before the students were exposed to the three methods but after the test, there was a general increase in the achievement scores with performance of students taught using concept maps increasing from mean of 8.78 and standard deviation of 2.864 to mean of 13.53 and standard deviation of 3.578 while performance among students taught using experiments increase from mean of 11.17 and standard deviation of 4.13 to mean of 17.16 and standard deviation of 3.78. Performance among students taught using lecture method increased from mean of 8.33 and standard deviation of 1.952 to mean of 14.29 and standard deviation of 4.70. In order of magnitude, the students in the use of experiments could be said to have the highest score followed by students were taught with the lecture method with the group taught with concept maps as the least.

Research Question three: What is the mean score of students taught using concept maps and experiments in the retention of Biology concepts used for the study?

To determine the level of retention of Biology knowledge of students taught using the two methods (concept maps and experiments), the retention scores before and after the test were compared as shown in Table 4.3. The mean score are presented in Figure 3.

Table 4.3: Mean retention scores of students before and after their exposure to the use of concept Mapping and experimental techniques in the teaching of Biology

Methods	Status	N	Mean	Std. Deviation	Std. Error
Concept mapping	Pre-test	64	4.06	1.390	0.174
	Post test	64	4.06	1.379	0.171
Experimental	Pre-test	64	5.75	1.458	0.182
	Post test	64	5.77	1.4654	0.180

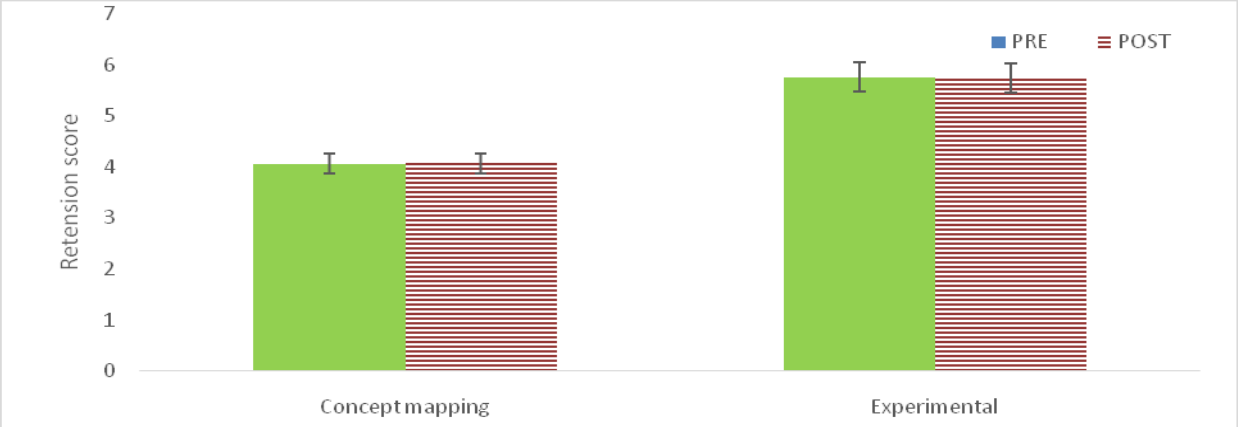

Fig. 3: Students' Retention before and after exposure to Concept mapping and Lecture methods

The table and the chart did not show much variation in the retention of students in both the concept mapping and experimental techniques before and after the test. The students who were exposed to the use of experiments in the teaching of the subject were generally higher in their retention. The exposure did not increase their retention level after the test. Those in the use of Concept mapping did not increase in their retention level after the test. This would mean that the use of the Concept mapping and experimental techniques did not significantly increase the retention abilities of the students.

Research Question four: What are the mean scores of students taught using concept mapping, experiments and lecture method in the retention of Biology concepts?

The mean retention scores of the students exposed to the three methods of teaching Biology involved in the test are presented in Table 4.4 along with their standard deviations and standard errors. The level of retention before the exposure is resented along the level after the exposure. The mean retention levels for the different methods are presented in Figure 4.

Table 4.4: Mean retention level of the students exposed to the three methods of teaching the subject.

Method of teaching Biology	N	Pre Test Scores			Post Test Scores		
		Mean	Std. Dev.	Std. Error	Mean	Std. Dev.	Std. Error
Concept mapping	64	4.0625	1.39016	.17377	4.0625	1.39016	.17377
Experimental	64	5.7500	1.45842	.18230	5.7500	1.45842	.18230
Lecture	64	3.7344	1.21161	.15145	3.7463	1.19777	.14633
Total	192	4.5156	1.61465	.11653	4.5077	1.60659	.11505

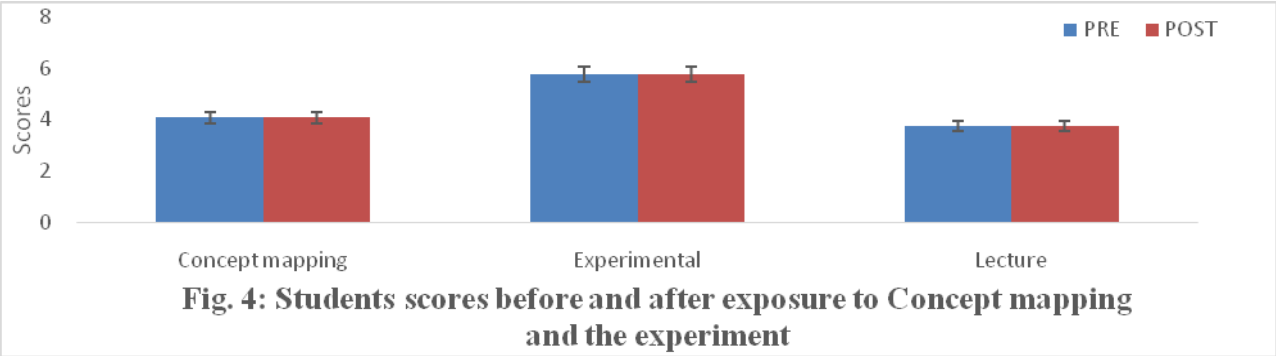

Fig. 4: Students scores before and after exposure to Concept mapping and the experiment

The exposure did not increase the retention abilities of the students to any considerable level as indicated in the table and the chart. However, the retention level of students who were taught with the use of experiments was higher than those who were taught with the concept mapping and the lecture method. But within each of the groups, retention level before and after were relatively equal. This would imply that the use of the three methods did not really have much impact on the retention abilities of the students.

Research Question five: What is the difference in attitude of students towards Biology when concept map and experiment are used for teaching Biology?

The aim here is to compare the attitude of students to the teaching of Biology when concept mapping and experiments are used for teaching Biology. The mean scores after

the test are presented in Table 4.5. The mean scores are graphically represented in Figure 5.

Table 4.5: Mean attitudinal scores towards the use of Concept mapping and experiments in the teaching of Biology concepts

Variables	N	Mean	Std. Deviation	Std. Error
Experimental	64	3.7219	.38646	.04831
Concept Mapping	64	3.8281	.31039	.03880

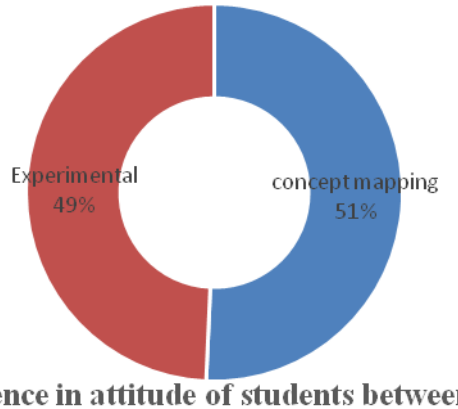

Fig. 5: Difference in attitude of students between Concept mapping and the experimal

The table and the chart show that the mean attitude of the students is in favour of students taught using concept mapping. Though both methods (Concept mapping and use of experiments) had positive attitude on the students but the scores for concept mapping is higher which means that the students likely have preference for the method than the use of experiments.

4.3. Test of hypotheses

The hypotheses formulated to validate the solutions to the research questions of the study are tested as follows:

Hypothesis I: There is no significant difference in the mean scores of students taught Biology using concept mapping and those taught using experiments.

This hypothesis was tested by comparing the post test scores of subjects exposed to the use of concept maps and those taught using experiments. The test was conducted with the two sample t-test because of the two independent variables. The result is summarized in Table 4.6.

Table 4.6: Two sample t-test on performance of students exposed to concept mapping and use of experiments in the teaching of Biology

Variables	N	Mean	Std. Deviation	Std. Error	t-value	DF	P
Concept mapping	64	13.53	3.578	0.466	5.366	126	.000
Experimental	64	17.15	3.877	0.505			

(t-critical = 1.96)

The result reveals that students who were taught Biology with the use of experiments were significantly better in their performances than those exposed to the use of the Concept mapping. This is indicated by the observed mean score of 17.15 for those taught with the use of experiment compared with 13.53 for students who were taught Biology with the use of Concept maps. The observed level of significance for the test is 0.000 ($P < 0.05$). With these observations, there is enough evidence to reject the null hypothesis that there is no significant difference in the mean scores of students taught Biology using concept maps and those taught using experiments.

Hypothesis II: There is no significant difference in the mean scores of students taught Biology using concept map, experiments and those taught using lecture method.

The performance scores of the three groups exposed to the three different teaching methods were compared here for possible significant difference after the test. The covariance analysis procedure was used for the test because of the need to ensure that observed significant variability between scores is not attributable to chance or any effect of exogenous factors. The pre-test score for the groups was therefore used as a

covariate factor while the selected teaching methods constituted the main independent variable. The result of the covariance analysis model is summarized in Table 4.7.

Table 4.7: Covariance analysis on performances by students from the three methods of teaching

Source	Sum of Squares	DF	Mean Square	F	Sig.
Pre Test	.030	1	.030	.002	.966
Grouping	407.258	2	203.629	12.505	.000
Error	2914.763	179	16.284		
Total	44373.000	183			

The data presented in table 4.7 show that the F- vaule for groping is 12.505 with significance at.000 which is less than 0.005.The null hypotheses is therefore rejected at less than 0.05.The result in the table revealed that the improvement on the performances of the students in the post test scores was not significantly influenced by any exogenous factors. This is indicated by the no significance of the pre-test as the covariate factor in the model. However the observed variability in the mean scores from the three methods was statistically significant. This is indicated in the model by an observed P-value of 0.000 ($P < 0.05$). By these observations, the null hypothesis that there is no significant difference in the mean scores of students taught Biology using concept map, experiments and those taught using lecture method is therefore rejected. A post hoc test was conducted on the mean scores to determine the method that had significantly higher score than the other. The pair wise comparison was carried out on the mean scores using the Least Significant difference procedure as summarized in Table 4.8.

Table 4.8: Pairwise Comparisons of performance scores by students taught with the three methods.

(I) Methods	(J) Methods	Mean Difference (I-J)	Std. Error	Sig.
Concept mapping	Experiments	-3.627(*)	.764	.000
	Lecture	-.622	.736	.399
Experiments	Concept mapping	3.627(*)	.764	.000
	Lecture	3.005(*)	.772	.000
Lecture	Concept mapping	.622	.736	.399
	Experiments	-3.005(*)	.772	.000

* The mean difference is significant at the .05 level.

The result in the table revealed that scores of students taught Biology with the use of experiments performed significantly higher than those taught with concept mapping and lecture method. Between students taught with Concept mapping and Lecture method, no significant difference was observed in their performance.

Hypothesis III: There is no significant difference in the mean scores of students taught using concept maps and those taught using experiments in the test of retention of selected Biology concepts used for the study.

The retention score by groups subjected to the use of Concept maps and the use of experiments in the teaching of the Biology was subjected to a two sample t-test procedure to determine the method that facilitated higher retention ability among the students than the other. The result of the test is summarized in Table 4.9.

Table 4.9: Two sample t-tests on retention level by students exposed to concept mapping and use of experiments in the teaching of Biology

Variables	N	Mean	Std. Deviation	Std. Error	t-value	DF	P
Concept mapping	64	4.0615	1.37928	.17108	6.679	126	.000
Experiments	64	5.7385	1.44997	.17985			

(t-critical = 1.96)

The test as indicated in the table revealed that students who were taught the subject with the use of experiments performed significantly higher than those taught with Concept maps ($P < 0.05$). By this observation, the null hypothesis that there is no significant difference in the mean scores of students taught using concept mapping and those taught using experiments in the test of retention is therefore rejected.

Hypothesis IV: There is no significant difference in the mean scores of students taught using concept maps, experiments and those taught with lecture method in the test of retention of selected Biology concepts used for the study.

Significant difference in the retention ability of the students was tested here with Covariance analysis procedure. This was necessary to eliminate any effect of exogenous variable on the outcome of the test. The pre-test score for the groups was therefore used as a covariate factor. The result of the covariance analysis model is summarized in Table 4.10.

Table 4.10: Analysis of covariance on mean retention levels by students exposed to the use of concept mapping, experimental techniques and lecture method

Source	Sum of Squares	DF	Mean Square	F	Sig.
Pre test	163.709	1	163.709	165.892	.000
Grouping	9.696	2	4.848	4.913	.008
Error	185.526	188	.987		
Total	4429.000	192			

The data presented in table 4.10 show that the F- value for grouping is 4.913 with significance at.008 which is less than 0.005.The null hypotheses is therefore rejected at less than 0.05The result in the table 4.10 revealed that the improvement on the retention of the students in the post test for the three methods used in teaching the subject was

significantly different from each other (P < 0.05). By these observations, the null hypothesis that there is no significant difference in the mean scores of students taught using concept map and experimental techniques and those taught with lecture method in the test of retention of selected Biology concepts is therefore rejected. A post test was conducted on the mean scores to determine the method whose retention score was significantly different from the other. The pair wise comparison was carried out on the mean scores using the Least Significant Difference procedure. The result is summarized in Table 4.11.

Table 4.11: Mean comparison between retention levels by the different methods used in the teaching of the subject

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.(a)
Concept mapping	Experiments	-.530(*)	.197	.008
	Lecture	.072	.176	.684
Experiments	Concept mapping	.530(*)	.197	.008
	Lecture	.602(*)	.206	.004
Lecture	Concept mapping	-.072	.176	.684
	Experiments	-.602(*)	.206	.004

Based on estimated marginal means

* The mean difference is significant at the .05 level.

The test revealed that the retention level obtained among students taught with use of experiments was significantly different from those of the Concept mapping and the Lecture methods. Between the retention level of those taught with the Concept mapping and the lecture method, no significant difference was observed. However, the significance of the pre-test score in the model clearly implies that the observed significant variability in the retention could not be attributable to the method of teaching the subject.

Hypothesis V: There is no significant difference in students' attitude towards Biology when concept map and experiments are used for teaching.

The attitude of the students towards the use of the concept mapping and the use of experimental technique for the teaching of Biology was compared here with the two sample t-test. The result of the test is summarized in Table 4.12.

Table 4.12: Two sample t-test on attitude towards the use of Concept mapping and experimental techniques in the teaching of Biology.

Variables	N	Mean	Std. Deviation	Std. Error	t-value	DF	P
Experiments	64	3.72	0.386	0.048	5.707	126	.000
Concept Mapping	64	3.83	0.310	0.039			

(t-critical = 1.96)

The result revealed that students were more favourably disposed towards the use of concept mapping than the use of experimental techniques in the teaching of Biology. This is indicated by the observed mean score of 3.83 for concept mapping compared to 3.72 for experimental technique. The observed level of significance for the test is 0.000 ($P < 0.05$). With these observations there is enough evidence to reject the null hypothesis.

4.4 Summary of Major Findings

The major findings from the data analysis and test of the hypotheses are summarized as follows:

1. The use of experiments in teaching significantly improved the performance of students in Biology more than the use of concept mapping and lecture method.
2. The use of concept mapping though enhances performance of students is not significantly better than the lecture method.
3. The use of experiments makes for better retention levels than the use of concept mapping and lecture method.

4. There is no significant difference in the retention level of students taught Biology with lecture method and concept mapping.
5. Students have a more positive attitude toward the use of concept mapping for teaching Biology than experiments

4.5 Discussion of Results

From the analysis of the data from this experiment, the use of experimental techniques for teaching biology was found to have better advantages over the conventional method (lecture) and the concept mapping method. In the test of hypothesis I, possible difference in the achievement of students exposed to the two methods was conducted. The result revealed that the academic performance of the students who were exposed to the experimental techniques was significantly better than those exposed to the concept mapping method. The null hypothesis was therefore rejected. This finding is consistent with the report of Nwagbo and Chikelu (2011), Nwagbo (2008) and Nzewi (2008) who respectively found that experimental techniques as helping students to acquire basic scientific skills which helps to improve performance because students are involved in process skills and not only the theories behind them. The reports respectively pointed out that the acquisition of science process skills are the basis for scientific inquiry and the development of intellectual skills and attitudes that are needed to learn concepts. This result in line with previous studies from the research works of (Nwosu1991, Mandor 2002 and Ibe 2004) who indicated that active participation of students gave rise to more meaningful and effective learning.

In the test of hypothesis two of the study, significant differences in the academic performance of students who were exposed to the three teaching methods (Concept mapping, experiments and lecture method) used for the study were tested. The analysis

of covariance procedure was used for the test. The result revealed that the performances from students exposed to the three different methods were significantly different. From the post hoc test conducted on the mean scores, it was revealed that the observed significant difference was between students who were taught with experiments and the other two groups (Concept mapping and Lecture). Between the lecture and concept mapping methods, no significant difference was observed. The result here is contradictory to the reports of Udeani and Okafor (2012), Okoye and Okechukwu (2006) and Ajaja (2011) where it was established that the group taught by the concept mapping instructional strategy performed significantly ($p < 0.05$) better than their control group. The results are however in agreement with the work of Stensvold and Wilson (1992) who investigated on the effect of students' construction of concept mapping on high school chemistry laboratories on their comprehension of chemical concepts. They found no differences between the experimental and control groups. In addition, Boujaound and Attieh (2008) in their study on concept maps as study tools on achievement in chemistry also noted that results from the mean scores of chemistry achievement post-test for the experimental and control groups showed statistical insignificant difference.

Hypothesis III tested for significant difference in the retention level of students who were taught the subject with the use of the experimental techniques and those taught with concept mapping. The result revealed significant difference in the academic performances of the two groups. From the mean scores, it was observed that students who were exposed to the use of experimental technique had a significantly higher retention level compared with their counterparts who were taught the subject with concept mapping. The null hypothesis was therefore rejected. The finding here clearly

showed that the use of experimental techniques have an edge over the use of concept mapping. The finding is consistent with the study of Lyop and Mangut (2001) who pointed out that there are inherent setbacks of lecturing method. They affirm that it does not promote meaningful learning as it appeals only to the sense of hearing. According to them, more effective learning goes on only when many senses are involved. It also agrees with the findings of (Eziefe 1996,Maduabum 1989 and Abdullahi 1982) who observed that experimentation is a means by which students acquire meaningful leaning of science concepts to the point of achieving transfer and application of knowledge. According to them, it has proved to be one of the most effective ways of teaching science.

Possible significant variability in the retention level induced by the three methods used in teaching the subject was tested in Hypothesis IV. The test was conducted with covariance analysis procedure in order to determine the influence of exogenous variable on the outcome of the experiment by using the pre-test scores of the students as the covariate factor. The result revealed that all the students differed significantly in their retention level from the test. From the post hoc test conducted on the mean scores, using the pair wise comparison with the least Significant difference procedure, it was observed that students who were taught the concepts with experiments were significantly better in their retention ability than those who were exposed to the other two methods. No significant difference was however observed between students who were taught with concept mapping and those taught with lecture method. However, it was observed that the experiment did not directly influence the retention ability of the students. The finding here agrees with the report of Ozay, Ocak & Ocak 2009;on the sequential teaching method in Biology and their effects in academic achievement. The

result revealed that the retention level in lessons beginning with experiments and slide demonstrations was higher than that of the lesson beginning with lecture method because people remember 10% of what read,20% of what they heard, 30% of what they saw and 90% of what they had as hand-on experience. They concluded that experiments or laboratory work was hands-on experience. On the insignificant difference in the retention levels of students taught with concept maps and lecture methods Steveson and Wilson (1992) and Boujaound and Attieh (2008) suggested that concept maps can disadvantage high ability students who may have their own successful strategy which are not applied when concept maps where used. Furthermore Ajaja (2011) on the study concept mapping as a study skill: effects on students achievement" suggested that when students do not have much experience with a method, it puts them on the same level with students who have had several years of experience with the method of study the study is in agreement with Ajaja (1998) while discussing (Egelston and Lahnston :1973) findings on the effect of experience and task difficulty in achievement. They noted that task difficulty emanating from in lack of enough experience will result in a familiar method being superior on an immediate test of retention. Also, in another study by Ajaja(2013) on which "strategy best suits Biology teaching: lecturing, concept mapping, cooperative learning or learning cycle" he observed that lower retention of biological knowledge was found in students taught with lecture method and concept mapping than those taught with 5E learning cycle which comprised of Engagement, Exploration, Explanation, Elaboration and Evaluation and cooperative learning the problem Ajaja opined that the problem may not be unconnected with an earlier identified limitations associated with the two methods. These problems are difficulties in construction of concept map and their interpretation, and as pointed out by Bennet (2003) may have frustrated particularly the low ability students in the effective learning

and retention of the concepts they were exposed to. Bennet advocated for efficient acquisition of the skills necessary for use both by the Biology teachers and students to reduce the limitations associated with the method and also advocated that lecture method should still be used to teach very abstract topics to enable students easily acquire knowledge, new information and explanation of events or things as this will reduce the frustration students will experience with the other methods when dealing with very novel concepts.

Difference in attitudinal disposition of the students towards the use of the concept mapping and the experimental techniques for teaching the biology concept was conducted in hypothesis V. The result of the test revealed that the students had positive attitude towards the two methods but they were more significantly inclined to the use of concept mapping than the use of experimental techniques for teaching the subject. The null hypothesis was therefore rejected. The finding here is consistent with Yara (2009), who reported that attitude of the teacher and his method of teaching can influence students' attitude. The finding agrees with Karakuyu (2010) report from a study on effect of students' concept mapping on their physics achievement and attitudes towards physics lesson where it was observed that students exposed to concept mapping in the experimental group had a tendency of more positive attitude than the control group students .The finding also agrees with Abimbade(1983) and Aiyelaagbe (1998) in Adesoji (2008)in their study on managing students attitude towards science through problem solving instructional strategy. They opined that students exposed to programmed instruction recorded higher and more favorable attitude and a positive attitude after exposure to self learning strategy .Also Markow and Lonning (1998) tested the effect of concept map on concept understanding in college chemistry

laboratories, they found that students had a positive attitude towards the use of concept maps for better understanding of chemistry laboratory concepts.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The deteriorating performance of students in internal and external Biology examinations is a thing of concern to both teacher, parents, schools and even examination bodies like the WAEC. Other stakeholders have identified the teacher variable, as one of the factors, that is the teacher's teaching strategy as being responsible for students' poor performance in science and biology in particular. This therefore calls for a search for alternative teaching methods that will guarantee effective teaching and learning of science subjects especially biology in the secondary schools. The concept mapping method is said to makes students to remember information longer and enables them to use this knowledge effectively because it is moved to a long term memory. The use of experiments have been shown to give rise to effective learning .The study therefore investigated the effects of concept mapping and experimental techniques for the teaching and learning of selected concepts in Biology among Senior Secondary Schools of Karshi zone of the Federal Capital Territory Abuja.

To determine the effect of the investigation, a study was conducted where the performances from students exposed to lecture method, experiments and concept mapping were compared. A test was administered to each of the group before and after the experiment. Along with the result of performance in academic achievement and retention abilities of the students, their attitude towards the concept mapping and the use of the experimental techniques in the teaching of the biology concepts were assessed.

1. Students taught biology using experimental techniques had a significant improvement in performance than students taught using concept mapping.

2. Students taught biology using cc mapping and lecture method did not show any significant difference in performance.

3. Students had a higher retention level of biology concepts when experimental techniques were used over the use of concept mapping and lecture methods.

4. The study revealed that there was no significant difference in the retention level of students taught biology using concept mapping and lecture methods.

5. Students showed a positive attitude towards the use of concept mapping for teaching biology.

5.2 Conclusions

From the analysis of the data collected from the study and tests of the study's hypotheses, the following conclusions were drawn:

1. The use of experimental techniques for teaching biology concept enhances students' performance significantly better than the use of the concept maps and the lecture method.
2. The use of experimental techniques significantly improved students' performances in Biology concepts than the conventional lecture method.
3. The experimental techniques significantly improved students' retention ability than the concept mapping method.
4. The use of experimental technique significantly improved students' retention of Biology concepts than the conventional lecture method.

5. Students have higher preference for the use of concept mapping method of teaching than the experimental techniques of teaching the subject.

5.3 Recommendations

The following recommendations are made on the basis of the outcome of this study.

1. Science teachers should lay more emphasis on the use of experiments in the teaching and learning of Biology for improving performance among students.
2. Science teachers and Biology teachers in particular should give effective orientation to students towards the use of the experiments in the teaching of biology concepts and should be encouraged and trained in the use of concept maps alongside with other methods in the teaching of Biology.
3. The Science Teachers' Association of Nigeria (STAN) in conjunction with the Federal Ministry of Education and various secondary school boards should ensure the availability of standard laboratories in our secondary schools or the use of lableless labs.
4. Since attitude could be circumstantial, it would be necessary to put experiments and its merits before students to encourage them towards its use in the teaching and learning of the subject.
5. The lecture method should still be used to teach very abstract topics to enable students acquire knowledge, new information and explanation of events or things.

5.4 Suggestions for Further Studies

Further research studies can be carried out on:

1. The effect of using concept maps as study tools on achievement in Biology
2. Cognitive influence on Biology students' concept mapping ability and achievement in Biology.
3. Effect of concept maps and experiments on attitude, retention and achievement in other schools in states of the federation.

4. Critical appraisal of the role of concept maps and laboratory practical work in Biology.

5.5 Contribution to Knowledge

1. This study has been able to establish the fact that concept maps can be used by Biology teachers for instruction in FCT secondary schools to teach Biology, this will aid in the change of students attitude to Biology and invariably their performance as a result of this change in attitude.
2. The use of experiments in the teaching and learning of Biology could be a way out to improving the teaching and learning of Biology in our senior secondary schools.
3. The study has shown the correlation between positive attitude and improved academic performance.
4. The study has shown that students have preference for new teaching methods which maybe why they showed preference for the concept mapping method even though the use of experiments helped to improve their performances.

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APPENDIX A

BIOLOGY ACHIEVEMENT TEST (BAT) FOR

PRE-TEST AND POST-TEST.

PRE-TEST FOR CONTROL AND EXPERIMENTAL GROUPS

Instruction: From the options below, choose the correct option

1. What type of vertebra is represented in the diagram? (a) Atlas (b) Axis (c) cervical vertebra (d) Lumbar vertebra

2. The structure labeled A represents (a) transverse process (b) neutral spine (c) neutral canal (d) Centrum
3. Which of the following reagents is used for test for starch? (a) Million's reagent (b) iodine solution (c) benedict's solution (d) fehling's solution
4. When a mixture of a food substance and Benedict's solution is warmed, the colour changes from blue to brick-red precipitate indicating the presence of (a) reducing sugar (b) amino acid (c) sucrose (d) fatty acid
5. Which of the following food substance turns red when warmed with Sudan (iii) solution? (a) Starch (b) fat (c) reducing sugar (d) protein
6. Living things are classified into (a) Plants and Algea (b) Plants and Animals (c) Domestic and Non-domestic (d) Wild and Domestic
7. Which of the following crop is a beverage crop (a) Cocoa (b) Cotton (c) Kolanut (d) Rubber
8. Biennial plants are plants that are planted, grow and are ready for harvest in (a) every 2 years (b) every 3 years (c) every 1 year (d) every few months.
9. One major difference between osmosis and diffusion is that diffusion (a) does not need a semi-permeable membrane (b) does not take place in living tissues (c) takes place only in a liquid medium (d) takes place only in gaseous medium.
10. When a food substance gives a purple colour on the addition of hydroxide and a drop of copper sulphate, then the food substance is likely to contain (a) Carbohydrate (b) Fat (c) Protein (d) Sugar
11. The process by which ink spread uniformly in a beaker of water is called (a) absorption (b) osmosis (c) plasmolysis (d) diffusion

12. During osmosis a semi-permeable membrane allows (a) only solute molecules to pass through it (b) both solute and solvent molecule to pass through it (c) only solvent molecule to pass through it (d) only gaseous molecules to pass through it.
13. Which of the following vertebrate provides articulating surface for the ribs? (a) Thoracic (b) Lumbar (c) Cervical (d) Sacral
14. Which of then following food substances would produce a translucent mark when rubbed on a white paper (a) bean (b) mango (c) groundnut (d) osmosis
15. The experiment below is used to demonstrate the process of (a) transpiration (b) water culture (c) diffusion (d) osmosis

16. A fresh Kolanut weighing 10 grams was put into slat solution and after 3 hours, the Kolanut weighed 12 grams. These simple experiments demonstrate that the (a) cell sap of the Kolanut is more concentrated than the salt solution. (b) salt solution is more concentrated than cell sap of the Kolanut (c) Kolanut lost some water molecules to the salt solution (d) salt solution has the same concentration as the cell sap of the Kolanut
17. Plants can be classified into _____ parts (a) 2 (b) 3 (c) 4 (d) 5
18. Which of the following plants is not a leguminous plant? (a) Cowpea (b) Pulse (c) Soya beans (d) Beans
19. Which of the following groups of vertebrate have two branches at the end of their transverse process? (a) Sacral (b) Thoracic (c) Cervical (d) Lumber
20. The organ for storing food in birds is (a) stomach (b) crop (c) cloaca (d) rectum
21. Which organ is responsible for grinding food in birds (a) stomach (b) gizzard (c) Pharmx (d) Pancreas
22. Absorption in birds takes place in the (a) stomach (b) intestine (c) esophagus (d) liver
23. Reabsorption of water takes place in the (a) caecum (b) rectum (c) cloaca (d) intestine
24. The waste from the digestion of food is passed out of the bird through (a) anus (b) cloaca (c) mouth (d) beak
25. Which of the following substances pass through cell membrane by osmosis. (a) cell sap (b) carbon dioxide (c) oxygen (d) water.

POST-TEST FOR CONTROL AND EXPERIMENTAL GROUPS

Instruction: From the options below, choose the correct option

1. When a mixture of a food substance and Benedict's solution is warmed, the colour changes from blue to brick-red precipitate indicating the presence of (a) reducing sugar (b) amino acid (c) sucrose (d) fatty acid
2. Living things are classified into (a) Plants and Algea (b) Plants and Animals (c) Domestic and Non-domestic (d) Wild and Domestic
3. What type of vertebra is represented in the diagram? (a) Atlas (b) Axis (c) cervical vertebra (d) lumbar vertebra

4. The structure labeled A represents (a) transverse process (b) neutral spine (c) neutral canal (d) Centrum
5. Biennial plants are plants that are planted, grow and are ready for harvest in (a) every 2 years (b) every 3 years (c) every 1 year (d) every few months.
6. Which of the following crop is a beverage crop (a) Cocoa (b) Cotton (c) Kolanut (d) Rubber
7. Which of the following food substance turns red when warmed with Sudan (iii) solution? (a) Starch (b) fat (c) reducing sugar (d) protein
8. One major difference between osmosis and diffusion is that diffusion (a) does not need a semi-permeable membrane (b) does not take place in living tissues (c) takes place only in a liquid medium (d) takes place only in gaseous medium
9. During osmosis a semi-permeable membrane allows (a) only solute molecules to pass through it (b) both solute and solvent molecule to pass through it (c) only solvent molecule to pass through it (d) only gaseous molecules to pass through it
10. A fresh Kolanut weighing 10 grams was put into slat solution and after 3 hours, the Kolanut weighed 12 grams. These simple experiments demonstrate that the (a) cell sap of the Kolanut is more concentrated than the slat solution. (b) salt solution is more concentrated than cell sap of the Kolanut (c) Kolanut lost some water molecules to the salt solution (d) salt solution has the same concentration as the cell sap of the Kolanut
11. When a food substance gives a purple colour on the addition of hydroxide and a drop of copper sulphate, then the food substance is likely to contain (a) Carbohydrate (b) Fat (c) Protein (d) Sugar
12. Reabsorption of water takes place in the (a) caecum (b) rectum (c) cloaca (d) intestine
13. The process by which ink spread uniformly in a beaker of water is called (a) absorption (b) osmosis (c) plasmolysis (d) diffusion

14. Which organ is responsible for grinding food in birds (a) stomach (b) gizzard (c) Pharmx (d) Pancreas
15. Which of the following plants is not a leguminous plant? (a) Cowpea (b) Pulse (c) Soya beans (d) Beans
16. Absorption in birds takes place in the (a) stomach (b) intestine (c) esophagus (d) liver
17. Which of the following food substances would produce a translucent mark when rubbed on a white paper (a) bean (b) mango (c) groundnut (d) osmosis
18. Which of the following vertebrate provides articulating surface for the ribs? (a) Thoracic (b) Lumbar (c) Cervical (d) Sacral
19. Which of the following reagents is used for test for starch? (a) Million's reagent (b) iodine solution (c) benedict's solution (d) fehling's solution
20. The organ for storing food in birds is (a) stomach (b) crop (c) cloaca (d) rectum
21. Plants can be classified into _____ parts (a) 2 (b) 3 (c) 4 (d) 5
22. Which of the following groups of vertebrate have two branches at the end of their transverse process? (a) Sacral (b) Thoracic (c) Cervical (d) Lumber
23. The experiment above is used to demonstrate the process of (a) transpiration (b) water culture (c) diffusion (d) osmosis
24. The waste from the digestion of food is passed out of the bird through (a) anus (b) cloaca (c) mouth (d) beak
25. Which of the following substances pass through cell membrane by osmosis. (a) cell sap (b) carbon dioxide (c) oxygen (d) water

APPENDIX B

BIOLOGY ACHIEVEMENT TEST FOR RETENTION (BATR)

Instruction: From the options below, choose the correct option

1. When a mixture of a food substance and Benedict's solution is warmed, the colour changes from blue to brick-red precipitate indicating the presence of (a) reducing sugar (b) amino acid (c) sucrose (d) fatty acid
2. Living things are classified into (a) Plants and Algea (b) Plants and Animals (c) Domestic and Non-domestic (d) Wild and Domestic
3. Biennial plants are plants that are planted, grow and are ready for harvest in (a) every 2 years (b) every 3 years (c) every 1 year (d) every few months.
4. Which of the following crop is a beverage crop (a) Cocoa (b) Cotton (c) Kolanut (d) Rubber
5. Which of the following food substance turns red when warmed with Sudan (iii) solution? (a) Starch (b) fat (c) reducing sugar (d) protein
6. When a food substance gives a purple colour on the addition of hydroxide and a drop of copper sulphate, then the food substance is likely to contain (a) Carbohydrate (b) Fat (c) Protein (d) Sugar
7. Which of the following plants is not a leguminous plant? (a) Cowpea (b) Pulse (c) Soya beans (d) Beans
8. Which of the following food substances would produce a translucent mark when rubbed on a white paper (a) bean (b) mango (c) groundnut (d) osmosis
9. Which of the following reagents is used for test for starch? (a) Million's reagent (b) iodine solution (c) benedict's solution (d) fehling's solution
10. Plants can be classified into _____ parts (a) 2 (b) 3 (c) 4 (d) 5

APPENDIX C

CONCEPT MAPPING LESSON PLAN AND INSTRUCTIONAL PACKAGE (CMLPIP)

School: Government Secondary School, Nyanya

Subject: Biology

Topic: Relevance of Biology to Agriculture

Sub-Topic: Classification of Plants

Duration: 80 minutes **Date:** 8 – 10 – 2014

Class: SS 2A

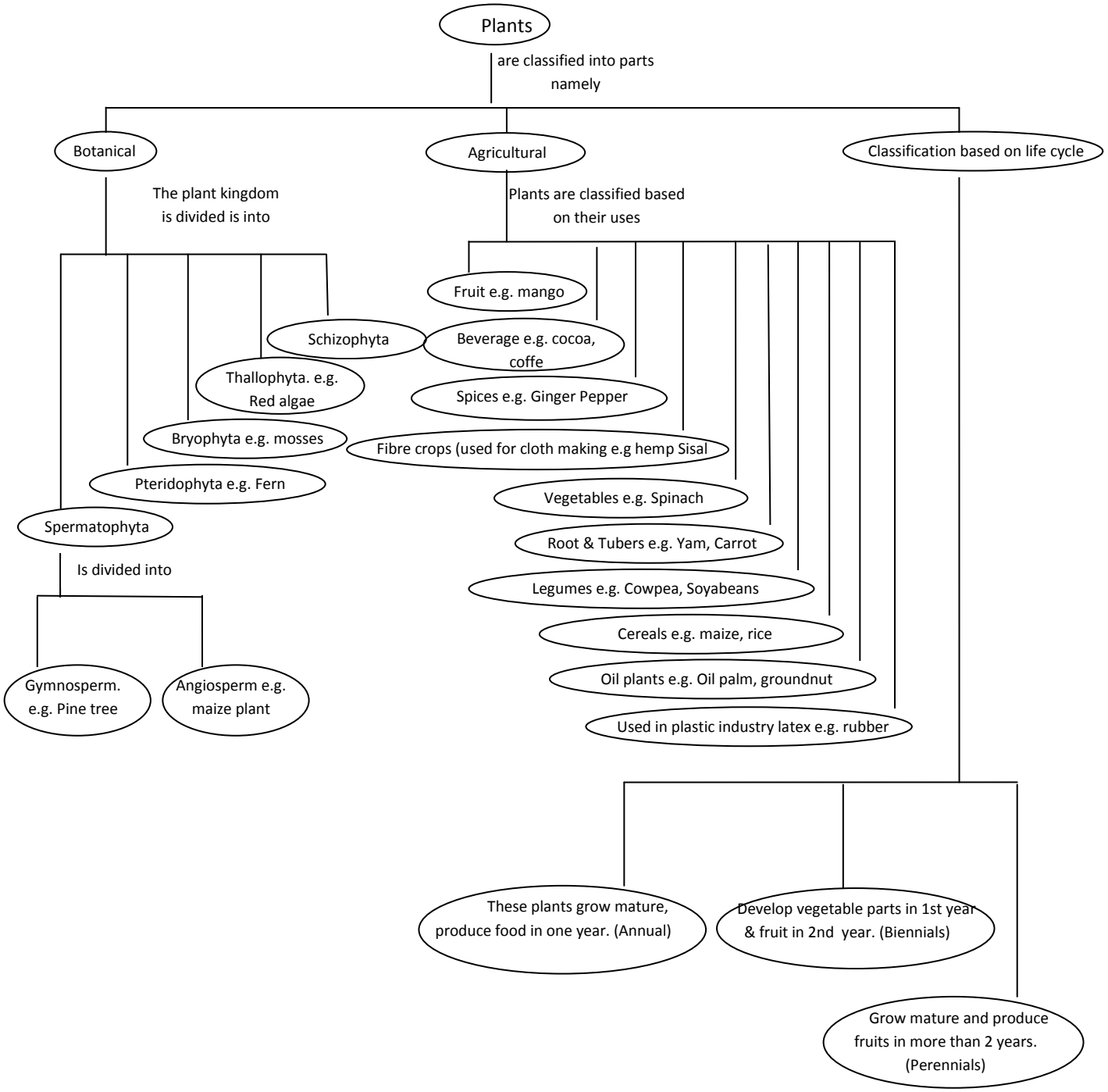
Specific Objectives: By the end of this lesson students should be able to.

(i) List the various classification of plant

(ii) List the Botanical classification with examples

(iii) List the Agricultural classification with examples

(iv) List the classification based on life cycle with examples.

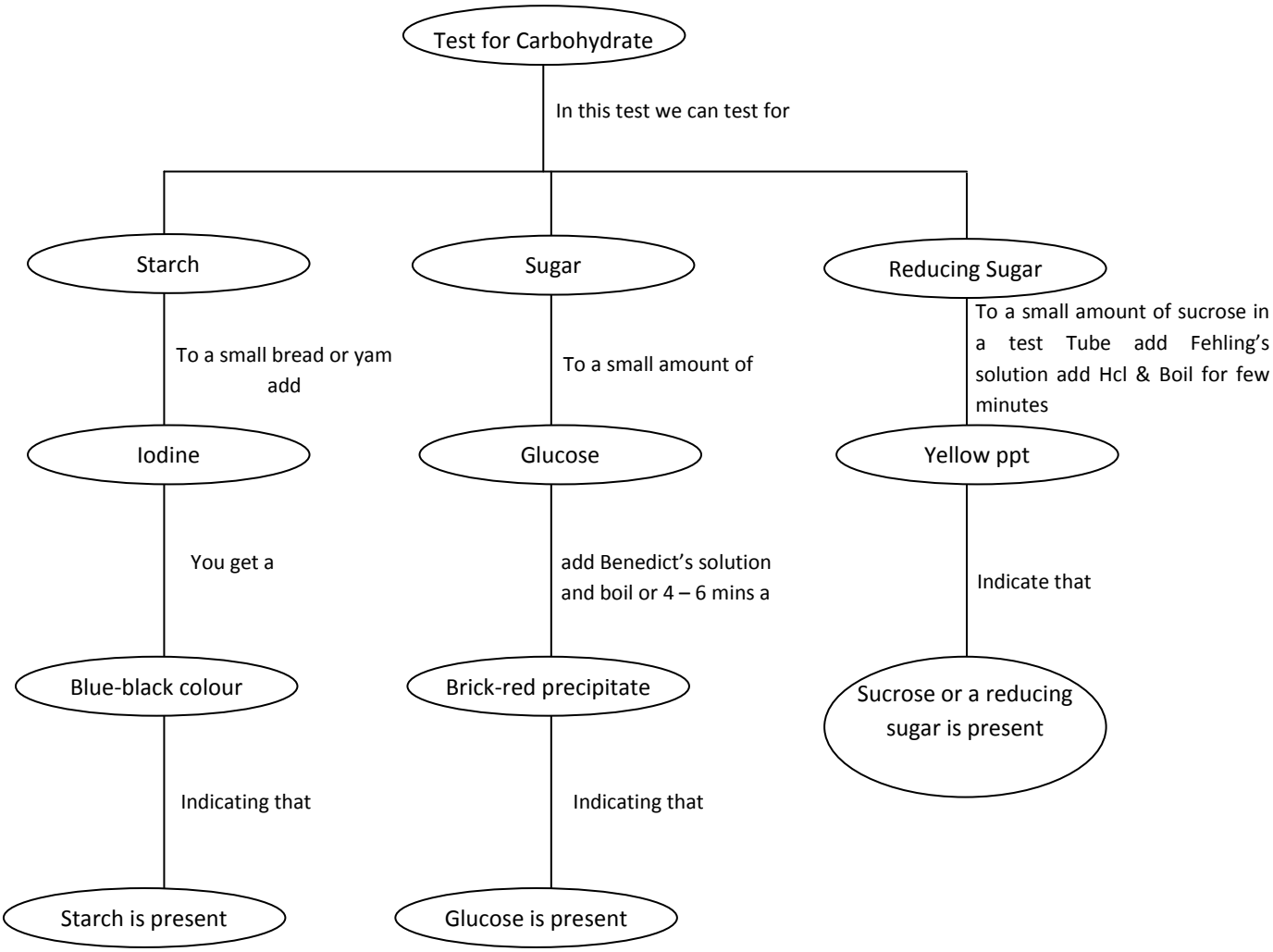

Plants
are classified into parts namely
Botanical
Agricultural
Classification based on life cycle
The plant kingdom is divided is into
Plants are classified based on their uses
Schizophyta
Thallophyta. e.g. Red algae
Bryophyta e.g. mosses
Pteridophyta e.g. Fern
Spermatophyta
Is divided into
Gymnosperm. e.g. Pine tree
Angiosperm e.g. maize plant
Fruit e.g. mango
Beverage e.g. cocoa, coffe
Spices e.g. Ginger Pepper
Fibre crops (used for cloth making e.g hemp Sisal
Vegetables e.g. Spinach
Root & Tubers e.g. Yam, Carrot
Legumes e.g. Cowpea, Soyabeans
Cereals e.g. maize, rice
Oil plants e.g. Oil palm, groundnut
Used in plastic industry latex e.g. rubber
These plants grow mature, produce food in one year. (Annual)
Develop vegetable parts in 1st year & fruit in 2nd year. (Biennials)
Grow mature and produce fruits in more than 2 years. (Perennials)

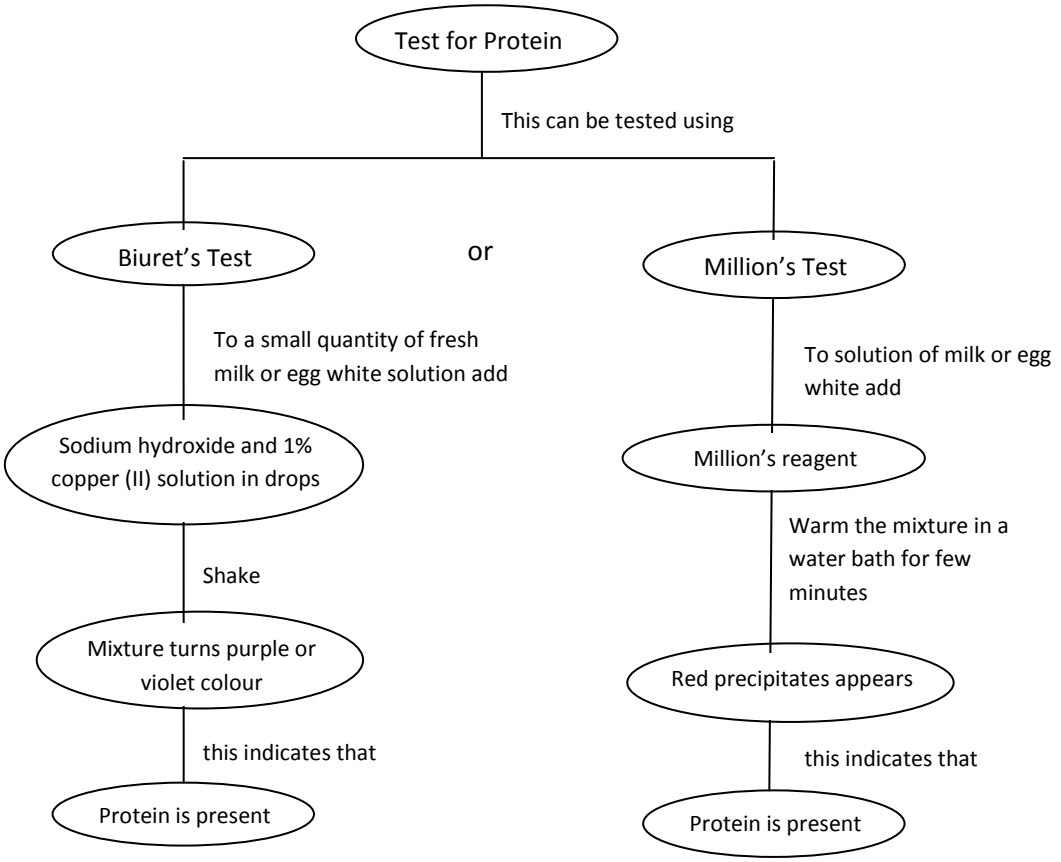
School: Government Secondary School, Nyanya
Subject: Biology
Topic: Food Test
Sub-Topic: Test of starch, protein and fats and oil
Duration: 80 minutes **Date:** 15 – 10 – 14

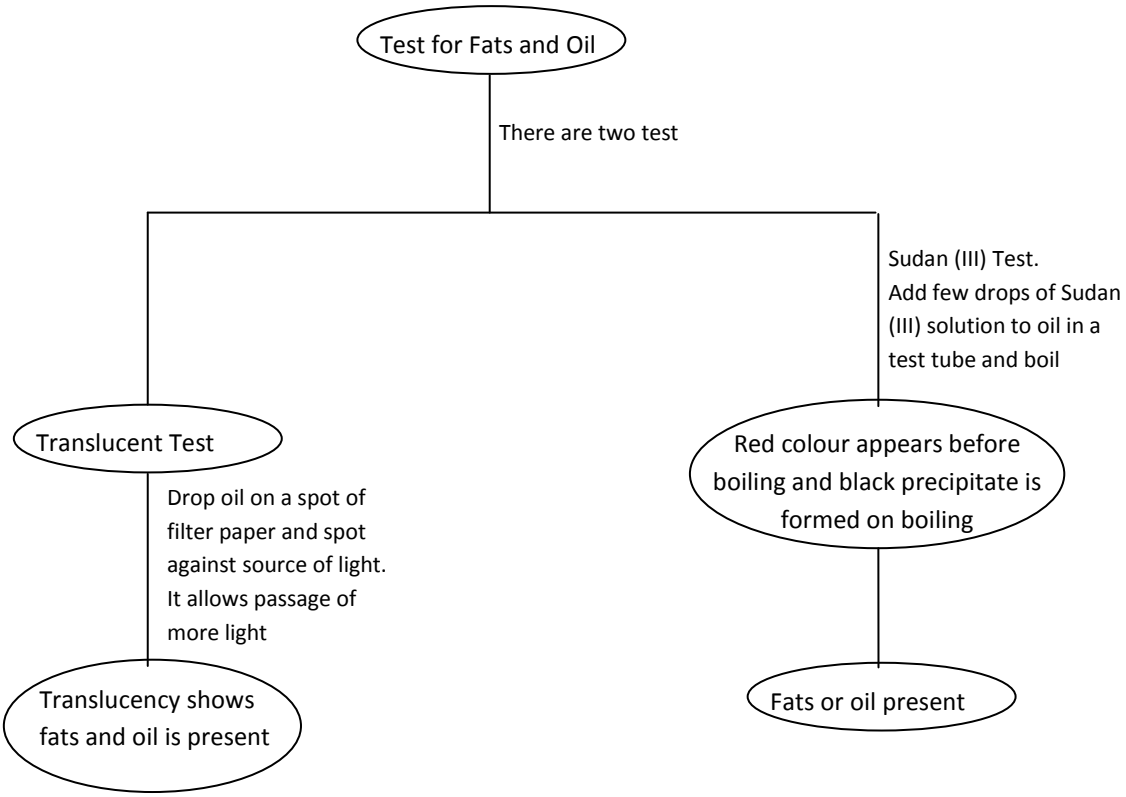
Class: SS 2A

Specific Objectives: By the end of this lesson, the students should be able to.

1. Identify chemicals used for the test of starch and the result it gives.
2. Identify chemicals used for the test of sugar and the result it shows.
3. Identify chemical used for the test of protein and the result it shows.
4. Identify chemicals used for the test of fats and oil and the result it shows.




Test for Protein
This can be tested using
Biuret's Test
or
Million's Test
To a small quantity of fresh milk or egg white solution add
Sodium hydroxide and 1% copper (II) solution in drops
Shake
Mixture turns purple or violet colour
this indicates that
Protein is present
To solution of milk or egg white add
Million's reagent
Warm the mixture in a water bath for few minutes
Red precipitates appears
this indicates that
Protein is present


Test for Fats and Oil
There are two test
Sudan (III) Test.
Add few drops of Sudan (III) solution to oil in a test tube and boil
Translucent Test
Drop oil on a spot of filter paper and spot against source of light. It allows passage of more light
Translucency shows fats and oil is present
Red colour appears before boiling and black precipitate is formed on boiling
Fats or oil present

School: Government Secondary School, Nyanya

Subject: Biology

Topic: Skeletal System

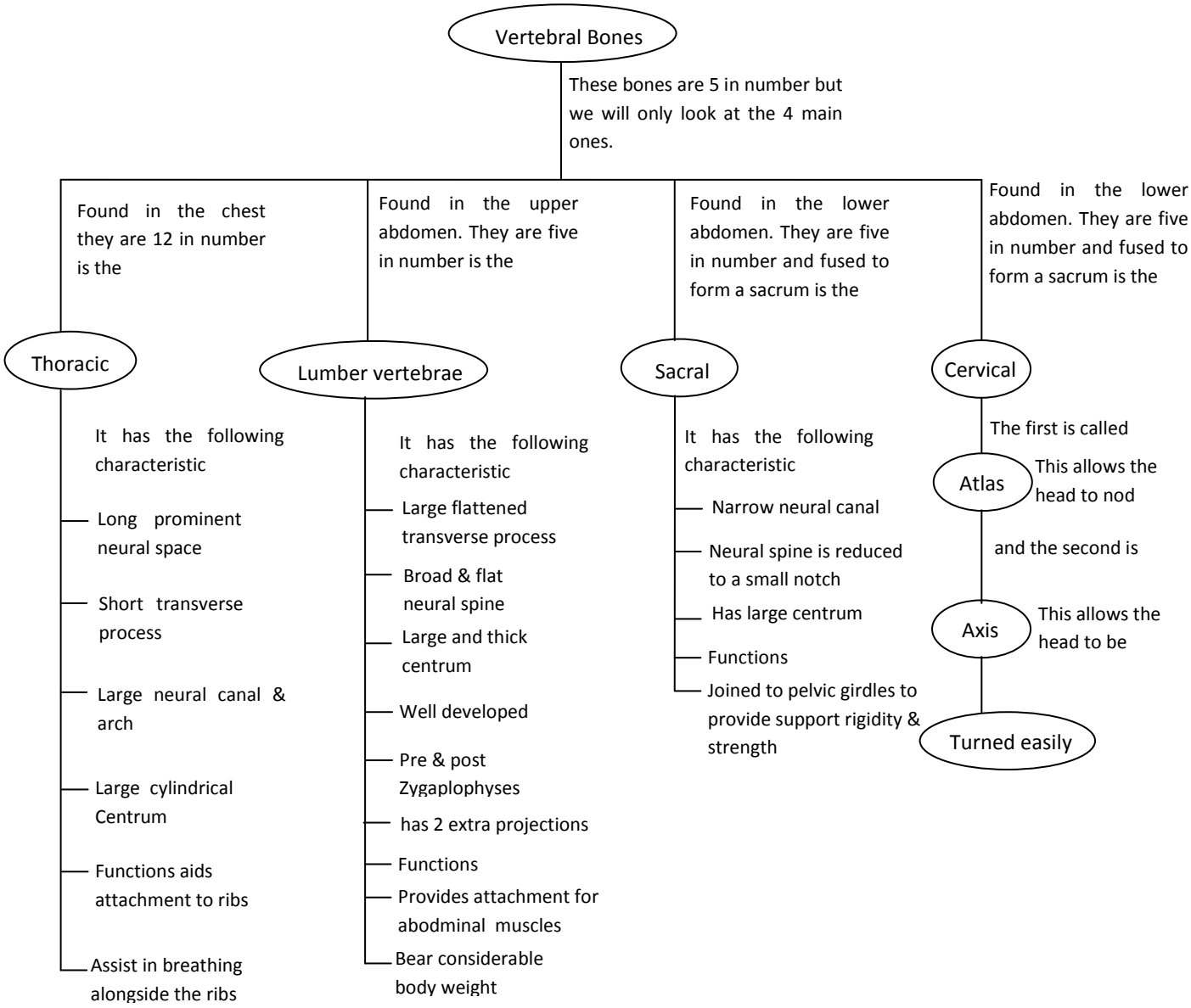
Sub-Topic: The vertebral column

Duration: 40 minutes **Date:** 22 – 10 – 14

Class: SS 2A

Specific Objectives: By the end of this lesson students should be able to.

1. List the bones in the vertebral column
2. Identify each bone of the vertebral column
3. List the characteristics of each bone


Vertebral Bones
These bones are 5 in number but we will only look at the 4 main ones.
Found in the chest they are 12 in number is the
Thoracic
It has the following characteristic
Long prominent neural space
Short transverse process
Large neural canal & arch
Large cylindrical Centrum
Functions aids attachment to ribs
Assist in breathing alongside the ribs
Found in the upper abdomen. They are five in number is the
Lumber vertebrae
It has the following characteristic
Large flattened transverse process
Broad & flat neural spine
Large and thick centrum
Well developed
Pre & post Zygaplophyses
has 2 extra projections
Functions
Provides attachment for abodminal muscles
Bear considerable body weight
Found in the lower abdomen. They are five in number and fused to form a sacrum is the
Sacral
It has the following characteristic
Narrow neural canal
Neural spine is reduced to a small notch
Has large centrum
Functions
Joined to pelvic girdles to provide support rigidity & strength
Found in the lower abdomen. They are five in number and fused to form a sacrum is the
Cervical
The first is called
Atlas
This allows the head to nod
and the second is
Axis
This allows the head to be
Turned easily

School: Government Secondary School, Nyanya

Subject: Biology

Topic: Cell and its environment

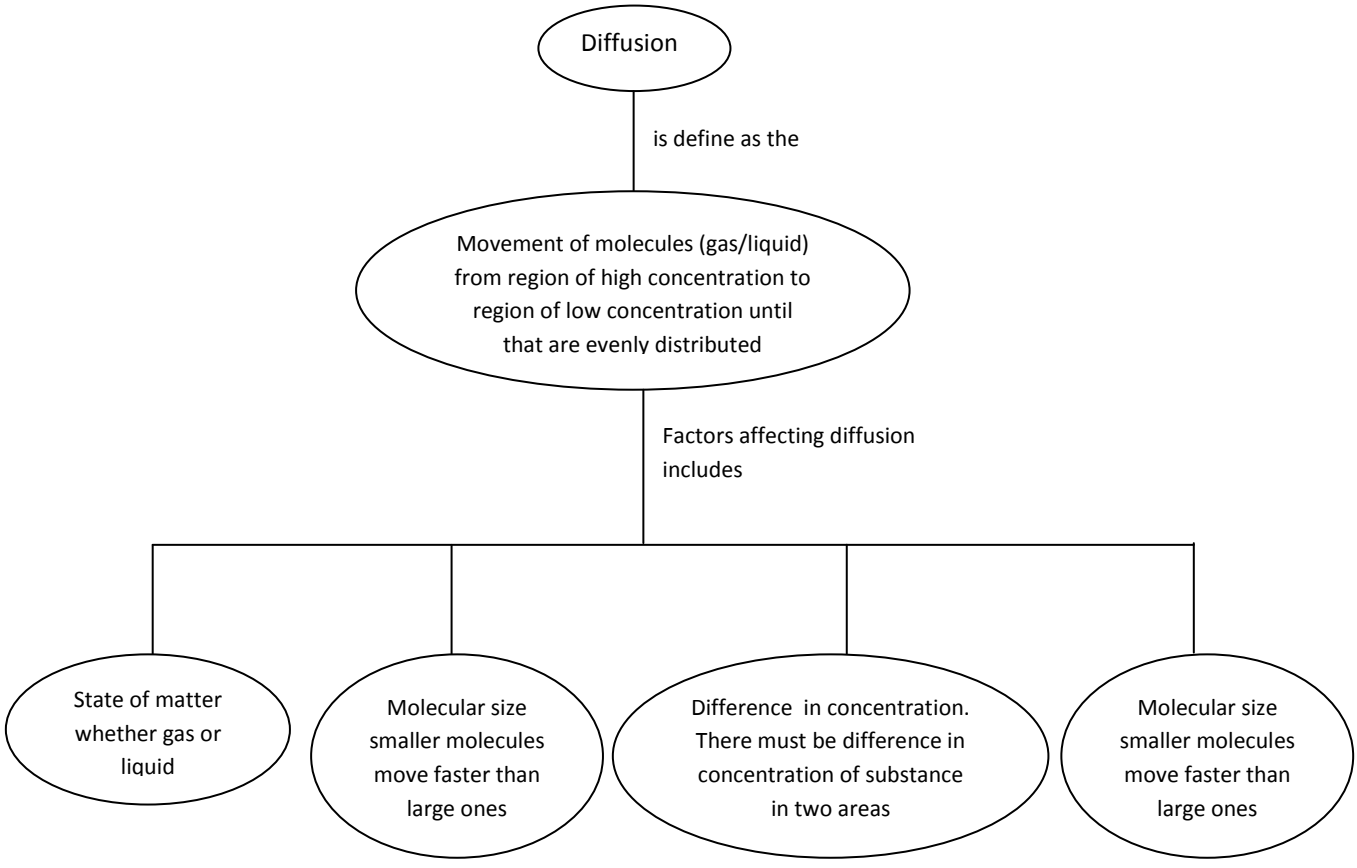
Sub-Topic: Osmosis and diffusion

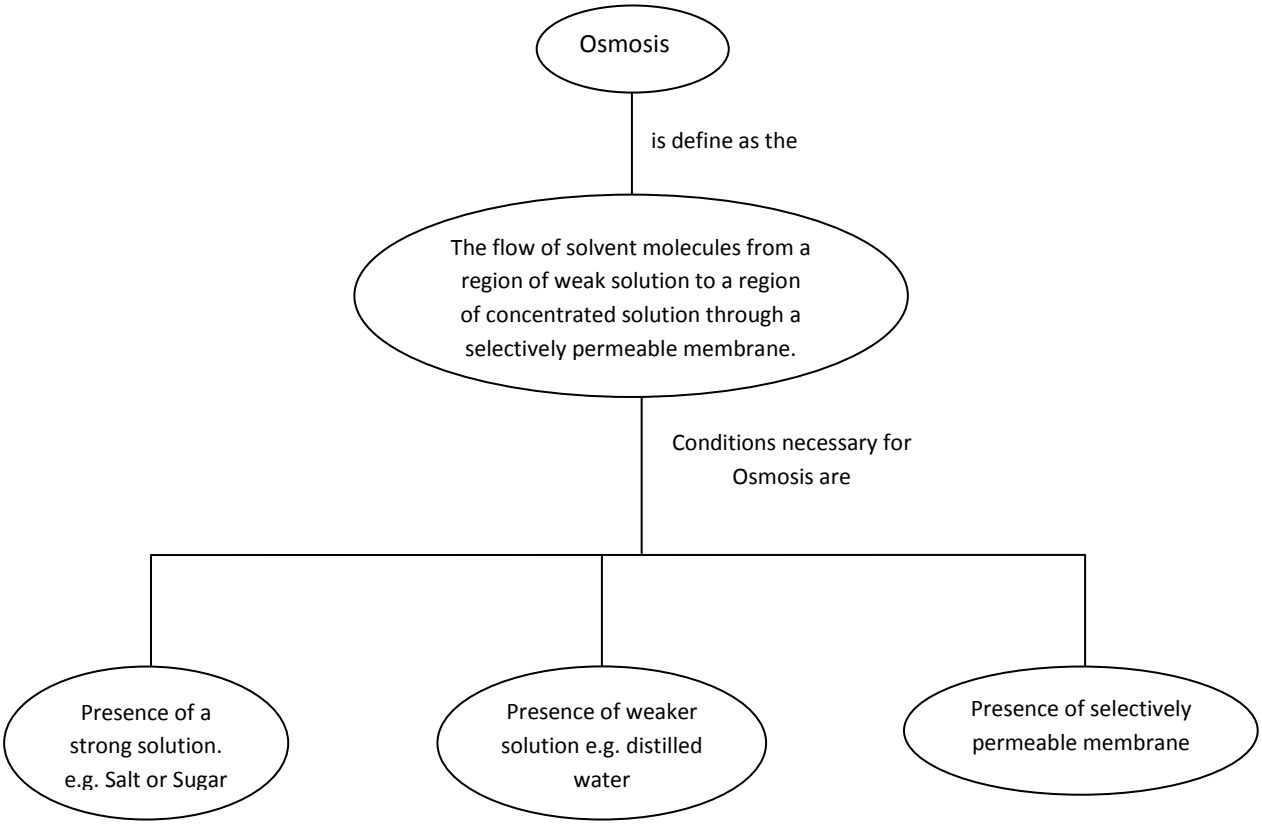
Duration: 40 minutes **Date:** 05 – 11 – 14

Class: SS 2

Specific Objectives: By the end of this lesson students should be able to.

1. Define osmosis and describe its experiment in living cells.
2. Define diffusion and describe diffusion in gases and liquids.
3. List conditions necessary for osmosis and diffusion.




Osmosis
is define as the
The flow of solvent molecules from a region of weak solution to a region of concentrated solution through a selectively permeable membrane.
Conditions necessary for Osmosis are
Presence of a strong solution. e.g. Salt or Sugar
Presence of weaker solution e.g. distilled water
Presence of selectively permeable membrane

School: Government Day Secondary School, Karu

Subject: Biology

Topic: Digestive System

Sub-Topic: Alimentary Carnal of birds and their functions.

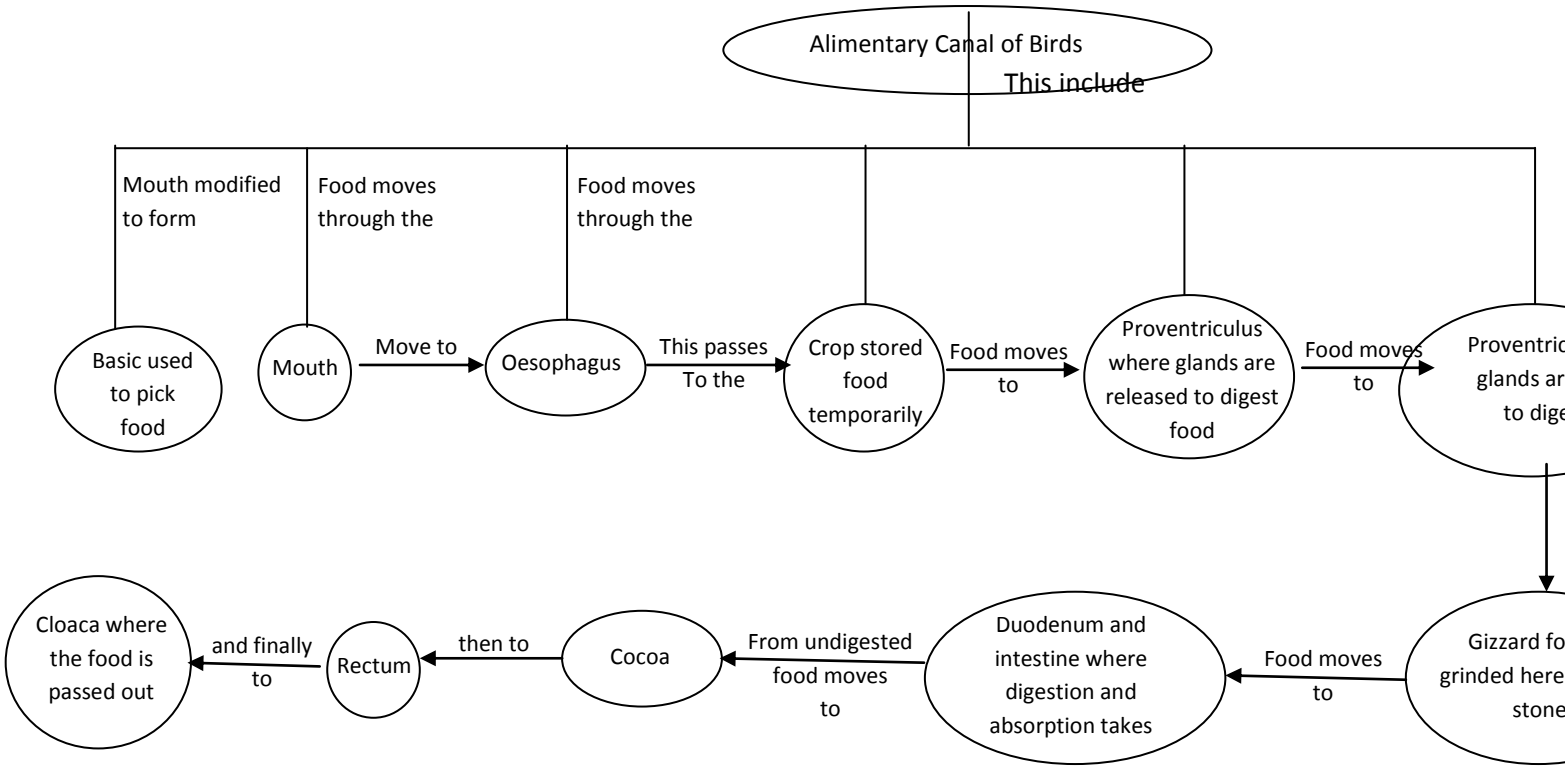
Duration: 40 minutes **Date:** 29 – 10 – 14

Class: SS 2A

Behavioural Objectives: By the end of the lesson, the students should be able to:

(1) Identify the parts of the alimentary canal of a bird.

(2) List the function of each of these parts.


Alimentary Canal of Birds
This include
Mouth modified to form
Food moves through the
Food moves through the
Basic used to pick food
Mouth
Move to
Oesophagus
This passes To the
Crop stored food temporarily
Food moves to
Proventriculus where glands are released to digest food
Food moves to
Proventric
glands ar
to dige
Gizzard fo
grinded here
stone
Food moves to
Duodenum and intestine where digestion and absorption takes
From undigested food moves to
Cocoa
then to
Rectum
and finally to
Cloaca where the food is passed out

APPENDIX D

LESSON PLAN FOR EXPERIMENTS

School: Government Secondary School, Nyanya

Subject: Biology

Class: SS 2B

Lesson Topic: Classification of Living things

Unit Topic: Classification of Plants.

Duration: 80 minutes **Date:** 9 – 10 – 14

Behavioural Objectives: By the end of this lesson students should be able to.

(i) List the division of plants by Binomial system with examples.

(ii) List the classes of plants under Agricultural classification with examples

(iii) List the classes of plants based on life cycle with examples

Instructional Materials: Charts showing examples of plants under Botanical classification, fruits, cocoa, seed spinach, pepper, vegetable, vegetable, yam, soya beans, oil palm, and picture of rubber, charts of plants under Annual, Biennial and Perennials.

Presentation:

Step I: Teacher's Activity:

Placing the charts showing Bryophytes, Thalophytes, Pteridophytes and Schizophytes, and placing cone, maize plant on the table the teacher shows that students classification of plants botanically.

Students' Activity: Students observe and note down examples

Step II: Teacher's activity

Placing the plants under fruits, beverages (e.g. Cocoa), spices (ginger, pepper), vegetables (Spinach), Roots and tuber (yam, potatoes, picture of fibre crops, legume (cowpea), cereals, oil palm and picture of rubber on the table. The teacher shows the students agricultural classification.

Students' activity: Students observe and note down examples.

Step III: Teacher's Activity

Placing the chart of annual & biennials and perennials on the board the teacher shows the students the examples.

Students' activity: Students observe and jot down notes.

Evaluation: The teacher asks the students the following questions to evaluate the lesson:

1. List three (3) classes of Botanical classification with one example each.
2. List six (6) classes of Agricultural classification with one example each by identifying the examples.
3. List the classes of plants under life cycle with examples.

Reference:

Michael, M.C. (2008). Essential Biology for Senior Secondary Schools. Pp. 54

Idodo-Umeh, (2010). College Biology. Idodo Umeh Publishers. Pp. 7 – 10.

School: Government Secondary School, Nyanya

Subject: Biology

Topic: Classification of Food

Sub-Topic: Food Test

Duration: 80 minutes **Date:** 16 – 10 – 14.

Class: SS 2B

Behavioural Objectives: At the end of the lesson, the students should be able to:

(i) Perform food test experiment on starch and identify chemicals used

(ii) Perform food test experiment on glucose and identify chemicals used

(iii) Perform food test experiment on protein and identify chemicals used

(iv) Carry out food test experiment on fats and oil and identify chemicals used

Instructional Resource: Yam, Oil (Groundnut), Glucose, Egg.

Step I:

On a piece of yam on a tile add a drop of iodine. What colour do you notice? Students' response: blue-black. The teacher informs them that the colour indicates the presence of starch.

Step II:

To a little solution of glucose, the teacher asks the students to add small quantities of Fehling's solution and heat gently. A brick-red precipitate shows that glucose is present. To another quantity of a little solution of glucose in a test-tube, the teacher instructs the students to add Benedict's solution, boil and allow to cool. A red or orange precipitate is formed.

The teacher informs them, that, it indicates the presence of glucose.

Step III:

To a protein solution in a test-tube, students add equal amount of million's reagent and boil for a few minutes. A brick-red precipitate is formed.

The teacher informs them, that it indicates the presence of protein.

To $1cm^3$ of protein solution, the student adds $1cm^3$ of 20% sodium hydroxide and a drop of 1% copper (II) sulphate solution. A violet or purple colour emerges. The teacher informs them that it indicates Biuret's test showing the presence of protein.

Step IV:

The teacher instructs the students to drop the oil provided on the piece of paper given to them and hold it against the sun rays of light entering the laboratory.

The teacher informs them, that, the translucent spot indicates the presence of oil and fats.

To a small quantity of oil, the teacher instructs the students to add a few drops of Sudan III solution. A red colour appears. The teacher informs them that the red colour shows the presence of starch.

Evaluation:

The teacher evaluates the lesson by asking students the following questions.

i. In the test for starch what colour indicates that starch is present in the food been tested.
ii. In the test for glucose name the who two types of test that can used and the colour. For each test which shows that glucose is present.
iii. In the test for protein what colours help to show that protein is present.
iv. In the test for oil the effect of oil on what paper is called _____?

Reference Text:

Michael, M.C. (2004). Essential Biology for Senior Secondary Schools. Pp. 39 – 40

Idodo-Umeh, (2009). College biology. Pp. 101.

Obidiwe J.O.C. Comprehensive Practical Biology.

School: Government Secondary School, Nyanya

Subject: Biology

Topic : Skeletal system

Sub Topic: Identification of vertebral column bones.

Duration: 80 minutes **Date:** 23 – 10 – 14

Class: SS 2B

Behavioural Objectives: At the end of the lesson, the students should be able to:

(a) Identify, draw and label a typical vertebra of a rabbit.

(b) Identify, draw and label axis vertebra of a rabbit.

(c) Identify, draw and label atlas vertebra of a rabbit.

(d) Identify, draw and label a cervical vertebra of a rabbit.

Instructional Resources: Vertebra, atlas, axis and cervical bones

Step 1: Teacher's Activity

The teacher asks the students to identify the bones placed on their table namely; vertebra, atlas, axis and cervical. The teacher helps them out where they encounter difficulty.

Student's Activity: Students identify these bones.

Step 2: Teacher's Activity

The teacher asks the students to draw and label the identified bones.

Reference Text :

Idodo-Umeh, (2010). College biology. Pp. 195 – 203

Michael, M.C. (2008). Essential Biology for Senior Secondary Schools. Pp. 240 – 241.

Obidiwe J.O.C. Comprehensive Practical Biology.

School: Government Secondary School, Nyanya

Subject: Biology

Topic: Digestive System

Sub-Topic: Alimentary Carnal of Birds and their functions.

Duration: 80 minutes **Date:** 30 – 10 – 14

Class: SS 2B

Behavioural Objectives: By the end of the lesson, the students should be able to:

1. Identify the parts of the alimentary canal of a bird.
2. List the function of each of these parts.

Instructional Resource: A disserted fowl

Step I:

Teacher's Activity: Placing the disserted fowl on a table, the teacher points out the various parts of the alimentary canal of fowl.

Students' Activity: The students observe and note down the parts.

Step II:

Teacher's Activity: The teacher lists out the functions of each of these parts.

Students' Activity: Students note the functions of each of those parts.

Evaluation:

The teacher evaluates the lesson by asking the following questions:

1) List seven parts of the alimentary canal

2) State the function of each part you have mentioned.

Reference Text:

Idodo-Umeh, (2010). College biology. Pp. 110.

Michael, M.C. (2008). Essential Biology for Senior Secondary Schools. Pp. 213 – 217

Obidiwe J.O.C. Comprehensive Practical Biology.

School: Government Secondary School, Nyanya

Subject: Biology

Topic: Cell and its environment

Sub-Topic: Osmosis and Diffusion

Duration: 80 minutes **Date:** 6 – 11 – 14

Class: SS 2B

Specific Objectives: By the end of this lesson students should be able to.

(1) Define osmosis and perform osmosis experiment in living cells.

(2) Define diffusion and demonstrate diffusion in gases and liquids.

(3) List conditions necessary for osmosis and diffusion.

Instruction Resource: Beaker, pipette, potassium permanganate solution, yam tuber, sugar solution, water, knife, petri dishes.

Presentation:

Step I: Teacher's Activity

The teacher asks the students to define osmosis. The teacher furthers takes 2 peeled pieces of yams makes a hole in the middle place them in petri dishes filled with water. The teacher labels the petri dishes A and B into A the teacher pours sugar solution and into B. The teacher pours water and calls it control experiment. The teacher measures the position of water in the petri dish and inside the yam and records. The teacher informs the student to carry out same experiments in their tables.

Student's Activity:

Students define osmosis as the movement of water from a region of weaker solution to a region of stronger solution through a semi-permeable membrane.

Step II: Teacher's Activity

Placing the beaker on the table with some water in it; the teacher uses the pipette to draw some few drops of potassium permanganate. The teacher dips the pipette in the potassium permanganate at the bottom of the beaker after a few minutes the colour of the water changes. The teacher asks the students: "what has taken place?" The teacher goes to one corner of the laboratory and sprays air freshener and goes back to the front of the class after some few minutes, the teacher asks the students if the whole class can perceive the small of the air fresher. The teacher later informs them that the experiments demonstrate diffusion in gases and liquids. The teacher asks them to define diffusion and carry out the experiments in their tables.

Step III: Teacher's Activity

The teacher lists out to the students' conditions necessary for osmosis and diffusion using the experiments.

Student's Activity:

Students listen and jot down points.

References:

Idodo-Umeh, (2010). College biology. Pp. 70 – 72

Michael, M.C. (2004). Essential Biology for Senior Secondary School, Pp. 158

Obidiwe J.O.C. Comprehensive Practical Biology

APPENDIX E

LESSON NOTES FOR CONTROL GROUP

School: Government Day Secondary School, Karu

Subject: Biology

Topic: Relevance of Biology to Agriculture

Sub-Topic: Classification of Plants

Duration: 80 minutes **Date:** 8 – 11 – 14

Class: SS 2A

Specific Objectives: By the end of this lesson students should be able to.

(i) List the various classification of plant

(ii) List the Botanical classification with examples

(iii) List the Agricultural classification with examples

(iv) List the classification based on life cycle with examples.

Instructional Materials: A chart showing these classification and their examples.

Previous Knowledge: Students are familiar with some these plants.

Introduction: The teacher introduces the lesson for the day and asks the students list the names of some plants they know.

Students' Response: Students name these plants.

Presentation:

Step I: Teacher's activity:

The teacher list out the classification of plants to the students namely botanical, agriculture and classification based on life cycle.

Students' activity:

Students listen, jot down notes and ask questions.

Step II: Teacher's activity

The teacher ask the students to mention the two classes of animals. The teacher further informs them that invertebrates have the following phyla namely. Protozoa, coelenterate platyhelminthes, Mollusca, Nematoda, Annelids Echinodermata and Anthropoda.

Students' activity:

Teacher's Activity: Using the chart the teacher points out Botanical classification with their examples.

Students' Activity: Students listen, jot down notes and ask questions.

Step III:

Teacher's Activity: The teacher ask the students to list some plants they think can be classified under agricultural classification. And using the chart, the teacher points them out stating their examples.

Students' Activity: Students list out the plants they know.

Step IV:

Teacher's Activity: Using the chart, the teacher explains classification of plants based on life cycle and asks students to list examples.

Students' Activity: Students lists out the examples they know.

Evaluation:

The teacher ask the students the following questions to evaluate the lesson.

1. List the three (3) classifications of plants
2. List the examples under each class

Reference:

Michael, M.C. (2004). Essential Biology for Senior Secondary Schools. Pp. 54

Idodo-Umeh, (2009). College biology. Pp. 7 – 10

School: Government Day Secondary School, Karu

Subject: Biology

Topic: Food Test

Sub-Topic: Test of starch, protein and fats and oil

Duration: 80 minutes **Date:** 15 – 11 – 14

Class: SS 2A

Specific Objectives: By the end of this lesson, the students should be able to.

1. Identify chemicals used for the test of starch and the result it gives.
2. Identify chemicals used for the test of sugar and the result it shows.
3. Identify chemical used for the test of protein and the result it shows.
4. Identify chemicals used for the test of fats and oil and the result it shows.

Instruction Resource:

A chart showing test for food, chemicals, observation and results.

Previous Knowledge:

Students are familiar with these classes of food from the knowledge of Basic Science.

Introduction:

The teacher introduces the lesson and asks the students to list the classes of food.

Student's Response: Students list classes of food.

Presentation:

Step I: Teacher's Activity

Using the chart, the teacher shows the students that on a piece of yam, when iodine is added, it turns blue-black indicating the presence of starch.

Students' Activity:

Students' listen, jot down notes and ask questions.

Step II: Teacher's Activity:

Using the chart, the teacher explains to the students the process of testing for reducing sugar using Fehling's, Benedict solution and heating the solution. It gives a yellow precipitate for sucrose and black red for simple sugar.

Student's Activity:

Students' listen, jot down notes and ask questions

Step III: Teacher's Activity

The teacher asks the students to mention examples of protein. Using the chart, the teachers identifies the chemicals used for the test of protein, Sodium hydroxide &

copper (II) solution it gives a purple or violet colour to fresh milk or egg white solution it is called Biuret test. To milk when million's reagent is added it gives a red precipitate.

Student's Activity:

Students list examples of protein and jot down notes and ask questions.

Step IV: Teacher's Activity

The teacher ask the students to list examples of fats and oil using the chart, the teacher explains that when Sudan (III) is added to oil and boiled the oil changes colour from red to black after boiling. The teacher also explains translucent list to them.

Students' Activity:

Students list examples of fats and oil.

Evaluation:

The teacher evaluates the lesson by asking the students the following questions:

1. What is used to test for starch and what colour does it give to show starch is present.
2. List the chemicals used to test for simple and reducing sugars. What colours do they show?
3. List the chemicals used to test for proteins and the colour they show.
4. What is the name of the chemical used to test for fat and oil? What colour does it show?

Conclusion:

The teacher summarizes the lesson, stressing the salient points.

Reference Text:

Michael, M.C. (2004). Essential Biology for Senior Secondary Schools. Pp. 39 – 40

Idodo-Umeh, (2009). College biology. Pp. 101.

School: Government Day Secondary School, Karu

Subject: Biology

Topic: Skeletal System

Sub-Topic: The vertebral column

Duration: 80 minutes **Date:** 22 – 11 – 14

Class: SS 2A

Specific Objectives: By the end of this lesson students should be able to.

1. List the bones in the vertebral column
2. Identify each bone of the vertebral column
3. List the characteristics of each bone

Instruction Resource:

A chart showing the five vertebral bones and the physical vertebral bones.

Previous Knowledge:

Students are familiar with the skeletal system from their study of integrated science.

Student's response: Skeleton is a bony framework of the body which provides, support, shape and protection to soft tissues and organs in animals.

Presentation:

Step I: Teacher's Activity

The teacher using the bones lists out-types of bones in the vertebral column as cervical, Thoracic, Lumber, Sacral and caudal.

Student's Activity:

Students' listen, jot down notes and ask questions.

Step II: Teacher's Activity:

Raising up the bones one after the teacher asks the students to identify each one the teacher corrects them were wrong.

Student's Activity:

Students' listen, jot down notes and ask questions.

Evaluation:

The teacher evaluates the lesson by asking the students the following questions:

1. List the five (5) parts of a vertebral column.
2. Mention two (2) characteristics of each of these bones.

Conclusion:

The teacher summarizes the lesson.

Reference Text:

Michael, M.C. (2004). Essential Biology for Senior Secondary Schools. Pp. 213 – 217

Idodo-Umeh, (2009). College biology. Pp. 110

School: Government Day Secondary School, Karu

Subject: Biology

Topic: Digestive System

Sub-Topic: Alimentary Canal of bird

Duration: 80 minutes **Date:** 27 – 11 – 14

Class: SS 2A

Specific Objectives: By the end of this lesson students should be able to.

1. Identify the various parts of the alimentary canal of a bird.
2. List the function(s) of each of these parts.

Instruction Resource:

A chart showing the Alimentary canal of a bird.

Previous Knowledge:

Students are familiar with some of these parts from eating chicken at home.

Introduction: The teacher introduces the lesson and asks the students to list some parts they know from the alimentary canal of bird.

Student's response: Students list the parts they know.

Presentation:

Step I:

Teacher's Activity:

Using the chart the teacher point out to the students the various parts of alimentary canal of bird.

Student's response:

Students listen and jot down notes.

Step II:

Teacher's Activity:

Using the chart, the teacher lists out the functions of some parts and asks the students to list the functions of some parts.

Students' Activity:

Students list the functions of parts they know.

Evaluation:

The teacher asks the students the following questions to evaluate the lesson,

(a) List seven (7) parts of the alimentary canal of bird

(b) List the function(s) of each of the parts listed above.

Conclusion:

The teacher summarizes the lesson, by stressing the salient points.

Reference:

Michael, M.C. (2004). Essential Biology for Senior Secondary Schools. Pp. 54

Idodo-Umeh, (2009). College biology. Pp. 7 – 10

School: Government Day Secondary School, Karu

Subject: Biology

Topic: Cell and its environment

Sub-Topic: Osmosis and diffusion

Duration: 40 minutes **Date:** 5 – 11 – 14

Class: SS 2A

Specific Objectives: By the end of this lesson students should be able to.

1. Define osmosis and describe its experiment in living cells.
2. Define diffusion and describe diffusion in gases and liquids.
3. List the conditions necessary for osmosis and diffusion.

Instruction Resource:

A chart showing osmosis using a living cell and diffusion in liquid.

Previous Knowledge:

Students are familiar with the fact that when you should at a particular spot to spray insecticide in no time it spreads to all the part of the room.

Introduction: The teacher introduces the lesson and asks the students what happen when someone comes in and spray insecticide from the door of their class:

Students' Response: Everyone in the class will perceive the odour.

Presentation:

Step I: Teacher's Activity

The teacher defines osmosis as the flow of water molecules from a region of diluter of weaker solution to a region of concentrated solution through a semi-permeable membrane. Using the chart the teacher explains to the students the process of osmosis in a living tissue.

Student's Activity:

Students' listen, jot down notes and ask questions.

Step II: Teacher's Activity:

The teacher defines diffusion as the process by which molecules or ions of a substance move from region of high concentration to region of low concentration until they are evenly distributed.

Using the chart the teacher explains diffusion in liquid.

Student's Activity:

Students' listen, jot down notes and ask questions.

Step III: Teacher's Activity

The teacher lists out the conditions necessary for diffusion namely state of matter. i.e. gas and liquid molecular size difference in concentration and temperature, while for osmosis presence of strong solution sugar or salt, presence of weaker solution, distilled water and the presence of a selectively permeable membrane are needed for osmosis to take place.

Evaluation:

The teacher evaluates the lesson by asking the students the following questions:

1. Define osmosis
2. Define diffusion
3. List the conditions necessary for each to take place.

Conclusion:

The teacher summarizes the lesson, stating the important points.

Reference Text:

Michael, M.C. (2004). Essential Biology for Senior Secondary Schools. Pp. 158

Idodo-Umeh, (2009). College biology. Pp. 70 – 72.

APPENDIX F

CONCEPT MAPPING ATTITUDE SCALE TOWARDS BIOLOGY QUESTIONNAIRE (CMASTBQ)

From below choose the one that describes appropriately your attitude towards concept maps. Agree (A), Not Sure (NS), Disagree (DS), Absolutely Disagree (ADA) by ticking.

S/N.	Question	A	NS	DS	ADA
1.	The use of concept maps during lessons have increased my understanding of biology.				
2.	Concept map is a good method for learning Biology				
3.	Concept map is a good method in teaching Biology				
4.	Concept maps displays the logic of the subject and help to pass it on				
5.	Concept map helps to understand the subject matter.				
6.	Concept maps produces transferable learning				
7.	Concept maps ensures that lessons move at students' pace.				
8.	Concept map is active and interesting activity for students				
9.	Concept maps are motivating, makes students want to learn				
10	Concept maps should be used more frequently for students				

APPENDIX G

EXPERIMENTS ATTITUDE SCALE TOWARDS BIOLOGY QUESTIONNAIRE (EASTBQ)

From below choose the one that describes appropriately your attitude towards concept maps. Agree (A), Not Sure (NS), Disagree (DS), Absolutely Disagree (ADA) by ticking.

S/N.	Question	A	NS	DS	ADA
1.	Experiments help to produce instant feedback				
2.	Experiments helps to produce transferable learning				
3.	Experiments should be used more frequently for lessons.				
4.	Experiments are active and an interesting activities for students.				
5.	Experiments helps to uncover incorrect ideas and assumptions.				
6.	Experiments are motivating that is makes students want to learn.				
7.	Experiments encourages high level thinking skills				
8.	Experiments helps to give better understanding of a topic				
9.	Using experiments helps to increase understanding of topics taught				
10.	Experiments are good in the teaching of Biology it makes Biology come alive.				