# EFFECT OF CONCEPT MAPPING ON STUDENTS' ACHIEVEMENT AND RETENTION IN GENETICS AMONG BIOLOGY STUDENTS IN MINNA METROPOLIS NIGER STATE

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**2014/1/50584BE**

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**SUBMITTED TO: DEPARTMENT OF SCIENCE EDUCATION, SCHOOL OF SCIENCE TECHNOLOGY EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BARCELOR OF TECHNOLOGY [B.TECH] IN BIOLOGY EDUCATION**

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### ABSTRACT

The study was aimed at determining the Effect of Using Concept Mapping on student anxiety and achievement in genetics concept among Biology Students in Minna Metropolis. The design of the study was quasi experimental pretest posttest control group design. The population consisted of 3,522 SS2 Biology students in Minna. From which 140 were selected from two schools within Minna Metropolis. To guide the study, four research questions were raised and four hypotheses stated and tested at 0.05 level of significance. The instruments used for data collection were Biology Achievement Test (BAT).The items were lifted based on the topics used for the study. The reliability of these instruments used was 0.78 for BAT. The data collected was analyzed using mean and standard deviation for research questions while the null hypotheses were analyzed using t-test, statistics. The findings of the study showed a significantly better academic achievement of students who were taught using concept map than those taught using conventional lecture method. Recommendations were made such as, Teachers should be encouraged to use Concept mapping alongside lecture method in teaching Biology in Senior Secondary Schools.

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# CHAPTER ONE

# 1.0 INTRODUCTION

## 1.1 Background to the Study

The global aim of science education is to enable learners acquire knowledge, skills and attitude that would be relevant to their future livelihoods (Hendry and King, 2009). Science, as a concept, is a process geared towards problem solving in order to enhance the living standard of man. Okebukola and Jegede (2011) defines science as a complex human activities that lead to the production of a body of universal statement called laws, theories or hypotheses, which serve to explain the observable behaviour of the universe or part of it, which, in themselves, have predictive characteristics. Sakiyo (2012) has observed that the economic and political strength of a nation is always assessing in terms of her achievements in science and technology. This is why the National Policy on Education (FME, 2013) has emphasized on the provision of science education at all levels of education in Nigeria. The emphasis placed, alongside the important role it plays towards national development, makes it pertinent and practically necessary for science to be taught in an organized and well-structured pattern involving activities for both teachers and students (Van der Laan and Dean, 2013).

Agaba (2013) defines Biology as a branch of science that is concerned with the characteristics and behavior of organism how species and individual come into existence, and the interaction they have with their environment. Agbo and Oyoywi (2015) have observed that Biology, as a discipline, has contributed tremendously to financial, physical and aesthetic benefits of humanity and to the nation building. The areas of contributions of

Biology include but not limited to, the followings: medicine, aquaculture, crime detection, forestry, genetic engineering, parasitology.

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 Agbo and Oyoywi (2015) 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 Chei- chang (2008). 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. Expository methods according to Akong *et al,* (2015) 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.

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 (2009) 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. The major problems affecting teaching in general and biology teaching in particular could be attributed to the inappropriate usage of some instructional techniques by teachers. The use of lecture method alone by teachers create a lot of tension among students because often little or no room is given to students to express their areas of difficulties either by way of asking questions or contributing to the progress of the lesson. This situation leads to restlessness, frustration and anxiety which impair students learning (Okonkwo, 2012).

Oloyede (2010) observed that many students especially at secondary school level develop some form of fear, apprehension and nervousness whenever they are faced with test or examination situation. This situation is referred to as anxiety, and this invariably lead to students' low academic achievement (Wikipedia, 2010). The anxiety in schools has a negative effect on students' achievement in the classroom especially in test or examination situation or both. Anxiety has an influence on the degree of achievement (Bonjaonde and

Attich, 2008). Agbo and Oyoywi (2015) also asserted that; many reasons have been attributed to the possible causes of students' poor achievement in science subjects such as biology; one of which is anxiety. This disturbing situation needs to be investigated so as to come up with possible solution(s).

The type of teaching methods used which are teacher-centred (example lecture method) as observed by Asuru (2015) are capable of causing high anxiety in students because the students are given little or no opportunity to contribute or ask questions. Similarly, despite several reform attempts to make a shift from the teacher-centred methods to student-centred methods, the teaching and learning of science is still characterized by the ineffective chalk and talk method (Asuru, 2015). In this study, discussion and lecture methods were used to determine their effects on biology students' achievement in secondary schools.

Learning according to Ausubel (2010) 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 (2009), he 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 on student anxiety and achievement in genetics concept among biology student.

## 1.2 Statement of the Problem

The consistent poor performance of Biology students at the Senior Secondary School Certificate Examinations (SSCE) leaves one in doubt about the effectiveness of the teaching methods popularly used by Biology teachers for teaching the subject. Empirical studies have shown that students‟ performance in biology has been poor. 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 & 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. Egolum & Nwafor (2012) showed that the traditional teaching methods have not yielded expected results.

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 (2009), 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 on achievement and retention in genetics among biology students in Minna Metropolis.

## 1.3 Aims and Objectives of the Study

This study sought to achieve the following objectives:

i. Determine the difference in students achievement in Biology when taught genetics using concept mapping and lecture method in Minna Metropolis.
ii. Determine the difference in male and female students achievement in Biology when taught genetics using concept mapping and lecture method in Minna Metropolis.
iii. Determine the difference in retention ability of students when taught genetics using concept maps and lecture method in Minna Metropolis.
iv. Determine the difference in students retention based in gender when taught genetic using concept maps and lecture method in Minna Metropolis.

## 1.4 Research Questions

i. What are the mean achievement scores of the students in Biology when taught genetic using concept mapping and those taught using lecture method in Minna Metropolis.
ii. What are the mean achievement scores of male and female students in Biology when taught genetics using concept maps in Minna Metropolis

iii. What are the mean retention scores of students taught genetics using concept map and those taught using lecture method in Minna Metropolis.

iv. What are the mean retention score of students based on gender when taught genetics using concept maps in Minna Metropolis.

## 1.5 Hypotheses Testing

**$HO_1$:** There is no significant difference in the mean achievement scores of students in Biology when taught genetics using concept mapping and those taught using lecture method in Minna Metropolis.

**$HO_2$:** There is no significant difference in the mean achievement scores of male and female students in Biology when taught genetics using concept maps in Minna Metropolis.

**$HO_3$**: There is no significant difference in the mean retention scores of students in Biology when taught genetics using concept maps and those taught using lecture method in Minna Metropolis.

**$HO_4$:** There is no significant difference in the mean retention score of male and female students taught genetics using concept maps in Minna Metropolis.

## 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 in the teaching of biology will boost their achievement and help to increase their achievement in 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.

## 1.8 Scope of the Study

The study was on effects of concept mapping on student achievement and retention in genetics among biology students in Minna Metropolis. The senior secondary two (SS2) students will be 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 in teaching and learning of Biology.

Genetics concepts such as the Independent variable is concept map while the dependent is retention and achievement and the moderate variable in gender. The study lasted four weeks.

## 1.9 Operational Definition of Terms

**Biology:** is the natural science that studies life and living organisms, including their physical structure, chemical processes, molecular interactions, physiological mechanisms, development and evolution.

**Genetics:** is the study of heredity. Heredity is a biological process where a parent passes certain genes onto their children or offspring. Every child inherits genes from both of their biological parents and these genes in turn express specific traits

**Achievement:** is the extent to which a student, teacher or institution has achieved their short or long-term educational goals. Cumulative GPA and completion of educational benchmarks such as secondary school diplomas and bachelor's degrees represent academic achievement

**Retention:** The ability to remember things for future reference

**Concept Mapping:** A concept map or conceptual diagram is a diagram that depicts suggested relationships between concepts. It is a graphical tool that instructional designers, engineers, technical writers, and others use to organize and structure knowledge.

# CHAPTER TWO

# 2.0 LITERATURE REVIEW

## 2.1 Introduction

In this chapter, previous research woks and other related literature that assessed effects of concept maps on student anxiety and achievement in in genetics concepts 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.

## 2.2 Conceptual Framework

### 2.2.1 Concept Maps

Metacognitive strategies, as explained by Novak (2009) 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 (Novak, 2009). 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 & 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, 2006).

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 & 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, 2012).
- 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, 2008).
- Organize their thoughts and visualize the relationship between the key concepts in a semantic way (Pill, 2015).

Qarareh (2010) 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 (2009) 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) 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 (Jegede, *et al.,* 2013).

According to the "dual-coding" Theory of Information Storage, Paino (2011), 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 (2010) 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". 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 2009). 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, 2010). 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 in the Teaching of Biology

Concept maps are constructed to represent visually "meaningful relationships among concept in the form of propositions" (Novak & Gowin, 2008). As Novak & 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" (McAleese, 2012). 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 2008) 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 2008). 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 & his team to the construction of the first concept map (Novak, 2011). Novak & Gowin 2008) 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".

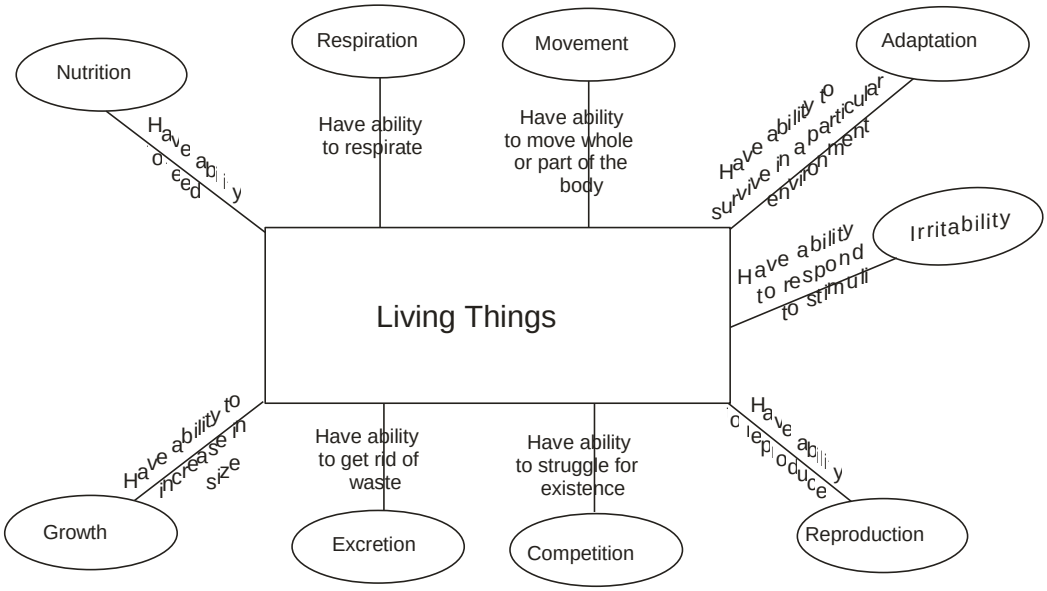


**Figure 2.1: Concept Maps on Characteristics of Living Things.**

**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 & 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, 2006). 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, 2013). 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. 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:

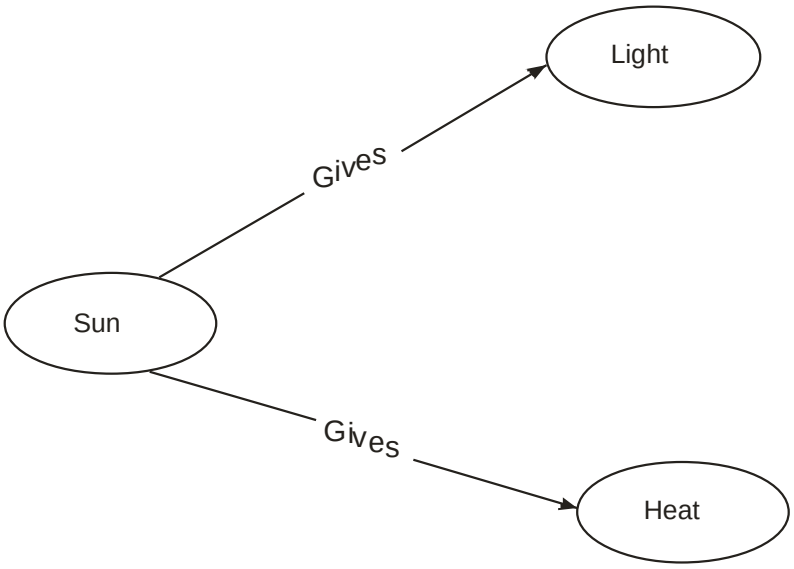


**Figure 2.2: Example of a simple concept.**

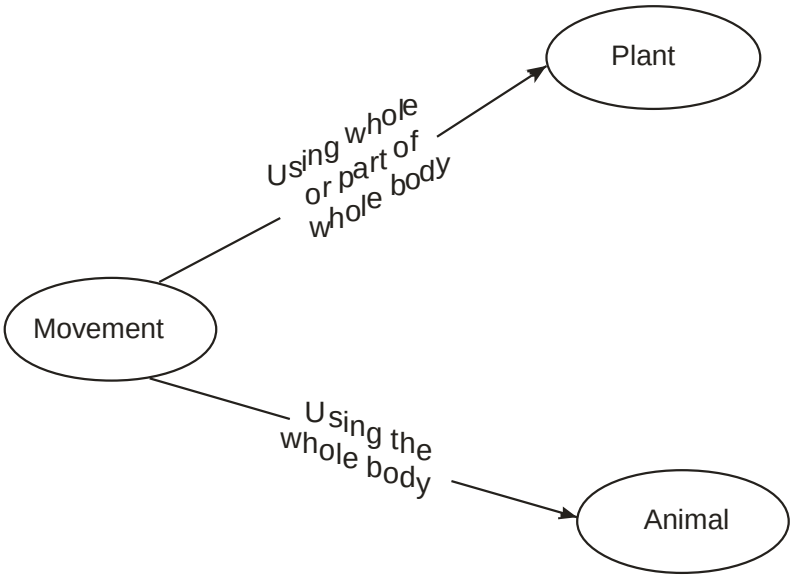


**Figure 2.3: Another example of a simple concept.**

**Source: Sparks and Warwick (2013)**

Sparks *et al,* (2013) discussed the positive import of using concept maps on instruction and learning in secondary biology education. Building on the researches conducted, Sparks *et al* 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.

Sparks *et al,* (2013) 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.

Nwezi (2008) review of research in science teaching, identified three rationale generally advanced by those that supported the use of the laboratory in science teaching. They included:

i. The subject matter is highly complex and abstract.
ii. Students need to participate in enquiry to appreciate the spirit and methods of science.
iii. Practical work is intrinsically interesting to students.

Nwezi 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 Biology as a Subject in Senior Secondary School.

Biology according to Nwagbo & 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:

i. Adequate laboratory and field skills in Biology.
ii. Meaningful and relevant knowledge in Biology.
iii. Ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture.
iv. 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:

i. Organization of life
ii. Organisms at work
iii. The organisms and its environment
iv. 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).

## 2.4 Conventional Teaching Method for Biology in Senior Secondary School

Teaching has been defined in many ways by different authors 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 (2009) defined teaching as the action of someone who is trying to assist others to reach their fullest potentials in all aspects of development. Lyop & Mangut (2011), 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 & Mangut (2011) 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 & Famwang (2006) 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 (2003) 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 & Mangut (2011) 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 and 2 by Butler (2002) 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 & 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 (2011) 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 Lyop and Mangut (2011) 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:

i. It gives opportunity for use sophisticated apparatus and difficult experiments.
ii. Hazardous and dangerous experiments can be carried out.
iii. It is effective for teaching manipulative and applied practical skills.
iv. 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:

i. Plan the demonstration
ii. Prepare students for demonstration
iii. 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 (2011) 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.
ii. It creates meaningful learning and allows easier application of learning to real life.
iii. Likely to arouse varied type of interest in students‟ work with actual objects which are likely to generate curiosity than ideas do
iv. Helps to add reality to, and verification of scientific laws.

The project method according to Lyop and Mangut (2011) 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) 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 (2011) 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.

## 2.5 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 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 (2006) 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.

## 2.6 Theoretical Framework of the Study

This research is hinged on the following theories of learning.

i. The operant conditioning models and stimulus Response (SR), Association theory
ii. Jean Piaget's development theory
iii. Bruner's theory of cognitive learning
iv. John Dewey's theory on experience, reflection and learning
v. Ausubel's subsumption theory

### 2.6.1 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.

### 2.6.2 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.

### 2.6.3 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.

### 2.6.4 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.

### 2.6.5. 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, 2008; 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 (2008) 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 (2008) 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, 2008), the main basis for concept mapping are:

i. Concepts derive their meanings through their inter-connections with other concepts; and
ii. Meaningful learning occurs when fresh knowledge is consciously anchored to relevant concepts in the Cognitive structure of the learner.

According to Wandersee (2010), 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. 2013).

A student may not remember a name he learnt previously but when the bearer of the name is physically present, he may recall. Idialu (2008) & Ughamadu (2009) 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.

## 2.7 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 & 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 & Okafor (2006) 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 & 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 pretest, 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

## 2.8 Summary of Literature Reviewed

The literature reviewed for this study focused on conceptual framework, theoretical framework, and review of empirical studies. The conceptual framework is on concept mapping, uses and concept of Biology. Concept mapping is perceived as very useful in the

teaching and learning process for systematizing and organizing not only the concepts under study, but also the already learned concepts. The use of concept maps in instruction on a specific topic helps to make the instruction "conceptually transparent" to students. 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.

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. Biology as a branch of science and the prerequisite subject for many fields of learning contributes immensely to the technological growth of nature.

Operant Conditioning Model and Stimulus response association theory states that 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. 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. 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.

In the review of empirical studies, works reviewed focused on concept mapping, problem solving, instructional materials (strategy) on student achievement in secondary school

Furthermore, the studies differ in methodology in the sense that none of the empirical studies used the same population, sample and sampling techniques and the studies were conducted in areas outside Niger State different from the area of this present study. The gap between knowledge and practice underscores the relevance and need for the present study, which is aimed at empirically investigating the effect of concept mapping on student anxiety and achievement in genetics concepts among Biology students in Minna Metropolis Niger State.

# CHAPTER THREE

## 3.0 RESREACH METHODOLOGY

### 3.1 Introduction

This chapter was 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 class (non-randomized groups) were used for the study. According to Sambo (2005) & Offor (2000) quasi experimental research design permits the use of intact classes where two arms of a class would be selected, sampled and used for the study. Intact class always allow small number of subject for easy management of the variables involved in the study

### 3.3 Population

The population for the study comprised of all the SS2 Biology student in Minna Metropolis all SS2 Biology students in public senior secondary schools in Minna formed the population with a total number of 3,522 students

## 3.4 Sample and Sampling Technique

Two senior secondary schools was purposely sampled for the study. The schools sampled include Ahmadu Bahago Senior Secondary School, Minna and Zarumai Model School, Minna. 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 SS2 classes were randomly sampled and used for the study. One hundred and forty (140) SS2 students, constituted the students in the experimental group and Control group.

## 3.5 Instrumentation

The Biology Achievement Test (BAT) was used in the study. The dependent variable in this study is the student's "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. The posttest measured students' achievement at the conclusion of the study. Three of these topics are drawn from SSI syllabus in order to test their previous knowledge in line with the topic listed out and two (2) from SSII. According to Willerman & MacHarg (2001), attest must be at the comprehension level and above in order to measure meaning full earning. Consequently, many items on the achievement tests used in this study were at the comprehension level or above. The pre-test assessed student's "achievement on the topics listed out for the research. The post test also assessed students achievement on these topics.

### 3.5.1 Validity of the Instrument

The BAT achievement tests are past questions developed by Educational Resource Centre (ERC) 2015–2019. Only the items on the syllabus were lifted. The lesson plans were face validated by two experts in the Department of Science Education, Federal University of Technology, Minna

### 3.5.2 Pilot Study

Two topics on concept map work meant for the treatment group (experimental group) namely transport system, blood clotting and excretory system information, and identification of vertebral bones and experiment on Food Test was administered on a class of 50 students at Government Secondary School, Minna. The student were taught the two topics using concept map and were taught experiment son which they identified bones and carried out experiment on Food Test each class was taught using a double period of 80 mins 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-Richard son 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

There searcher 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 were provided for the students to mark the correct answers for the BAT. There searcher marked the sheet soft he 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 of teach the second experimental group. The researcher administered are tention test to the two experimental groups after two weeks of teaching, while the trained Biology teacher administered there tention 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. There searcher 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. There searcher 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.

## 3.7 Method of Data Analysis

The research questions was answered using mean and standard deviation while the two sample t-test, analysis of covariance and pair wise comparison was used for testing the hypotheses at 0.05 level of significance..

# CHAPTER FOUR

## 4.0 RESULT AND DISCUSSION

### 4.1 ANOVA Summary of Pretest Result

| Variable | N | Df | $\bar{x}$ | SD | t-cal | P-value |
|---|---|---|---|---|---|---|
| Experimental | 75 | 138 | 10.41 | 2.87 | 9.60 | 0.01 |
| Control | 65 | | 6.14 | 2.31 | | |

### 4.2 Research Questions

**Research Question One**

What are the mean achievement scores of students in biology taught genetic using concept mapping and those taught using lecture method?

**Table 4.2 Mean achievement score of students taught genetic using Concept Mapping and those taught Lecture method**

| Variable | N | Mean | SD |
|---|---|---|---|
| Experimental | 75 | 10.20 | 3.01 |
| Control | 65 | 6.78 | 2.55 |

Table 4.2 showed that the mean achievement scores of students taught genetics with concept mapping performed better than those taught with lecture method

**Research Question Two**

What are the mean achievement scores of male and female in biology when taught genetics using concept maps?

**Table 4.3: Mean achievement scores of male and female students taught genetics using Concept maps**

| Variable | N | Mean | SD |
|---|---|---|---|
| Experimental Male | 50 | 10.44 | 2.99 |
| Experimental Female | 25 | 9.72 | 3.05 |

Table 4.3 above revealed that the male performed better than the female when taught genetics using concept map in the mean achievement scores with the mean gain score 0.72.

**Research Question Three:**

What are the mean retention score of students taught genetics using concept map and those taught using lecture method.

**Table 4.4: Mean Retention scores of students taught genetics using Concept map and Lecture method**

| Variable | N | Mean | SD |
|---|---|---|---|
| Experimental | 75 | 10.08 | 2.61 |
| Control | 65 | 6.81 | 2.44 |

Table 4.4 showed the mean retention score of students exposed to concept map and lecture method. The mean gain is 0.48.Those exposed to concept map performed better than those exposed to lecture method

**Research Question 4**

What are the mean retention scores of students based on gender when taught genetics using concept mapping

**Table 4.5: Mean Retention Score of Students based on Gender Taught Genetic Using Concept Map**

| Variable | N | Mean | SD |
|---|---|---|---|
| Experimental Male | 50 | 9.70 | 2.56 |
| Experimental Female | 25 | 10.84 | 3.10 |

Table 4.5 shows the mean retention score of students based on gender taught genetics using concept map, the outcome of the result shows that the mean gain score is 1.14 in favour of female taught genetics using concept mapping,

***$H_{01}$*** There is no significance difference in the mean achievement scores of students in biology taught genetic using concept map and those taught using lecture method.

**Table 4.6: ANOVA Analysis of Mean achievement score of students taught genetic concept using Concept Map and those Taught Using Lecture Method.**

| Variable | N | Df | $\bar{x}$ | SD | t-cal | P-value | Decision |
|---|---|---|---|---|---|---|---|
| Experimental | 75 | 138 | 10.20 | 3.01 | 7.18 | 0.001 | S |
| Control | 65 | | 6.78 | 2.55 | | | |

*S =significant

Table 4.6 shows the significant difference in the performance of students taught genetic with concept map and those taught lecture method. The outcome of the result shows that the means achievement of those expose to concept map is 10.20 and the SD=3.01 with p-value of 0.001, while the mean scores of those taught with lecture is 6.78, SD =2.55, therefore hypothesis one was rejected. Hence, that there is statistical significant different in the mean achievement score of students exposed to concept map to those expose to lecture method

***$H_{02}$***: There is no significant difference in the mean achievement scores of male and female students in biology taught genetics using concept maps.

**Table 4.7: ANOVA Analysis of Mean Achievement of Male and Female Students Taught Genetics using Concept Maps and those Taught Using Lecture Method**

| Variable | | N | Df | $\bar{x}$ | SD | t-cal | P-value | Decision |
|---|---|---|---|---|---|---|---|---|
| Experimental | male | 50 | 73 | 10.44 | 2.99 | 0.97 | 0.33 | NS |
| | female | 25 | | 9.72 | 3.05 | | | |

*NS = Significant,

Table 4.7 reveal the significant difference in the post-test gain scores in the performance of male and female students taught genetic with concept map. The outcome of the result shows the male mean achievement score is 10.44 and the SD=2.99,with p-value of 0.33,while those taught with lecture method is 9.72,SD=3.05'therefore hypothesis two was retained,.hence,that there is no significant difference in the mean achievement scores of male and female students expose to concept map

**4.8**

**$H_{03}$**: There is no significant difference in the mean retention score of students in biology taught genetic using Concept Map and lecture method.

**Table 4.8: ANOVA Analysis of difference in mean retention score of student in biology taught genetic concept using Concept Map and Lecture method**

| Variable | N | Df | $\bar{x}$ | SD | t-cal | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Experimental | 75 | 138 | 10.08 | 2.78 | 7.37 | 0.001 | S |
| Control | 65 | | 6.81 | 2.38 | | | |

*S = Not Significant

Table .4.8 reveal the significant difference in the post-test level in students taught genetic with concept map and lecture method, The outcome of the result shows the mean score of those expose to concept map is 10.08,SD=2.78 with p-value of 0.001, while those taught with lecture method is 6.81,SD = 2.38, therefore hypothesis was rejected. Hence, that there is statistical significant different in the mean retention score of student expose to concept map and lecture method

**4.9**

**$H_{04}$**: There is no significant difference in the mean retention score of male and female student taught genetic using Concept Map.

**Table 4.9: ANOVA Analysis of difference in mean retention score of male and female student taught genetic concept using Concept Map**

| | Variable | N | Df | $\bar{x}$ | SD | t-cal | p-value | Decision |
|---|---|---|---|---|---|---|---|---|
| Experimental | Male | 50 | 73 | 9.70 | 2.56 | 1.69 | 0.09 | NS |
| | Female | 25 | | 10.84 | 3.10 | | | |

*NS = Not Significant

Table 4.9 reveal the significant difference in the post-test gain scores in the performance of male and female students taught genetic with concept map. The outcome of the result shows the male mean score achievement when expose to concept map is 9.70, with p-value of 0.09, while the female is 10.84, therefore hypothesis was retained. Hence, there is no significant different between male and female student achievement on exposure to concept map.

## 4.10 Discussion of Result

The analysis of research hypothesis revealed that experimental group (concept map) did better than the control group (lecture method), also male in the experimental group did not give better gap that their female counter part in the same group.

Findings of the study revealed the significant difference in the retention level of students taught genetic with concept map and those taught lecture method. The outcome of the result shows that the means retention score of those expose to concept is 10.08 and the SD=2.78, df = 138, with p-value of 0.001, while the mean scores of those taught with lecture is 6.81, SD = 2.38, therefore hypothesis one was rejected. Hence, that there is statistical significant different between the retention level of students exposed to concept map and those expose to lecture method

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.

The outcome of the study, also disclosed the significant difference in the post-test gain scores in the achievement of students taught genetic with concept map and those taught lecture method. The outcome of the result shows the male means score of those expose to concept map is 10.20 and the SD=3.01, df =138, with p-value of 0.001. This show that there is direct impact of concept map, on academic achievement of the student.

The result here is contradictory to the reports of Udeani and Okafor (2006), 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 (2011) 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.

From hypothesis three, the outcome of the result also revealed the significant difference in the post-test retention score in male and female students taught genetic concept with concept map. The outcome of the result shows the male mean retention score of those expose to concept map is 9.70, df =73, with p-value of 0.009, while those taught with lecture method is 6.14, SD =2.31, therefore hypothesis was rejected. Hence, that there is statistical significant different between male and female student retention level on exposure to concept map.

The finding is consistent with the study of Lyop and Mangut (2011) 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 2009, Maduabum 2013 and Abdullahi 2008) 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.

The findings of the study also show significant difference in the post-test gain scores in the performance of male and female students taught genetic with concept map. The outcome of the result shows the male mean score achievement when expose to concept map is 10.44, df =138, with p-value of 0.33, while the female mean scores of those taught with lecture method is 9.72, SD = 3.05, therefore hypothesis was rejected. Hence, there is statistical significant different between male and female student achievement on exposure to concept map.

# CHAPTER FIVE

## 5.0 CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

From the analysis of the data collected from the study and tests of the study's hypotheses, the following conclusions were drawn; the use of concept mapping method for teaching genetics concept enhances students' achievement significantly better than the use of lecture method, the use of concept mapping method has also significantly improved students' retention ability better than lecture method.

From the study it was concluded that concept map teaching method is one of the effective methods of teaching genetics concepts at the Senior Secondary School Level, since it shows potentiality of improving student's academic achievement and retention. The use of experimental techniques significantly improved students' achievement in Biology concepts than the conventional lecture method.

### 5.2 Recommendations

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

- Teachers need to use concept mapped teaching method so as to improve the academic achievement and retention of students in genetics.
- There is the need for training of biology teachers on the effective use of concept mapped teaching method in teaching genetics.

- Facilities should be provided by the Federal and State governments as well as PTAs and NGOs for effective use of concept mapped teaching method for teaching in senior secondary schools
- Biology education researchers may replicate and improve this study at a different location and at other education levels in the country.

## 5.3 Suggestions for Further Studies

Further research studies can be carried out on:

- The effect of using concept maps as study tools on achievement in Biology
- Cognitive influence on Biology students‟ concept mapping ability and achievement in Biology.
- Effect of concept maps on attitude, retention and achievement in other schools in states of the federation.
- Critical appraisal of the role of concept maps in teaching and learning genetics concepts.

## 5.4 Contribution to Knowledge

- This study has been able to establish the fact that concept maps can be used by Biology teachers for instruction in Minna secondary schools to teach Genetics concepts, this will aid in the change of students attitude to Biology and invariably their performance as a result of this change in attitude.
- The use of instructional materials in the teaching and learning of genetics concept could be a way out to improving the teaching and learning of Biology in our senior secondary schools.

- The study has shown that students have preference for new teaching methods which maybe why they showed preference for the lecture method even though the use of concept map helped to improve their performances

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