EFFECT OF TWO MODES OF CONCEPT MAPPING ON STUDENTS' ACHIEVEMENT IN BIOLOGY

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TITLE PAGE

EFFECT OF TWO MODES OF CONCEPT MAPPING ON STUDENTS' ACHIEVEMENT IN BIOLOGY

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JUNE, 2015

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Abogonye Adisa, a postgraduate student in the department of Science Education, Faculty of Education, University of Nigeria, Nsukka with the registration number PG/M.ED/SD/08/48930 has satisfactorily completed the requirements for course, and research work for the award of Masters Degree in Biology Education. The work embodied in this project is original and has not been submitted in part or full for any Diploma or Degree of this or any other University.

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DEDICATION

This work is dedicated to Almighty God for his kindness towards me and my family. Also to my lovely wife Emiene Faith Abogonye and children, Caroline Victoria, David, Daniel, Clinton and Patience for their encouragement.

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The researcher is immensely grateful to God Almighty for good health, divine favour, provision and protection throughout the period of this research work. Making this work a reality was the dedicated effort of so many persons.

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ABSTRACT

This study was designed to investigate the effect of two modes of concept mapping on studentsô achievement in biology. It was guided by five research questions and six hypotheses. The study adopted a quasi experimental design, specifically, the non-equivalent control group design. The population for the study comprised all the SSII students in six co-educational secondary schools in Apa Education zone of Benue State. The sample for the study comprised six secondary schools from seventeen co-educational schools in the area. Out of these schools, two schools form collaborative group, two schools were also assigned to individualistic groups, while the remaining two schools form the control groups respectively. In each of the six schools, one arm/stream was assigned a treatment condition. One instrument was used for data collection namely Biology Achievement Test (BAT) which was developed by the researcher. The validity and reliability of the instrument was established. For the validity of BAT, the researcher used face and content validation using table of specification. The reliability of the instrument was established using Kudder ï Richardson formula 20 (K ï R_{20}) for BAT. Mean and standard deviation was used to answer research questions, while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Results from the study revealed that students exposed to collaborative and individualistic concept mapping techniques achieved more in the biology content than the students who were exposed to conventional lecture method. It also showed that male students in the collaborative group achieved more than the female students. Finally, the interaction effect of method of teaching and gender on students mean achievement in biology was not statistically significant. The study recommended that biology teachers should be trained adequately in the use of the concept mapping technique and should therefore incorporate it as one of the techniques used in teaching biology.

CHAPTER ONE

INTRODUCTION

Background of the Study

Over the years, Nigeria has embarked on scientific, industrial and technological take off. In the National Policy on Education (FRN, 2004:6) it was stated that ñNigeria should be a free, just and democratic society, a land full of opportunities for its citizens, able to generate a great and a dynamic economy and growing into a united, strong and self-reliant nationò. All these reflect an indication of the increasing need and desire for scientific and technological advancement. The philosophy of education in Nigeria is geared among other things towards social, cultural, economic, political, scientific and technological progress. This philosophy can only be attained if Nigerian citizens are properly equipped with necessary skills and knowledge offered in science especially in Biology (Olarewaju, and Jimoh, 1995). Biology is the study of life or living things. It also concerns itself with the study of structure, behaviours, distributions, the origin of plants and animals and their relationships with their environments. Being dynamic, the scope of biology is always expanding as new discoveries are made.

Biology can be divided broadly into two namely; Zoology and Botany. Zoology deals with the study of animals, Botany is the study of plants. Some other specific aspects of Biology are Morphology, Ecology, Physiology, Entomology, Histology, Parasitology, Microbiology, Mycology, Embryology

and genetics. Biology has continued to play a significant role in the development of any society.

In view of above statement, Ambuno, Egunyomi and Osakwe (2008), stressed that biology is an indispensable subject because it forms the basis of disciplines in Human medicine, veterinary medicine, Nursing, Agriculture, pharmacy, science, technology and human nutrition. Despite the status of biology as a popular subject in Senior Secondary School level of Education, students achievements in Senior School Certificate Examination (SSCE) Biology is persistently poor (Nwagbo, 2001, Okoli, 2006). Some of the reasons that causes poor achievement in Biology include lack of interest for the subject, lack of curiosity and commitment to study by the learner, lack of encouragement from the parents, lack of variety of instructional materials, overloaded biology curriculum, insufficient number of science teachers, inadequate laboratory facilities, non-existence of trained laboratory assistant, lack of administrative support from the principals and lack of funds (Nworgu, 2009). In addition, most Nigerian students are unable to retain the biology concepts learnt and produce them when needed. This is because some of the students take the study of Biology for granted and see it as an easy subject to pass (Ugwuadu, 2006).

Some researchers such as Hay, (2000); Umoiyang, (2000); Udom, (2004); Okereke, (2006); and Ugwuanyi, (2011) had identified some of the factors which are capable of causing poor students achievement in senior secondary school

biology and science subjects in general to include poor background preparation, scarcity of qualified science teachers, poor motivation of biology teachers, sex and occupation stereotyping, lack of science laboratory, lack of students interest in the science subjects amongst others. Moreso, some researchers however, seemed to be pointing at teaching method as the major contributory factor (Ezeliora, 1999, and Moore, 2002). These studies further stressed that, poor methods used by secondary school teachers have been found to contribute in no small way to poor achievement in sciences.

The teaching method commonly adopted by teachers is the traditional or the conventional lecture method. The use of lecture method entails a one way flow of communication from the teacher to the students. It is a teacher ï centered or teacher-dominated approach. Most of the talking is carried out by the teacher while the students remain as passive listeners taking down notes. (Nworgu, 2009). According to Aniodoh (2001), the use of lecture methods in a negation of teaching as it does not give rooms for effective and meaningful learning but only enhances intellectual positivity and weariness of the learners.

West African Examination Council Chief Examinerôs Report (WAEC, 2002) stated that students achievement in biology is still very poor due to inadequate exposure to relevant skills and teaching methods of the subject. Research studies however showed that the teaching of science generally in Nigerian secondary schools falls short of the standard expected of it (Okebukola, 2001). The overall poor academic achievement in the science and

biology in particular among secondary school students raises doubts on efficacy of the teaching methods utilized by the teachers in school (Ibe and Nwosu, 2003).

Indeed, poor achievement in science and its effects on the economy of the country has been the major concern of various science educators, educationalists and other institutions directly concerned in the educational system. Poor achievement especially in biology implies obtaining low or failure grade by students in examination. As a result of this situation, considerable research efforts are being expended on how to improve students achievement in biology. A report by Ezeudu (2002), suggested a re-orientation in the teaching and learning of science, Biology in particular for better results. She emphasized the need to seek out for innovative method of teaching science subjects. Again, Okafor (2009), called for a renewed teacherôs effort at using innovative and self-learning approach or methods in secondary science teaching because such provide more meaningful learning experiences to the learners and tremendously improve students achievement in science subjects. Some of the innovative teaching methods that could be used in teaching are scaffolding, problem-solving method, team teaching, constructivist-based methods, games and simulation and concept mapping instructional strategies (Nworgu, 2009).

Consequently, efforts are made by some biology teachers to make students acquire meaningful learning in biology by making the teaching of biology exciting, purposeful and participatory. This calls for the use of

instructional methods that would make students develop adequate assimilation and understanding of the concept taught and acquire process skills in biology such as abilities, potentials and technical know-how which can be developed by experience and used in carrying out mental operation and physical action in biology. One of such methods may be the use of concept mapping strategy. Concept mapping is a product of recent advances in cognitive sciences and new philosophy of science. Contemporary perspectives of cognitive psychologists and new philosophers of science on cognition view learning as an active process of construction where the learners prior knowledge plays significant roles in conceptual learning (Ausubel, Novak and Hewson, 1978; Hewson, 1986; Novak, 1990).

The technique of concept mapping was developed by Joseph D. Novak and his research team at Cornell University in the 1970s as a means of representing the emerging science knowledge of students. Concept mapping depicts hierarchy and relationship among concepts. According to Novak (1998), concept mapping is a process of organizing and representing concepts and their relationships in visual forms. The use of concept mapping tactics is embedded within Ausubelôs (1963) learning theory which emphasized on meaningful learning. Meaningful learning results when a person explicitly and consciously ties new knowledge to relevant concepts or proposition already possessed (Okebukola, 1990). Mapping creates a picture that illustrate the interconnections within information presented as well as related information.

Concept mapping is one tool that can overtly engage students in meaningful learning processes. Furthermore, concept mapping promotes meaningful learning and retention of knowledge for a long period of time and helps students negotiate meaningful learning (Hyerle, 2002). Simone (2001), describes concept mapping as a learning strategy that allows learners to externalize their thinking in a visual and verbal form to improve students understanding of learning. It allows the learners to extract important information, relate ideas and represent them in a structured manner. It provides a visual road map showing the pathways that we may take to construct meanings of concept and prepositions.

Based on meaningful learning which is one of Ausubelôs most important principles in his theory of cognitive learning, learners learn meaningfully by anchoring new concepts and proposition to one they have already known (Canas and Novak, 2006). Boxtel etô al (2002), view concept map as a graphical representation of concept and proposition. It represents the main concept and relationships within a domain. It is a network in which the nodes represent concepts, the line linking the nodes represent the relationships, and the labels on the line, the nature of the relationships. Okebukola (2001), defined concept as perceived regularity in events or objects designated by an arbitrary label. Maps are diagrammatical representations of geographical regions. Map help to show oneôs bearing, thus helping one to proceed to oneôs destination.

Concept mapping is a graphical arrangement of key concepts to show meaningful relationships among the selection of concepts or ideas being studied (Ossai, 2004). Concept mapping strategy enables teachers to select, organize and represent subject matter content concisely. It enables students take notes easily, summarize and synthesize what they are reading and write reports. Completed concept maps can present a quick (at a glance) view of the concept or topic taught. Concept mapping as an instructional strategy extends the element of observations, inferring, and classifying to hierarchical structuring and construction (Inomiesa and Unuero, 2003). This strategy places more emphasis on the influence of a students prior knowledge on meaningful learning.

Novak and Ca□as (2006), equally stated that concept map can be used to support many kinds of learning activities, from reading expert maps, to various active learning like data collection, report preparation, oral presentation, group collaboration and finally evaluation. Presently, as educators are now seeking new methods to respond to the demand for personal education and knowledge acquisition and production, concept mapping as a powerful learning and teaching technique provides these educators with the new methods that are beginning to be implemented at all educational levels in many institutions world wide. In view of the usefulness of concept mapping, an investigation to determine the effect of two modes of concept mapping on studentsô

achievement in Biology became very imperative. This calls for further research on collaborative and individualistic concept mapping.

Statement of the Problem

Researchers have observed that biology achievement is still very poor due to some of the factors which include lack of interest for the study, lack of curiosity and commitment to study, over-loaded biology curriculum, lack of variety of instructional materials, insufficient number of science teachers, inadequate laboratory facilities, non-existence of trained laboratory assistants, lack of administrative support from the principals that are not science inclined, lack of fund and some other aversive issues. Teaching and learning is done in a hurry to meet the examination deadline without recognizing the level of understanding among the learners. The instructional strategies commonly used in Nigerian educational system encourage rote learning rather than meaningful learning.

The science education community therefore, has developed new tools for making students go beyond rote learning. Thus, there is need to implement concept mapping technique. Concept mapping however is an effective teaching strategy that has been extensively used in so many subjects. Evidence has shown that little or no work has been done using different modes of concept mapping in relations to students achievement. In view of this, there is therefore need to investigate the applicability of different modes of concept mapping

namely, collaborative and individualistic concept mapping on students achievement in biology in order to determine its efficacy. Hence, the problem investigated in this study, posed as question is what are the effects of collaborative and individualistic concept mapping on students achievement in biology?

Purpose of the Study

The main purpose of this study is to investigate the effect of two modes of concept mapping on students achievement in biology (collaborative and individualistic). Specifically, the study seeks to achieve the following:

1. Determine the effect of collaborative concept mapping and conventional lecture method on student achievement in biology.
2. Establish the effects of individualistic concept mapping and conventional lecture method on students achievement in biology.
3. Establish the comparative effects of collaborative and individualistic concept mapping on students achievement in biology.
4. Determine the influence of gender on students achievement in biology when exposed to collaborative concept mapping.
5. Determine the influence of gender on students achievement in biology when exposed to individualistic concept mapping.
6. Determine the interaction effect of method and gender on students achievement in biology.

Significance of the Study

The results of this study have both theoretical and practical significance. The theoretical significance of this study is anchored on the Ausubelôs assimilation learning theory and constructivist theory. Ausubel assimilation learning theory focuses on what he describes as meaningful learning. This is a process where new information is related to existing relevant aspects of the individualôs knowledge structure. The component of his theory fits with concepts of short and long term memory in cognitive information processing. This theory integrates the cognitive, affective and psychomotor domains. Based on meaningful learning, the use of concept mapping tactics is embedded within Ausubelôs theory of cognitive learing as it promotes creativity and critical thinking among the learners.

A major theme in the theoretical framework of Bruner is that learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge. The learner selects and transforms information, hypothesis and makes decision, relying on cognitive structure to do so. The finding of the study will therefore encourage the learner to become actively involved in the learning process by relating new knowledge to prior knowledge. Learners can recall what is taught and applying them at any time. Theoretically, this work is in a position to add valuable literature to the area of gender studies generally.

In practical terms, the finding of this study will be of benefit to students, teachers, curriculum planners, educational administrators, parents, teachers training institutions, researchers and other stakeholders in education. To the students, the study will promote a positive interdependence among learners of the same group. This enables the students to help each other to overcome problems, by involving in peer tutoring, exchange of ideas or materials, and challenging each otherôs views. It will also foster creativity and cooperation between students and the teachers which in turn helps them to be highly motivated in the learning process and subsequently reduce the spirit of fears, frustration, negative attitudes and failure which students experience in biology.

To the teacher, the result of the study will make them to be more innovative with new ideas, skills, knowledge and attitudes that will equip them to function effectively in the realization of instructional objectives. It will also enable the teachers to discard the use of conventional instructional approach and adjust to more meaningful and effective teaching strategies that make them to be highly efficient and productive in classroom instructions. However, if this innovative teaching strategy is continuously used by the biology teachers, it will soon become part of the teachers and students thereby making teaching more purposeful, exciting and participatory. This, it is hoped, will help produce the much desired result in biology and science in general.

To educational administrators, the findings of this study will provide information with which they organize seminars, conferences, workshops,

symposiums and training programmes for teachers such as to communicate to teachers the alternative methods to the teaching of biology for maximum comprehension and can equally guide them in the provision of necessary materials for effective learning of biology.

To the curriculum planners, the outcome of this study will enable them in restructuring and reviewing the curriculum to include new innovations of teaching. Using the study in planning curriculum or instruction on a specific topic helps to make the instruction conceptually transparent to students.

Parents also benefit from the findings of the study in the sense that the better achievement of their wards and children bring joy and satisfaction to them as a result of better and effective teaching strategies involved in the classroom instructions and subsequently leading to their good achievement as an assurance of better future for the family and country in general.

Furthermore, the outcome of this study will also be in a better position to add valuable literature to the area of new methods of teaching in science education generally as well as of immense benefit to future researchers who may wish to conduct further research in this area or other related areas. All this will help to broaden the knowledge base of the researchers and scientists in general.

Finally, the result from this study also provide more and useful information for teacher training institutions, tertiary institutions such as colleges of education, research centres and faculties of education in Nigerian

universities. Their biology methods course could be enriched with concept mapping models as alternative teaching techniques or strategies for teaching biology.

Scope of the Study

This study is on effect of two modes of concept mapping (collaborative and individualistic) on students achievement in biology. The study was limited to SS II students in Apa Education zone of Benue State. SS II students were used because topics to be used are contained in their scheme of work taken from national curriculum for senior secondary school, year two. The specific content scopes are skeletal system and excretory system. The topics were chosen because many students perceive them as difficult. Students rather perform poorly in them and at times the topics are either hurriedly taught or not taught at all. However, the use of collaborative and individualistic concept mapping as main effects may help to enhance understanding for better achievement of students in biology.

Research Questions

In carrying out the study, the following research questions were formulated:

1. What is the mean achievement score of students taught using collaborative concept mapping and those taught using conventional (lecture) method in biology?

2. What is the mean achievement score of students taught using individualistic concept mapping and those of conventional (lecture) method in biology?
3. What is the comparative effect of collaborative and individualistic concept mapping on students achievement in biology?
4. What is the effect of collaborative concept mapping on achievement scores of male and female students in biology?
5. What is the effect of individualistic concept mapping on achievement scores of male and female students in biology?

Hypotheses

The following hypotheses were formulated to guide the study.

Ho_1: There is no significant differences between the mean achievement score of students in biology when taught using collaborative concept mapping and those taught using the conventional lecture method.

Ho_2: There is no significant difference between the mean achievement scores of students in biology when taught using individualistic concept mapping and those taught using the conventional lecture method.

Ho_3: There is no significant difference between the mean achievement scores of students taught biology with collaborative concept mapping and those taught using individualistic concept mapping.

Ho_4: There is no significant difference in the mean achievement scores of male and female students taught biology using collaborative concept mapping.

Ho_5: There is no significant difference in the mean achievement scores of male and female students taught biology using individualistic concept mapping.

Ho_6: There is no significant interaction effect of methods and gender on the mean achievement scores of students in biology.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews the works and opinions of some authors and researchers which are related to this study. The literature is organized under the major headings, viz, conceptual framework, theoretical framework, empirical studies and summary of literature review.

a. Conceptual Framework

- Concept of teaching and learning
- Concept of science teaching
- Traditional methods of teaching biology
- Innovative teaching strategy
- Concept mapping instructional strategy (Collaborative and Individualistic)
- Concept of Gender
- Concept of achievement in biology

b. Theoretical Framework

- Burnerôs theory
- Gagneôs hierarchical theory
- Ausubelôs theory

c. Empirical Studies

- Studies on concept mapping
- Studies on achievement in biology (science)
- Studies on gender in science achievement
- Studies on innovative teaching strategies and achievement.

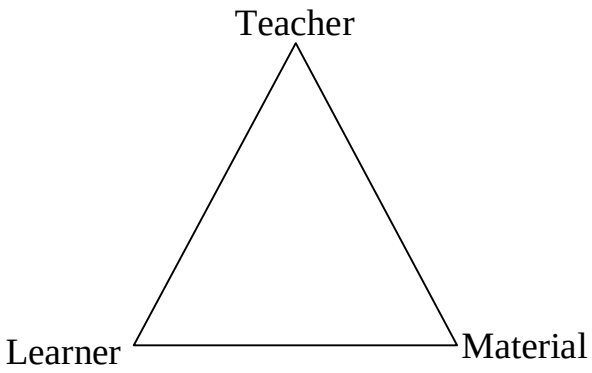
d. Summary of Review of related Literature

Conceptual Framework

- ***Concept of teaching/learning***

In our society today, a lot of teaching and learning takes place on daily basis. Some of these teaching and learning that go on take place in informal settings, while some others take place in a formal classroom environment which is a formal setting. Indeed, teaching as a concept has been defined in various way by different scholars in education. In the context of formal setting, the term can be used to refer to a particular profession that requires the act of teaching, just like some other professions which includes engineering, law, medicine and nursing. Therefore, the act of teaching according to Onwuka (1981) is the ñvarious activities undertaken by a more experienced and more knowledgeable person in order to enable others learnò.

Akudolu (1994) also defined teaching as ña systematic activity deliberately engaged in by somebody to facilitate the learning of the intended worthwhile knowledge, skills, and values by another person and getting the necessary feedbackò. Teaching is an act because it involves guiding, directing and stimulating learning. Teacher helps the child to develop the right skills, assimilate the facts, right habits, ideals and ethical standard (Aduloju, 2012). Teaching is defined as a process whereby a teacher guides the learner in the acquisition of knowledge, skills and attitudes. It is essentially a system of interaction involving the teacher, the learner and the learning materials, as shown in the diagram below.



Teaching connotes knowing what to teach the learners and the way of imparting the knowledge most effectively. Gagne (1978) defined teaching as any kind of interpersonal influence aimed at improving the learning of another person. Akindutire (2001) stated that teaching occurs when one individual deliberately attempts to help another individual or group of persons in performing or learning a specific activity or a concept. The key to this definition is the intent on the part of the teacher to provide assistance to another person(s) to learn. In collaboration Knellier in Akpoo (2011) informed that teaching is an intentional activity for which a teacher must plan his lesson very well in order to achieve his desired intention. Folajimi (2009) opined that teaching involves imparting verifiable facts and beliefs to students; encouraging participation and expression of their own views.

Teaching can therefore be said to be a process whereby a teacher guides the learner in acquisition of knowledge, skills and attitudes within learning environment. This involves interaction between the teachers, the learner and the material content to be learnt. Teaching and learning that takes place in a school is guided by certain rules and regulations, standard and values which all go to

affect the quality of interaction between a teachers and students. Teaching can be summarized as a purposeful activity carried out by someone with a specialized knowledge in a skillful way to enhance the cognitive, affective and psychomotor development of a person or a group of persons. Therefore, in teaching, the teacher pays particular attention to what is being taught, the instructional objectives as well as the learners. With this, two modes of concept mapping i.e. collaborative and individualistic concept mapping as a teaching method greatly enhance and improve students achievement in biology if properly utilized and at the same time reduce the problems related to the teaching of biology in secondary schools as the technique ensure teacher effectiveness and guarantee students achievement.

- ***Concept of science teaching (status of science teaching/learning in school biology teaching)***

Science according to Hornby (2001) is an organized body of knowledge. According to Aduloju (2012), science is a branch of knowledge which deals with the systematic study of the environment through experimentation, observation and reasoning. Science is therefore, a way of searching for meanings or explanation of the events in nature or a way of investigating about, events in nature. Science can be defined in terms of methods and processes i.e. (what scientists do) as well as its products (principles, facts, concepts, theories, laws) that make up the body of science (Nworgu, 2009). No one definition of science can actually convey the full meaning of science. To this effect, in

defining science, one should consider the dual nature of science that is in terms of its process and product. Hence science can be defined as a body of knowledge acquired through experimentation and investigation of events in nature.

The study of science started with the early man. Right from time, man had tried to find out explanations to the things in his environment. This is because man by his nature is a curious being. Science is dynamic and not static. In regard to the concept of science teaching and learning Ali (2009) clearly shows that no one science teaching method is totally effective all the time and for all the learners and all tops in promoting learning, interest and motivation i.e. for all the time and for all the learners and for all the subject matter, a combination of methods is mostly likely to achieve an enduring positive learning. In a typical primary school class anywhere, the best top one-fifth of the brightest and most intelligent pupils barely need teaching (talk and chalk); they need activity driven inspirational guidance in the structure, functions and methods of science contents of instruction. Among such pupils note that they will learn some science even without teaching them; they are cognitively independent.

A large number of teacher education programmes prepare teachers more on abstract contents they will not actually need or use in teaching while leaving unprepared much of the contents trainee teachers will need upon entry into teaching. The science teaching that positively endures and assures learning are

those that emphasise skills, attitudes and knowledge that have practical utility in the world. Such teaching engages the learners in science based activities of play, a lot of learning science through practice activities and what may appear as diversionary side talking on inspirational stories etc. mimicking and imitation as tools for effective teaching. Science is the study and understanding and some will say, appreciation of natural, phenomena existing in the world we live, i.e. all of Godôs creation. Scientific activities about natural phenomena exposes us to learn about transport systems, life forms, planets, erosion, the oceans, seas, rivers, our land forms and tides, waves, weather, Agriculture and so on. These phenomena are studied in terms of how men can harness what they have to offer and yet live in harmony with them. Science deals with studying and understanding Godôs creation or reality, using the scientific method as a tool for acquiring knowledge and skills of science and technology. Scientists know that there are certain things that science cannot however explain properly and satisfactorily and so they live with this fact of science. One is the Bermuda triangle. The essence of this information is that science teaching cannot explain everything on earth because science cannot explain everything on earth.

Science materials involve both physical/printed and e-resources or instructional documents which schools use for teaching and learning of science. These printed and e-resources include books, talking books, computer assisted learning materials, computer, tools, filmstrips, chemicals, equipment, specimens, CD-ROM, cell phones, SMS messages etc. Each science teacher

should, as a beginning insist and ensure that each learner has the full complement of recommended textbooks, graph books, rules, erasers, dissecting sets etc. without the working tools of instructions, science teaching cannot successfully take place.

Science methods involve the classroom and laboratory methods of face-to-face teaching of science at the school level. Ali (2009) has identified seventeen different methods of science teaching at the school level. Some of the methods include lectures, demonstration, individual projects, group projects, laboratory practical work, inquiry methods, fieldtrips, open class group discussion, discovery method, target task method, constructivism, exploration, simulation and games, imitation, observational investigation and reporting and so on.

With this, the science teacher that wants to be effective must be well trained in the knowledge and methods of teaching science which the present study hopefully will address by providing more effective science teaching method that increase students achievement in biology as the traditional method of teaching science and Biology in particular encourage rote learning and memorization of concepts without actually exposing students to challenges that will make them to be actively engaged in learning process.

Traditional Method of Teaching Biology

Obodo (1990), defined a traditional method as an approach, procedure or a position which a teacher adopts to explain a subject matter to a group of

students or learners. A technique according to him is a teaching device or strategy adopted by a teacher to teach a lesson. However, in this study the terms traditional or conventional methods, technique, approach and strategy are used interchangeably to mean the same thing. Nworgu (2009), however reported that the teaching of biology requires that the teachers should be knowledgeable in the various methods and strategies for teaching the subjects. The researcher further pointed out some of the traditional methods and strategies used for biology instructions to include lecture method, discussion method, project method, field trip, demonstration method, experimental methods etc.

Lecture method entails a one way flow of communication from the teacher to the students. It is a teacher-centred or teacher-dominated approach. Most of the taking is carried by the teacher while the students remain a passive listeners taking down notes. Lecture methods according to Aniodoh (2001), is a negation of teaching as it does not give room for effective and meaningful learning but only enhances intellectual positivity and weariness of the learners.

Discussion method can be seen as talking over something from various points of view. Discussion usually involves a group of people under a classroom setting, discussion is an interactive process involving the teacher and the students or among the students themselves. In this case, a problem or topic for lesson is presented for discussion while the teacher helps to direct the learnerôs views towards the lesson objective. In this method in some cases, students may find it extremely difficult to contribute meaningfully to the discussion due to

their poor background knowledge of the topic under discussion. This method takes a considerable length of time.

Conventional or traditional method is project method. Projects are organized or planned activities in which students are allowed to investigate or research on their own. Project method is very difficult to ascertain the extent to which particular student has gone with work since they may invite other people to do the work for them and difficult to get a topic that will interest all the students.

Demonstration method is also a traditional method used in teaching biology which entails a display or an exhibition usually carried out by the teacher while the students watch. It is mostly used in showing the students correct use of certain science equipment. Demonstration can be carried out by a single teacher alone or by a student or group of students. With demonstration, less scope is covered. Demonstration is restricted to the teacher alone. In view of all this, it has been shown that traditional methods of teaching biology do not enhance meaningful learning and students critical thinking skills, rather encouraged rote learning and memorization of science concepts. In this regard, the two modes of concept mapping i.e. collaborative and individualistic concept mapping as innovative teaching strategies would make the study and teaching of biology exciting, purposeful and participatory, thereby stimulating students critical thinking skills and hence, academic achievement in biology. Therefore the present study will make the study of biology so interesting and enjoyable by

the learner by providing the use of innovative teaching strategy like concept mapping and their different modes in teaching process.

Innovative Teaching Strategy

Innovation, according to the New Oxford Dictionary meaning, is bringing in new methods, ideas, skills etc and making changes. Innovation is compatible with change. It is a set of operating procedures, a strategy of intervention in a normal effort to reform social organization; a planned novel, spontaneous, deliberate specific change intended to help the organization achieve the existing goal more effectively or achieve new goals; the promotion of new ideal and methods within education. In biology like any other subjects, innovation can be in using new teaching methods, addition of new ideas in the curriculum content, learning experiences, introducing new/modern instructional material as well as adopting a new change in evaluating the outcomes of biology learning (Amaechi, 1995). In innovation in biology, the teacher may introduce a new thing into the subjects in the form of teaching methods, so as to promote dissemination of biology knowledge, skills and attitude among students. Innovation is established through the teacherôs urge to find something new that will help make his teaching more effective (Egbai, 1996).

In view of this, scientist and science educators over the years have been focusing attention on how to improve science instructions in schools by going beyond the stereotypic methods of obtaining knowledge in science. As a result of this, there has been emphasis in science teaching and on students active

involvement in doing science. Supporting the above view, Nworgu (2009), however noted that most of these conventional or traditional methods of teaching encourage rote learning and memorization of concepts without actually exposing students to challenges that will make them to be actively engaged in learning process. The over-reliance on these methods in our secondary school biology teaching and sciences tend to affect students performances and achievement in the subjects. Nworgu (2009), further identified the following innovative teaching strategies as effective tools to improve science teaching and learning through active involvement of learners in the learning process. These include concept mapping, constructivist-based methods, focus grouping, discussion, use of Analogy, problem solving, games and simulation, team teaching, cooperative learning, scaffolding, guided discovery, inquiry and mind maps.

In this regard, it is important to examine whether the two modes of concept mapping i.e. collaborative and individualistic modes of teaching as innovative teaching strategies will enhance achievement of students in biology. With this, it is hoped that the two modes of concept mapping (collaborative and individualistic) will further become an appropriate teaching method that would increases student achievement in biology.

Concept Mapping as an Instructional Strategy

In the educational process, it is important to arrive at a consensus of interpretation whenever a new idea is introduced. With this in mind, definitions

given by various authors have been stated so as to give a clearer idea of concept mapping. Moreso, its origin and application on other subject areas were reviewed.

A concept is a perceived regularity in events or objects designated by an arbitrary label (Okebukola, 1999). Concept usually represented as boxes or circles are connected with labeled arrows in downward branching hierarchical structure. The relationship between concepts can be articulated in linking phrases such as ñgive rise toò, ñresult inò or ñcontribute toò. A map on the other hand is a visual network showing regularity in events or designated by some label. Maps are also diagrammatic regions. Maps help to show oneôs bearing, thus helping one to proceed to oneôs destination. A map must challenge oneôs assumption, recognized new connection and visualized the unknown (Wandersee, 1991). The technique for visualizing their relationships among different concepts is called ñmappingò.

The technique of concept mapping was developed by Joseph D. Novak and his research team at Cornell University in the 1970s as a means of representing the emerging sciences knowledge of students. It has subsequently been used as a tool to create meaningful learning in sciences and other subjects as well as to represent the expert knowledge of individual and teams in education. It is a meta-cognitive instructional strategy developed from Ausubelôs subsumption theory by Novak. Concept mapping depicts hierarchy and relationship among concepts. This begins from the most general, most

inclusive concept at the top and proceeds downwards to less general specific examples (Novak, 1990). A concept map is a graphic organizers which uses schematic representation, hierarchically to organize a set of concepts, connected by means of words in order to build meaningful statements. It shows meaningful relationship among concepts in the shape of prepositions, and it reveals each student comprehension and knowledge structures (Novak and Gowin, 1999). Similarly, concept mapping may represents the information in the descending order of importance. The most important information is placed on the top and illustrates the downward classification of the concepts. The super concepts should be placed in the top and sub-concepts are downwardly depicted to express the total concept in true manner (Hinze-fly and Novak, 1990). Concept mapping is a graphical arrangement of key concept to show meaningful relationship among the selection of concepts or ideas being studied (Ossai, 2004). Concept mapping strategy enables teachers to select, organize and represent subject matters content concisely. It also enable, the students take notes easily, summarize, and synthesize what they are reading and write reports.

According to Mintze and Quin (2003), concept maps are schematic devices for representing interrelationships among a set of concepts meanings embedded in a framework of prepositions and two dimensional, hierarchical, node-links diagrams that represent verbal, conceptual or declarative knowledge in visual or graphic forms. In other words, concept maps are visual of concepts hierarchically organize and connected by labeled lines and prepositions (Snead

and Snead, 2004). Concepts mapping as an instructional strategy extends the elements of observation, inferring and classification to hierarchical structuring and construction. This strategy places more emphasis on the influence of studentsô prior knowledge on meaningful learning (Inomiesa and Unuero, 2003).

According to Nworgu (2009), concept mapping simply means a diagrammatic representation of concepts using arrows to indicate their relationships in order to represent a new knowledge structure. Concept mapping was developed as an innovative teaching strategy to improve science teaching and learning through active involvement of the learner in the learning process. It is a learning strategy that allows learner to externalize their thinking in a visual/verbal form to improve students understanding of learning which allow the learners to abstract important informations, relates ideas and represent them in a structure manner (De Simone, 2001). Again, concept mapping is an excellent device who shows or represent visually the hierarchical relationships between concepts within structure or segment of a discipline. It is a graphical way of representing hierarchically the conceptual structures within a course (Okebukola, 1992). Thus, the more general, more inclusive or more abstract concepts are place at the top, while the more concrete, more specific and less inclusive concepts are arranged below them.

Osisioma (1995), defined concept mapping as a diagrams indicating interrelationships among concepts as representation of meaning, thus

emphasising the fact that a relationships and hierarchical arrangement among concepts. It is a graphic structure contains nodes that are interlinked by labelled, directed areas which can be used as a knowledge representation tool to reflect relationships that exist between concepts that reside within an individual long term memory. When constructing a concept map, the focus is the relationships among concepts by a linking line and labelled by a linking words, create prepositions, which is the smallest unit that carriers meaning (Jacob Lawson & Hershey, 2002).

Hsiu (2002), however described concept mapping as a technique for representing knowledge in graphs. Knowledge graphs are network of concepts. Network consists of nodes and links. Nodes represent concepts and links represent the relationships between concepts. A good concept map shows key concept and preposition in explicit and concise words and super-ordinate-sub-ordinate relationship between key concepts and preposition. Plotnik (2002), also defined concept mapping as a visual representation which allows the development of a wholistic understanding that words alone cannot convey. Alktens and Deaker (2008), examined concept map as a constructivist tool for students learning and knowledge evaluation.

According to Novak and Ca□as (2006), defined concept mapping as a graphical tools for organizing and representing knowledge. They include concepts usually enclosed in a circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words

on line referred to as linking words or linking phrases, specify the relationships between two concepts. Concept mapping heuristics is predicated on Ausubelôs assimilation theory of cognitive learning which places central emphasis on the influence of students prior knowledge on subsequent meaningful learning (Horton et al, 1993). The study of concept mapping as a research and evaluation tools evolves from work conducted by Novak and his graduate students at Cornel University (Markham, Mintzes and Jone, 1994). According to Novak and Gowin (1999), ñour experience with meta-learning began when the graduate students who were working with us recognized that the concepts and methods, we were using in our research were helping them to learn how to learnò concept mapping was originally intended as a vehicle for exploring meaningful learning acquired through audio tutorial instruction in elementary science school. However, in the research done since Novak developed this tool, concept mapping has become a viable educational medium not only to improved educational research.

Typically, concept maps contain a subject where related people place concepts, ideas and facts are hierarchically arranged about the subjects. The node (point on the graph) represents a concept and a link (connecting arc) represent the relationships between concept. A concept map can be in the shape of a pyramid, a wheel with spokes of interrelated ideas etc. These can be enhanced by photos and pictures as examples and collaboration (Trochin, 2002) concept mapping is used to deliver instruction. It is brainstorming, notetaking, memory retention,

summary, new knowledge creation and to increase meaningful learning (Brown, 2002). Concept mapping can help to foster creativity, generate ideas, design complex structures, by explicitly integrating new and old knowledge and assess understanding or diagnose misunderstanding (Plotnik, 1997). Concept mapping help the learner understand the link between sets of concept. According to Novak and Gowin (1999), students learn meaningfully when the seen the nature and rote of concept and the relationships between concepts as they exists in printed or spoken instruction.

It provides the learner with a schematic summary of what has been learnt.

Roth and Roychondhury (1993), however reported that concept maps lead to sustained discourse on the topic. Preparation of concept maps help the learner improved on his cognitive organisation. Ahove (2005), reported that students exposed to concept mapping learning strategy score higher in Biology achievement test than those who were not. It however, provide a kind of visual roadmap showing some of the pathways a learner may take to connect the meaning of a concepts. Moreso, it allows the teachers and learners to exchange views on why a particular prepositional linkage is good or valid, serve as a useful social functions, lead to lively classroom discussion, fosters cooperation between students and teachers, used to development students capacity to learn independently, helps students understand their roles as learners, serve as a powerful evaluation tools and for improvement of evaluation tool or technique (Budd, 2004).

According to Nworgu (2009), concept mapping as a diagrammatic visual representation has several advantages and this include the following:

- It helps the students to achieve meaningful learning and make teacher to be highly effective in classroom instruction.
- It helps them to highlight key concepts in any topic and link them sequentially.
- Helps to represent knowledge inform of a structure or map.
- Helps in understanding of the subject thereby laying emphasis on the major concepts.
- Makes the student to feel very comfortable and stabilize their emotional state.
- It has been found to lower studentsô anxiety in science classroom.
- It can be used to teach any subject or discipline.
- It creates opportunities for students to be highly creative in the learning situation by making new connections and pattern of knowledge structures.
- Can be used to suggest further exploration while revealing the extent of knowledge of the individual.

A concept map is a way of representing relationships between ideas, images, or words in the same way that a sentence diagram represents the grammar of a sentence, a roadmap represents the locations of highways and towns, and a circuit diagram represents the working of an electrical appliance.

In a concept map, each word or phrase is connected to another and linked back to original idea, word or phrase. Concept maps are a way to develop logical thinking and study skills by revealing connections and helping students see how individual ideas form a larger whole. It is a graphical tool for organizing and representing knowledge.

Biology as a living or life science, needs to be thought of in terms of tangible/visual representation and the instructional methods well selected. Such materials (sketches, models and so on to concretize ideas), teaching methods and teaching strategies generate and arouse interest in teaching/learning of biology. Concept mapping techniques encourage an appropriate selection and use of instructional materials and arouse interest in biology. With this, it is hoped that the two mode of concept mapping (collaborative and individualistic) will further become an appropriate teaching method that would increases students achievement in biology. Consequently, there are different forms of concept mapping namely: collaborative and individualistic concept mapping.

Collaborative concept mapping can be defined as a situations in which a group of students or team of learners with different intellectual abilities engage in a variety of learning activities together in order to enhanced the understanding of a particular concept or topics. In other words, collaborative learning refers to an instructional strategy in which students explore their understandings and misunderstanding together helps students to think about what they already know, what they need to know and how they would present

and defend their own ideas in relation to an instructional situation (Ngeow, 1998). Students are responsible for one anotherôs learning as well as their own. Furthermore, collaborative concept mapping is an instructional method in which students at various levels work together in a small group to achieve a common goal (Gokhale, 1995). Thus, the success of one student helps other students to be successful. There, each members of the group engages in an activity not only for the purposes of learning but also encouraging each other to learn. (Chun, 2002). Students work together until they successfully completed their group work. It is an educational approach to teaching and learning that involves group of students working together to solve a problem, complete a task, or create a product. In collaborative learning, students work in heterogeneous groups to support the learning of their individual members. Collaborative learning leads to positive interdependence of group members, individual accountability, face-to-face interaction, and appropriate use of collaborative skills (Schaftert, 2006). Collaborative learning occurs whenever students interact in pairs or groups to share knowledge and experiences (Tochonites, 2000), Hall (2000), remarked that in collaborative learning the teacher systematically organizes students into groups to work and learn together. The students are assigned roles in their groups for completing the given task.

According to Gerlach (1994), collaborative learning is based on the idea that learning is a naturally social act in which participants talk among themselves. It is through the talk that learning occurs. Smith and MacGregor

(1992), pointed out that there are many approaches to collaborative learning. These are:

a. Leaning is an active process whereby students assimilate the information and relate this new knowledge to a framework of prior knowledge.
b. Learning require a challenge that opens the door for the learner to actively engage his/her peers, and to process and synthesize information rather than simple memorize and regurgitate it.
c. Learning flourishes in a social environment where conversation between learners takes place. During this intellectual gymnastics, the learner creates a framework and meaning to the discourse.
d. Learners benefit when exposed to diverse view points from people with varied background.
e. In collaborative learning environment, the learners are challenged both socially and emotionally as they listen to different perspectives, and are required to articulate and defend their ideas. In so doing, the learners begin to create their own unique conceptual frameworks and not rely solely on an expertise or text is framework. Thus, in collaborative learning setting, learners have the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question other conceptual framework and be actively engaged. Collaborative learning procedures can be incorporated into a typical 50 minute class in a

variety of ways some acquire a thorough preparation, such as a long present, while others less preparation, such as posing a question during lecture and asking students to discuss their ideas with their neighbours.

Smith and MacGregor (1992) state ñin collaborative classroom, the lecturing/listening/note-taking process may not disappear entirely, but it lives alongside other processes that are based in students, discussion and active work with the course materialsò. Regardless of the specific approach taken or how much of the ubiquitous lecture-based course is replaced, the goal is the same to shift learning from a teacher-centred to a student centred model.

In collaborative teaching strategy, all members of the group seek mutual benefit so that every member gains enormously from each others support. They work and discuss the section to their problems, through listening, explanation and encouraging each by providing academic assistance (Nworgu, 2009). Collaborative learning instruction is a learner-centred rather than teacher-centred and knowledge is viewed as a social construct, facilitated by peers interactions, evaluation and cooperation, therefore, the roles of the teacher changes from transferring knowledge to students (the ñusage on the stageò) to being a facilitators in the students construction of their own knowledge (the ñguide on sideò). Some examples of collaborative concept learning activities are seminar styles presentations, discussion, debates, group projects, simulation and roles playing exercises and collaborative compositions of essay, examination questions, stories or research plans (Hiltz, 1994, Jobring, 1999).

According to Abrami and Wandersee (1995), collaborative concept mapping or learning is an instructional strategy that is characterized by structured group work that support various form of thoughtful discussion and dialogue among group members. Collaborative concept mapping has been found to enhanced achievement and productivity significantly more than competitive or individual learning structures. Slavain (1990), also found that collaborative methods that employed group rewards are superior to other forms of reward distribution. Others add that it is the task focused interactions among students, which enhances learning by creating conflicts, by exposing to students to high levels of thinking and engaging them to high levels of interactions (Webb, 2001). In Piagetian cognitive development theory (Piaget, 1966), an individualôs cognitive structure can develop through the resolution of cognitive conflict that are generated during peers interactions. Cognitive processing of interactions which in turn modifies the individual learners cognitive structure (Brandon and Hollins, 1999). According to Mlilies (2002), collaborative learning helps students foster not only learning, but also positive outcomes such as increased self esteem, respects for others and civility. Ashman and Cillies (1997), indicated that the necessity of training students in group work and found that the trained groups are constantly more cooperative and helpful to each other than non-trained groups and become more responsive and active learners during group work. Training in how to collaborative teaches interpersonal skills and

knowledge about how to listen and contributes to discussion and establishes expectations about an appropriate of interactions.

Collaborative concept mapping can assist the students in taking more responsibility for their own conceptual learning during study time and provides students with the opportunity to talk about and explains phenomena (Boxtel et al, 2002). Leister and Kober (2008), identified collaborative concept mapping or learning as a successful teaching approach as it enhance the effectiveness of both short term learning in terms of subject/materials being studied and long-term learning in terms of cognitive skills and self esteem, when collaborative learning is compared with individual or competitive learning scenarios, it can be seen to help students perform better by increasing their ability to resolves problems and helping develops personality traits that will be benefits to them in both their academics and professional lives. It further empowers the individual and give him/her skills to live a more independent, collaborative and pleasant lives. However, when learners work in groups on the same task simultaneously, thinking together about demands and tackling complexities and positive cognitive outcome are demonstrated (Dillenbourg, 1999).

Furthermore, collaborative concept mapping or learning a situation in which two or more people learn or attempt to learn something together. Unlike individual learning, people engage in collaborative learning capitalise on one anotherôs resources and skills (asking one another for information, evaluating one anotherôs ideas, monitoring one anotherôs work etc). More specifically,

collaborative learning is based on the model that knowledge can be created within a population where members actively interact by sharing experiences and take on asymmetry roles. Put differently, collaborative learning refers engage in a common task where each individual depends on and is accountable to each other. These include both face to face conversation and computer discussion (online forums, chartrooms etc). Often, collaborative learning is used as an umbrella term of a variety of approaches in education that involves joint intellectual effort by student or students and teachers. Thus, collaborative learning is commonly illustrated when group of students work together to search for understanding, meaning or solution or to create an artifact or product of their learning.

Collaborative learning activities can include collaborative writing, group projects, solving problem, debates, study terms and other activities. The proponents of collaborative learning however claims that active exchange of ideas within small groups not only increase interest among participants but also promotes critical thinking.

Individualistic concept mapping is an innovative teaching strategy or attempt to study science concepts alone without the helps of other students. It is a learning process in which individual students learn and work independently, to promote interactions, and to encourage student metacognition skills in order to improve learning. The design of the individual courses allows individual exploration coupled with reflection as well as the encouragement of good

learning behaviours, then meta-cognition can be enhanced and good learning can results. (Fetherson, 2005, p. 15). Individual maps are more diversified in terms of visual representation; that collaborative maps score higher in all five dimension; considered in the analysis and that statistical difference are found when applying the Novak and Gowin (1984) formula to the concept maps due to the presence of more cross-links presented on groups maps when compared to individual ones.

According to Reese (2004), stressed that in an individualistic concept mapping, meaningful learning occurs when an individual assimilates existing cognitive structure of an individualôs prior knowledge with something they already know or have experienced, thereby altering what is known. Individualistic concept mapping helps students to become the foundation for a portfolio evaluation of his/her performance. These serve as a mechanisms to determined the levels of understanding students have about the topic being studied (Vitale & Romance, 2000). Rose and Meauby (1991), also views individualistic concept mapping as an assessment tools as it enables the students to express the conceptions (or their misconceptions) and can equally help the instructor to diagnose the misconceptions which make the instruction ineffective.

Wandersee (1996), described individual learning as a change in which instruction is responsive to the learnerôs need and value in individual learning, the learner has the choice of subjects matter and time for the learning, selection

of goal, and criteria for evaluation. In recent years, instructional emphasis has shifted from the instructor to the learner. The learner can use computer assisted instructions, school learning centres equipped with radio, television, Newspaper and other material which are suitable for individual use in learning science. According to Kinchin (2005), individual concept mapping serves as a strategy to help learners organize their cognitive framework into more powerful integrated patterns. In this regards, it serves as a meta-knowledge and meta-learning strategy. Indeed, many researchers on concept mapping have proved that individualistic concept can improved meaningful learning and also help learners to learn independently (Cliburn, 1990); Trowbridge and Wandersee, 1996). Thus, it offers a students through knowledge of their own learning (Leauby and Brazina, 1998). In this regards, it is a useful meta-learning strategy in relations to helping student.

In a nutshell, individualistic concept mapping therefore, encourages the learners to become actively involved in the cognitive learning process by asking the learners to visualise and actualise ways that new information is linked to established concepts and ideas. It encourages better understanding, promotes creative thinking, the ability to better apply knowledge in novel situations and aids in problem-solving. It will be fruitful exercises to look at whether sex of students (gender) has effect on their achievement in biology when taught with collaborative and individualistic concept mapping as an instructional teaching strategies.

Concept of Gender in biology (science)

The new Websterôs Dictionary of English language has defined gender as the classification of people into male and female. It could also refers to the socially constructed roles, behaviours, activities and attributes that a given society considered appropriate for men and women. Gender is a broad analytical concept which draws out womenôs roles and responsibility in relation to those of men (Mulemwa, 1991). Okeke (2007), refers to gender as the socially/culturally constructed characteristics and roles which are ascribed to males and females in any society. Males are assigned such attributes as bold, aggressive, logical in reasoning, intelligent, self-confident, dominating/assertive, tactful, economical in use of words etc, while females are assigned the opposite attributes such as fearful, timid, gentle, illogical in reasoning dull, passive, submissive, tactless and talkative.

According to Ann-Yao (2003), the concept of gender designates behaviours, attitudes, roles, status etc that a societies assign to the male and female gender groups in a given social-cultural setting to govern the relationships among the sexes. The issue of gender and academic achievement has become contentious and placed in the front burner in educational discussions and researcher in recent time. There are diverse opinions on gender differences and intellectual abilities. Literature reviews three distinct views on gender and academic achievement has become contentious and placed in the front burner in educational discussions and researcher in recent time. There are

diverse opinions on gender differences and intellectual abilities. Literature reviews three distinct views on gender and academic achievement. The first view is on those who argue in favour of male superiority in academic achievements, the second views is on those who believes on female higher academic achievement, while the third is on those who submit that intellectual ability are genetic endowment is the major influential factor in academic achievement. In view of this, research report on the issue of gender related difference in the achievement and classroom behaviours have continued to be inconsistent. Some studies however, reported that there are significant differences in the academic achievement of gender groups, while the result of some studies showed that there was no significant difference on the basis of gender.

Adigwe (1992), in a study on gender difference in chemical problem-solving among Nigerian students noted that boys perform better than girls in science. Wasogu (1995), also reported that boys perform better than girls in biology. Okeke (2001), also added that the perceived gender differences are innate but due to gender-stereotypism in the curriculum and instruction which is a reflection of such in the society in favour of the males. In their study on gender difference in intelligence test, Adedayo (1992) favoured the males in terms of better academic achievement. They instead acknowledge the existence of psychological differences between males and femalesò we declare therefore, that the better achievement of males as reported by this study is due to a

superior psychological predisposition of the malesò. Bolder and Levis (1996) cited in Okworo (2008) studied ñEarly sex differenceò of American pupils and students. The result showed that boys performed better in academic achievement than girls, in all science and mathematics related subjects, but that the girls had better performance in reading.

Francis and Skelton (2005), reported that the general trend is for young women to continue out-performing their male counterparts right up to degree levels. They posited that boys are generally doing less than girls in terms of examination performance and that inspite of much effort on the part of policy maker and many teachers, this gap remain evident. Utibe (2003), also supported girls better academic achievement. The work stated that girls are more likely to achieve better grades than boys and score higher in science test. A study by Alonge (1995) cited in Okworo (2008) showed that female students usually develop a lukewarm attitudes toward mathematics problems than their male counterparts. This is also the observation of Galadima (2003), which reported that girls lack the strength, vigour and charity in mind for subjects that are presumed masculine.

Often times, female students usually feel isolated or ignored in a science classes and this may contribute to gender inequality in science achievement. In the light of this, there has been recent emphasis on strategies to remedy inequalities and improved gender achievement in science and biology in particular as a means of attain sustainable development. Therefore, this has

created a need for the researcher to research on the methods of teaching that may not be gender biased in the area of biology.

The problem of girls and science is far beyond their low participation. By opting out of science courses, girls find it difficult to pursue carrier in scientific profession. As a result of this prevailing situation, girls do not contribute to the scientific and technological talent as their male counterparts do. Secondly, by failing to become scientifically literate, girls are denied the basic understanding of science which will help them in future as parents, citizens as well as decision-makers. To this effect, the problem of girls and science has far-reaching implication in the society.

In view of this, it is important that school should try to do everything possible to encourage girls to study science. Hence, the present study is directed towards developing an innovative teaching methods programme that will sensitized science teachers to gender issues in science classrooms and therefore increases studentsô achievement in Biology. This help to bridge gender gap in science subjects.

Concept of Achievement in Biology (science)

Achievement in science is very important in teaching and learning of science and it refers to students cognitive achievement, which is measured in terms of pass or fail science examination. Indeed, the overall poor achievement in the sciences among secondary school students raises doubts on the efficacy of teaching methods utilized by teachers in schools. Poor achievement in science

and its effects on the economy of the country has been the major concern of various science educators, educationist and other institutions directly concerned in the educational system. Poor achievement and performance in science especially biology implies obtaining low or failure grades from D7 to F9 in science D7, E8 and F9. This is because employer of labours and institution of higher learning do not accept this grade as passes. Biology is the core subject for science because it deals with all living things and their existence and relationship with one another and with non-living things.

In this regards, studies by (Rossiers, 1990; Ivowi, 1995; Ezeudu, 1995 and Ogunleye, 2002), indicated that students achievement in various aspect of science is very poor. The West African Examination Council Chief Examiners reports (2002), further showed improvements in the subjects, but students achievement in biology is still poor due to improper exposure and non-acquisition of relevant skills and inadequate exposure to practical work by the teachers.

Ogunleye (2002), also lamented over the declining popularity of the physical and biological sciences evident in various low enrolment patterns is school. According to Umeoduogu (2000), stressed that all blamed under achievements in science on conceptual difficulty in understanding science concepts (Adeyegbe, 1993 and Jegede, 1996). Report by Moore (2002), blamed students poor achievement and performance in science on ineffective teaching methods adopted by secondary school teachers. The science teachers

Association of Nigerian (STAN) in its 1986 an annual convention outlined the following major problems as some of the causes of mass failure (under achievement) in science subjects in Nigeria. These are attitudinal problem of students, cognitive and social-economic problems of teachers, administrative problems of policy makers and psychometric problem of examination.

However, efforts to help secondary school students improve in their science work and in their choice of careers should not be the sole responsibility of one person (The science teacher), staff, subject teachers, specialists, counsellors and so on. For instance, Bruner (1960) and Ali (1998), suggested that positive attitudes toward enables secondary school students teachers to achieve superior academic gains in their science course. It is therefore, necessary that aspect of schooling that secondary school students are made to have favourable attitudes toward school, one way of doing this is through encouraging them to participate in interesting science activities. In the light of this, concept mapping as innovative teaching strategy will go a long way in making the teaching of biology purposefully, exiting and participatory, thereby improving students achievement in biology. Therefore, the present study is hoped to greatly improve students achievement in biology as the teaching methods will encourage the learners to be actively involved in the learning process.

Conceptual Framework of the Study

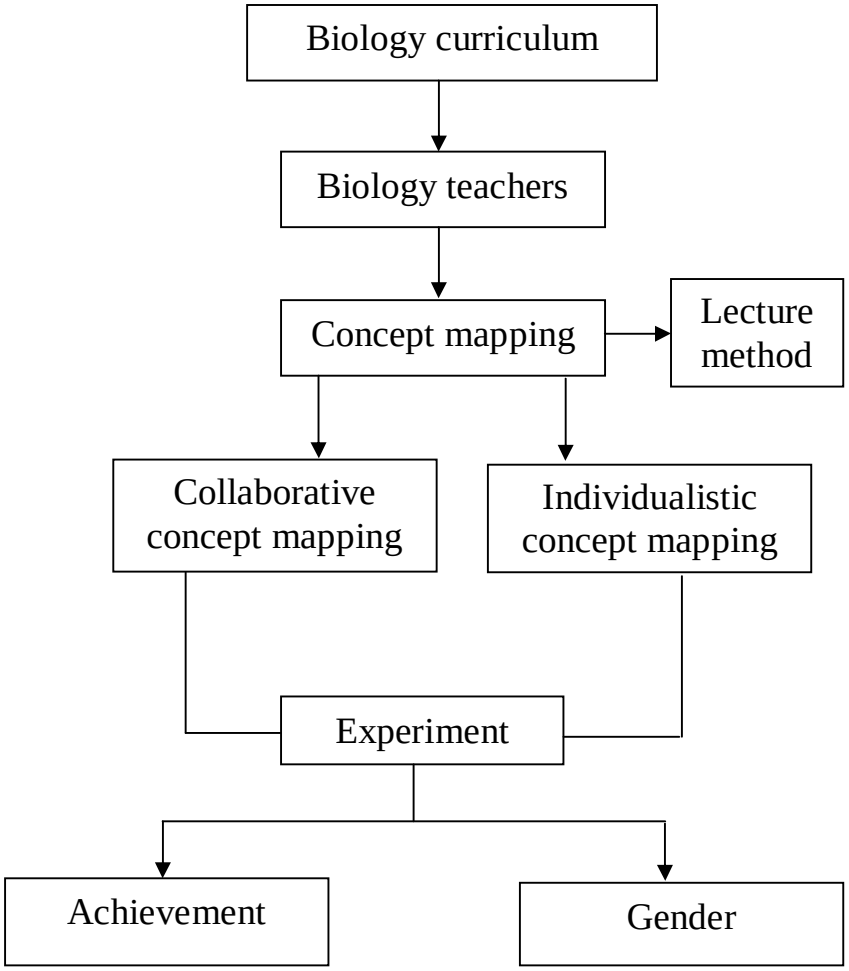


Figure 1: Schematic diagram of conceptual framework for concept mapping teaching techniques, designed by the researcher.

Diagram one above indicated that the biology teachers derive his/her lesson from the curriculum and teach same with concept mapping technique (collaborative and individualistic). The biology student will be exposed to experimental conditions peculiar to each concept mapping technique. The most appropriate technique for teaching biology topic (skeletal systems and excretory system) is expected to yield higher students achievement which in turn result into a competent Biologist.

Theoretical Framework

Bruner's Constructivist Theory

This theory was propounded by Jerome Bruner in 1960. Constructivist theory is based upon the study of cognition. The major theme in this theory is that ñlearning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge (Kearshley, 1994). Cognitive structures are used to provide meaning and organization to experiences and allow individual to go beyond the instruction given. According to Bruner, the instructor should try and encourage the students to construct hypotheses, make decision and discover principles by themselves (Kearshley, 1994). The instructor tasks is to translate information to be learned into a formats appropriate to the learnerôs current state of understanding and organized it in a spiral manner, so that the students continually builds upon what they have already learned.

Bruner (1966 cited in Kearshley, 1994) states that a theory of instructions should the following aspects, the most effective sequences in which to present materials, the way in which a body of knowledge and structured so that it can be most readily grasped by the learner. Bruner can be applied to instruction as (Kearshley, 1994b) summarizes by applying the following principles: instruction must be concerned with experience and context that make students willing and able to learn (readiness), instruction must be structured so that it can be easily grasped by the student, (spiral organization) and instruction should be

designed to facilities extrapolation and or fill in the gaps (going beyond instruction given). Good methods for structuring knowledge should result in simplifying, generating new propositions and increasing the manipulation of informations. In this regard, Bruner further outlined four topics related to teaching and learning science, particularly in Biology. These are discovery, intuition, analytical language and readiness. Thus, this theory encourages the learner to be inquisitive, explorative, innovative and to engaged in self-discovery in the process of learning.

Brunerôs constructivist theory is appropriate and related to the present study because concept mapping and its forms is designed in such a way that they ensure continuity of understanding and that all the above qualities are attained by the learners the learners. It also encourages the learners to discover the key concepts and concept relationships embedded in each biology topics. Secondly, science is a very important aspect in the development of any nation. One way of appreciating science teaching and learning is through effective method of instruction. A growing of evidence indicates that activity-based approaches to teaching science are more effective than traditional methods, in producing a wide range of desirable students outcome at all grade (Hartshom and Nelson, 1990).

The challenge to science teaching is to create a learning situation that is now interactive. This require a change from reliance on a single teaching method to the acknowledgement that there are considerable advantages in using

a variety of concept mapping technique strategies by a move away from a teacher-centered view of the classroom toward a student centered perspective. Therefore, the present study as a constructivist teaching approach is one of the activity-based teaching strategies for effective teaching of Biology as they believe that achieving the aims for science education is dependent not only on what is taught but how it is taught.

Gagne's Hierarchical Theory

This theory was propounded by Robert Gagne in 1962. Gagne contends that learning tasks for intellectual skills can be organized in a hierarchy according to complexity stimulus recognition, response generation, procedure following, use of technology discrimination, concept formulation, rule application and problem solving. The primary significance of this hierarchy is to provide direction for instruction so that they can identify ñprerequisites that should be completed to facilitates learning at each levelsò Gagne outline the following nine instructional events and corresponding cognitive processes (as cited in Kearshley, 1994), gaining attention (reception), stimulating recall of prior learning (retrieval), informing learners of objective (expectancy), presenting the stimulus (selective perceptions), providing learning guidance (semantic encoding), eliciting performance (responding), providing feedback (reinforcement), assessing performance (retrieval), exchange retentional transfer (generalization). Gagne nine instructional event and corresponding cognitive processes can serve as appropriate media.

In applying this instructional events, Kearshley, (1994) suggests keeping the following principles in mind. Learning hierarchies define a sequence of instructions, learning hierarchies define what intellectual skills are to be learned, different instructions is required for different learning outcomes. Instructional designing should anticipate and accommodate alternate learning styles by ñsystematically varying teaching and assessment methods to reach every students (Stemberg, 1994 as cited in Gordon, 1998, 227). Gagne further claims that people learn in many ways spanning the gamut from behaviourist, Skinnerian type conditioning to more cognitive processes. He suggests however that there are two steps that are critical in applying his theory. The first is to specify the type of learning outcome and the second is to determine the events of learning. It is important to note that Gagneôs theory is more closely aligned to an instructional type theory instead of learning theory. That is because he has formulated an outline that describes condition under which one can intentionally arranged for the learning of specific performance outcome (Perry, 2001).

Robert Gagneôs theory supports the following ideas: learning causes an observable change in the learner, skills should be learned one at a time, each new skill learned should build on previously acquired skills and learning and knowledge are both hierarchical in nature (Braxton, Bronico & Loons, 1995). Gagneôs hierarchical theory also argued that there are hierarchies of learning that one hierarchy differed from the other even though they may be related to one another in sequence. This lead to programmed learning methods. Gagneôs

theory categorized the factors that potentially affect learning of biology into two broad areas. These area instructional variables and topical order (Obodo, 1990).

Instructional variables refer to the set of functions which are carried out in learning a new topic, while topical order refers to the sequence of subordinate knowledge. In other words, an individual will not be able to learn a particular topic if he has failed to learn any of the subordinate topics that support it. In the light of this, Gagne theory is related to the present study as concept mapping and its two modes (collaborative and individualistic) teaching approach or strategies utilized the topical or hierarchical order of Gagne in which the more general, more inclusive or most abstract concepts are hierarchically placed at the top of the map, while the more concrete, more specific and less inclusive concepts are arranged below them. The whole arrangement are in sequence and hierarchically according to Gagneôs theory.

Ausubel's Theory (Assimilation Theory)

Assimilation learning theory was propounded by David Ausubel in 1963. This theory focuses on what Ausubel describes a meaningful learning. This is a process where new information is related to an existing relevant aspects of the individualôs knowledge structure. This components of his theory fits with concepts of short and long term memory in cognitive information processing. His theory integrates the cognitive, affective and psychomotor. He identifies two aspect of learning ï rote learning and meaningful learning. Rote learning is learning but it is not high level learning and has implication for recall and

transferability, while meaningful-non-arbitrary, non-verbation substantive incorporation of new knowledge. Meaningful learning has three requirements which includes the learnerôs relevant prior knowledge, the teacher constructing meaningful materials and the learners choosing to use meaningful learning.

Ausubelôs theory is concerned with how individual learn large amount of meaningful materials from verbal/textual presentations in a school setting in contrast to theories developed in the context of laboratory experiments. According to Ausubel (1963), learning is based upon the kind of super ordinates representational and combinational processes that occurs during the receptions of informations. A primary process in learning is subsumption in which new materials is related to relevant ideas in the existing cognitive structures on substantive, non-verbation basis. A major instructional mechanism proposed by Ausubel is the use of advance organizers. These organizers are introduced in the advance of learning itself and are also presented at a higher level of abstraction, generality and inclusiveness, and since the substantive content of a given organizer or series of organizer is selected on the basis of its suitability for explaining, integrating and interrelating the material they precede. This strategy simultaneously satisfies the substantive as well as the programming criteria for enhancing the organization strength of cognitive structure.

Ausubel emphasized that advance organizers are different from overviews and summary simply emphasis key ideas and are presented in the same level of abstraction and generality as the rest of the materials. Organizers

acts as subsuming bridge between new learning materials and existing related materials. Organizers are those ideals and materials that facilitate meaningful learning. When they are presented before learning experience, they are called advance organizers. On the other hand, when they are presented after a learning, they are called post-organizers. According to Okoye (1987), revealed that organizers subsume the existence of the learners existing body of previous experiences out of which he interacts with the new learning. Knowledge does not exist in isolation, they are related. Thus, learners always tries to associate the new learning materials with previous experiences. It is this associative meaning that facilitate learning according to Ausubel.

The use of concept mapping instructional strategy or tactics is embedded within Ausubelôs learning theory which emphasized on meaningful learning. (Okebukola and Jegede, 1988; Horton, etô al, 1983), stressed that the best learning theory that focus on concept and prepositional learning as the foundation on which individual construct their own perculiar meanings is the one proposed by David Ausubel. In Ausubelôs theory the peculiar primary focus is meaningful learning as contrasted with rote learning. Thus, Novak etô al (1983), have shown that this theoretical structure can be utilized to develop concept map which can be used as practical teaching and learning strategies. Based on the learning perspectives as described above, Ausubelôs theory of assimilation is related to the present study as the concept mapping and its modes (collaborative and individualistic), one of the instructional teaching method

could offer as a means for course design, which promotes the development of a structured course within a good pedagogical framework which will eventually foster meaningful learning and subsequently improved students achievement in Biology. This present study, effect of two modes of concept mapping will also offer great opportunity for the learners and encourage them to be actively involve in the learning process by relating new knowledge to prior knowledge as the long standing goal of education has been that students learn science concepts in a meaningful way and apply them to solve real problems (Briscoe, 1993). Concepts can be learn meaningfully when teachers ensure that materials to be learnt match the cognitive level or ability of students and or linked with learners acquired hierarchically organized framework of specific concepts, each of which permit them to make sense of new experiences.

Empirical Studies

Studies on concept mapping instructional strategies

Some researchers have evaluated the effectiveness of instructional strategies as exemplified by the concept mapping techniques in different subject areas.

Esiobu and Soyibo (1995), used 808 final year secondary school students to determine the ñeffectiveness of concept and vee mapping strategies in enhancing meaningful learning of difficult biology conceptò. The study also attempted to find out the appropriate class interaction pattern to tackle the

problem of large class in biology. A questionnaire, a paper and pencil test and attitudinal test were employed for data gathering by the researchers. The experimental group was given instruction on ecology and genetic, through concept mapping and vee mapping instructional strategies. Students in group were also made to construct their own individual concept maps on the topic of every lesson. The group maps data gathered were analyzed using ANOVA and ANCOVA statistical techniques. Results of the study indicated that experimental group performed better than control group in achievement test developed favourable attitude to ecology and genetic after treatment. In the light of this, students did recognized the benefit of being active learners. Again, this present study is posed to investigate the effect of two modes of concept mapping techniques on the students achievement in biology. To this therefore, it becomes pertinent to find out if the two modes of concept mapping techniques will provide similar effect on studentsô achievement in biology.

A study was also conducted by Ezeugo and Agwagah (2000), to determine the effect of concept mapping on students in Algebra in Nigeria. It is also determined the differential effect of concept mapping on the achievement of boys and girls in Algebra. Data were collected from 387 senior secondary school two (SS2) students selected randomly and were tested using Algbra Achievement Test (AAT). Concept map on quadratic equations and equalities were drawn and used for the study. The AAT, was validated and internal consistency was established for coefficient obtained was 0.67 and 0.86

respectively. Results of the study revealed that students exposed to concept mapping techniques achieved more in algebraic content than students who were not, male students in experimental group achieved more in the achievement test than the female students. It was recommended that mathematic teachers should be trained adequately in the use of concept mapping techniques and therefore, incorporates it as one of the techniques used in teaching mathematics. The above sited studies indicate that achievements and other academic gains are correlates of teaching methods and techniques used in impacting knowledge on students. It thus hoped that the present study will indicate the best technique for teaching biology to students.

Stensvolid and Wilson (1992) identified the effects of concept mapping in conjunction with chemistry laboratory. They used 180 high school and control groups. Both groups were found to be equivalently in terms of general ability as measured by IOWA test of Education Development (ITED). The result showed that no significant difference, while only group scores on comprehensive test were compared. But when (ATI) aptitude and treatment interactions was evaluated, treatment and control group regression scores were compared with analysis of covariance (ANCOVA). It was found to be significance difference (p.005). it was found that laboratory instruction was more effective with concept mapping because it reduced attention to distraction within activities and help to improve students comprehension of related concepts and improved achievements. From their study, it was found that concept mapping facilitate

learning by making students active in learning and subsequently reduced distraction. One major trust of the present study is to ascertain the influence of teaching technique on achievement of learnt skills. The relationship of achievement and teaching methods is also expected to be discovered in the study.

Recently, Bello (1997), conducted a study among over 400 Nigerians secondary school students to determine the comparative effects of two forms of concept mapping instructional strategies on students achievement in evaluation. A combination of clinical interviews protocol, easy and multiple choice tests were employed as data gathering instruments. The school were randomly selected. Analysis of variance (ANOVA) and t-test statistical technique were employed to analysed data gathered in this study. Results indicated that the two forms of concept mapping instructional strategies improved studentsô achievements and reduced students misconceptions and alternative conceptions of the theory of evolution. The above study corroborated the ascertain that concept mapping instructional strategies have been persistedly noticed to be more effective than any traditional teaching method. The present study is therefore set to discriminate between two modes of concept mapping techniques (collaborative and individualistic) in order to determine the one that will yield more gains interms of the achievement of learnt skills.

Gabriel (2011), also carried out a study to investigate the academic performance in English language using concept mapping instructional strategy.

The population of the study involved all the students in senior secondary school (SS II) in Obio/Akpor local government area of River State. The non-randomized control intact class was used for the study. The sample consisted of a total of 202 students, made up of 124 males and 78 females. Two types of instruments: English performance test (EPT) and English retention test (ERT) was used. A reliability coefficient of 0.87 for both instruments by Kuder-Richardson formula 21 was established. The subject were pre-tested before exposure to the instrumental strategy and post-test administrated to the groups. The data collected were statistically analyzed using T-test and ANCOVA. The result obtained showed that no significant difference exist between the performance and retention of male and female students in English language taught with concept mapping instructional strategies. In the light of this, it is hoped that the present study, the two modes of concept mapping will greatly increase students achievement in biology.

Okebukola (1992), used 60 pre-degree biology students from Lagos State University to prove whether good concepts mapper might be good problem solver in biology. The result revealed a significant difference in their capabilities to solve problems. The boys and girls were significantly different in their problem-solving performance. The group interaction was significantly at 0.05 level. Newman Kenls Posthoc comparison showed the source of significant difference for the main effect to be in favour of concept mapping groups. The girls performed better than boys. It then concluded that good concept mapper

would be better and good problem solvers. In view of this, it becomes pertinent to find out if the two modes of concept mapping strategies will provide similar functions in the achievement of students in biology.

In another study conducted by Udeani (1993), the effect of concept mapping on biology achievement of senior secondary school learner using 131 students selected on the basis of past promotion examination, teacherôs rating and comments were randomly selected and assigned to expository and concept mapping techniques. Concept mapping group performed significantly better than expository group in post-tests. Also, that girl in concept mapping groups performed than their boys counterpart. In this regard, it is therefore, concluded that from the study that students taught biology with concept mapping strategy had greater gain in the achievement score than those taught with traditional instruction. In view of this, it becomes pertinent to find out if the two modes of concept mapping i.e. collaborative and individualistic concept mapping techniques will provide similar gain in the achievement of biology students when compared to another teaching strategy.

In general, therefore, it appears from the above discussions that students who use concept, mapping seems to make a greater gains than those who do not use concept mapping. However, despite the significant results recorded in other subject areas and biology, not much have been done using different modes of concept mapping in relations to students achievement using biology as a content

focus. Thus, the researcher still wanted to find out the effect of two modes of concept mapping on students achievement in biology.

Studies on Achievement in Biology (science)

Bello (1997), conducted a research to determine gender influence on students concept mapping ability and achievement in evolution. As a case study, only a small group of students participated in the study. A total of eighty seven second year senior secondary school students took part in the study. A slightly modified form of the evolution theory test was developed for data collection. Analysis of variance (ANOVA) and t-test are the common statistical techniques employed for data analysis. The population for the study was all the senior secondary school biology students in Kwara State of Nigeria. Results of the study however, indicated that there is no significant difference in the achievement in evolution of male and female high scoring students. In the light of this, the researcher in the present study will find out the effect of two modes of concept mapping in relations to students achievement in biology.

Okoye etô al (2010), investigated the effects of concept mapping and problem strategies on achievement in biology among Nigerian secondary school students. The study involved one hundred and thirteen (113) senior secondary school three student (SS3) randomly selected from three mixed secondary school, located in Delta North senatorial districts of Delta State, Nigeria were used as subject for the study. Instrument used for data collection was genetic achievement test (GAT). The experimental group was taught selected topics

using concept mapping and problem solving strategies, while the control group was taught using traditional lecture methods. The result of the showed that there is significant difference in achievement test between the students taught genetics using concept mapping teaching strategy than those taught lecture method. Therefore, it is pertinent to conduct a study on effect of two modes of concept mapping in relations to students achievement in biology.

Ezeudu (2009), also carried out a study to investigate the interaction of concept maps and gender on achievement of students in selected organic chemistry concepts. The study was a quasi-experimental design of non-equivalent design. The study was carried out in Nsukka Education zone of Enugu State. Four hundred and eleven (411) SS3 students were used. The result of the study showed that male students had a higher mean achievement score than the female students.

Ugwuadu and Nzewi (2012), investigated the effects of dialogic, peer and teacher-guided discourse patterns on student achievement in biology. The study also determined the influence of discourse patterns on male and female student achievement in biology. The design of the study was a quasi-experimental of non-equivalent comparative group design. A sample of 164 students (94 males and 70 females) from three intact classes in Yola Education zone of Adamawa State participated in the study. The three intact classes were drawn from three secondary schools selected through purposive sampling techniques. Discourse patterns were randomly assigned to intact classes in the sample schools. The

main instrument used for data collection was Biology Achievement Test (BAT) which was both face and content validated. The internal reliability coefficient of BAT was 0.75 established with Kuder-Richardson formula 20 ($K\text{-}R_{20}$) methods. Mean and standard deviation were used to answer the research questions, while ANCOVA was used to test the hypothesis. Results of the study revealed that the three discourse patterns enhanced students achievement in biology. In view of all this, it is pertinent to conduct a research on the effect of two modes of concept mapping (collaborative and individualistic) on students in relation to achievement in biology.

Studies on gender in science achievement

Some science educators have been worried about female achievement in science courses. The differences have been considered to pose problems in science and technology. For nearly two decades now, there has been researches into the nature and origins of gender difference in ability and achievement in sciences.

Duyilemi and Olusa (2009), carried out a study to investigate the influence of gender and constructivist-teaching strategy on student learning of biology in secondary school in Ondo State. Using the achievement test on selected biology concept (ATBC) and constructivist instructional guide in biology on pollution. Data were analyzed using means scores and ANOVA as well as multiple classification analysis (MCA) were used to test the entire hypothesis at 0.05 alpha level of significance. The reliability measures of the

test was established using Kuder-Richardson formula after pilot administration of the instruments 50 student s which are not part of the study. A reliability coefficient of 0.79 was got.

The finding showed that girls in the experimental group taught with constructivist strategy performed higher in biology after treatment and also there is no significant difference in the main effect of constructivist teaching strategy on overall girls and boys achievement in biology. In view of this, it is hoped that the present study will investigate the effect of two modes of concept mapping on student achievement in relation to gender in biology.

Olasehinde (2004), undertook to analyze gender difference in the quantity and quality of graduates produced in the University of Ilorin from her inceptions in 1976 to 2001.

The objective was to generate a rich data-base that has far reaching effects on policy and counseling initiatives. All first degree graduates in the university except law faculty constituted the sample. And using descriptive statistics and chi-square procedures. The results of the study revealed that there was a significant difference in the classes of degree obtained by male and female graduates in all faculties except in the Faculties of Arts and Sciences. The directions of observed differences in the two faculties was inconsistent with stereotypical expectations of male gender- fair admission and employment policies for optimum female empowerment. In this regard, the two modes of

concept mapping is hoped to provide a significant achievement between a male and female students in relation to gender in biology.

Joseph (1996), surveyed gender differences in senior secondary school chemistry performance in Akwa Ibom State. Two null hypotheses were used to guide the study. A sample of 380 students who had finished SS2 in three different secondary schools were used for the study. The schools were selected through stratified random sampling.

The instrument used was chemistry achievement test (CAT), which was administered to the students. The result revealed a significant difference in favour of males. This trend maybe attributed to the facts that females regard science as intellectual complex and task oriented. He found that male students achieved better than females irrespective of school locations. For this reasons, it becomes pertinent to find out the effect of collaborative and individualistic concept mapping in the mean achievement scores of male and female students in relation to gender groups in biology.

Iloputaife (2001), compared the achievement scores of SS1 male physics students with that of their female counterparts in a physics achievement test. The finding of the study revealed that the mean score of male physics students was 13.02 with a standard deviation of 4.09, while that of a female physics was 13.02 with a standard deviation of 4.00. This shows that male physics students differed from female students by 0.67. Even though that male students performed higher than female students, the difference is very significant.

However, many studies have reported that the differences in the academic achievement of the gender groups is biological in nature especially, the research conducted by Fennena and Sherma (1977), argued that the spatial and verbal abilities were respectively identified as being related to the development in the ñrightò and ñleftò hemisphere more than the females in the spatial reasoning. Hence, the male dominate in sciences and science related courses. The female on the other hand, make use of the left hemisphere of the brain than males. Therefore, they perform better than males in verbal tasks.

To this effect, the use of two modes of concept mapping i.e. collaborative and individualistic concept mapping as an innovative teaching strategies will serve as an attempt to redress the issue of gender gap on the students achievement in biology and as well as to create the need for adoption of innovative techniques method of teaching in biology. Such as the use of innovative teaching which may facilitate, develop, sustain and retain the studentsô achievement in relation to gender group in biology. Therefore, the degree at which the adoption of the collaborative and individualistic concept mapping teaching technique can affect achievement of gender groups in biology creates the need for this research work.

Studies on innovative teaching strategies

Several studies have been carried out on innovative teaching strategies.

Adesoji (1997), carried out a study to investigate the impact of problem solving instructional strategy on performances on students different ability

levels in chemistry. The performances on students in high, medium, and low levels in a problem-solving task were compared after exposing them to teacher directed problem-solving instruction. The findings showed that there are no significant differences in the performances of students in different levels after treatment. This shows that problem-solving strategies as a teaching innovations were effective in teaching students of different ability levels. In this regard, two modes of concept mapping as an innovative teaching techniques will hoped to be an effective teaching methods in the teaching of biology concepts.

In a similar study, Nnamdi et al (2010), investigated the effects of concept mapping and problem-solving teaching strategies on achievement in biology among Nigerian secondary school students. The study involved one hundred and thirteen (113) senior secondary schools randomly selected from three mixed secondary schools located in Delta State. The study utilized quasi-experimental design, pre-testing, post-test, treatment-design. The results of the finding showed that the students exposed to problem-solving performed significantly better than those exposed to traditional method of teaching. In the light of this, the present study is believed to improve students achievement in biology.

Duyilemi and Olusa (2009), in their own study, investigated the influence of gender and constructivist teaching strategy on students learning of biology in secondary school in Ondo State using achievement test on selected biology concept (ATBC) and constructivist guide in biology pollution. Data were

analyzed using means scores and ANOVA well as multiple classifications, hypotheses at 0.05 alpha level. Findings of the results showed that girls in the experimental group taught with constructivist strategy as innovative teaching strategies performed higher in biology after treatment on school type, the girls in both mixed and single-sex school benefitted equally from constructivist strategy.

Nyabuti etô al (2006), conducted research to investigate the effects of using cooperative concept mapping (CCM) teaching approach on secondary school studentsô motivation in biology. A non-equivalent control group design under quasi-experimental research was used in which a random sample of four co-educational school was used. The study sample comprised of 150 second grade students in secondary cycle two students in Gucha district control group students were taught the same biology contents but experimental group were taught using CCM approach, while control group were taught using regular teaching methods. Data were analyzed using the t-test, ANOVA and ANCOVA. The results showed that students exposed to CCM approach have significantly higher motivation than those taught through regular method of teaching. All the above sited studies indicates that achievements and other academic gains are corolates of teaching methods and techniques used in impacting knowledge on students. It thus hoped that the present study will indicate the best techniques for teaching of students in biology.

In another study by Ndioho (2007), investigated the relative effectiveness of constructivist-based instructional mode on senior secondary school students achievement in biology in Obio/Akpor local government area of Rivers State. The study adopted a quasi-experimental design of non-equivalent control group involving two groups. A sample of 240 SSII biology students from four secondary schools, two mixed schools, one boys school and one girls school was randomly selected. From each school, 60 students were selected and divided into two groups of 30 students in each groups. One group was assigned to experimental group and the other the control group. A genetic achievement test with reliability coefficient was used to measured the students achievement before and after the treatment. Analysis of the data collected was done, using mean simple percentage, standard deviation and t-test. Results showed that constructivist based instructional model was significantly more effective in teaching and increasing biology achievement than the conventional lecture methods. The above study showed that students taught with innovative teaching methods had a greater gain in the achievement score than those taught with traditional teaching methods or instruction. The effect of two mode of concept mapping teaching strategy on achievement of students in biology when compared to another form of traditional technique of teaching is one major concern of the present study.

Ibe and Nwosu (2003), also carried out a study to investigate the effect of guided inquiry and demonstration method of teaching on science process skills

acquisition among secondary school biology students. The design of the study was quasi-experimental, specifically the non-equivalent pre-test, post-test was used. One hundred and fifty (150) senior secondary one (SS1) biology students in co-educational schools formed the sample of the study. Three (3) group co-educational schools were randomly drawn from seventeen (17) co-education secondary schools in Nsukka local government area of Enugu State. Intact class were randomly assigned to two experimental groups and a control groups. The experimental groups one and two were taught using guided-inquiry and demonstrations methods respectively. The control groups students were taught using conventional methods. A test of science process skills acquisition (TOSPSA) of twenty items was developed and used in obtaining data on students. Data were analyzed using mean and standard deviation to answers research questions. Analysis of covariance (ANCOVA) was used to test hypothesis at 0.05% level of confidence. The results revealed that students taught using guided-inquiry methods performed significantly better than those taught through demonstration and conventional methods.

Ogundola (2011), also carried out a study to determine the comparative effect of guided and structured inquiry techniques on the performance, interest and retention of motor vehicle mechanics work students in technical colleges. The design of the study was a quasi-experimental research design, precisely, pre-test, post-test non-equivalent control group design which involved students in their intact classes. The population of the study was 195 year two students of

motor vehicle mechanic work (MVMW) in the technical colleges in Ekiti State. The instrument used for data collection were the motor mechanic cognitive achievement and retention test (MMCART), and motor mechanic interest inventory (MMII). The reliability coefficient computed was 0.85; the coefficient of internal consistency was 0.78. Mean was used to answer research questions, while ANCOVA was employed to test the hypothesis. The results revealed that the guided inquiry instructional technique as an innovative teaching strategy is more effective in improving students cognitive and psychomotor achievement of students. Therefore, in views of all this, it is pertinent to conduct a study on the effect of two modes of concept mapping instructional strategies on students achievement in biology namely individualistic and collaborative concept mapping in order to determine its efficacy. Furthermore, the use of concept mapping and its various forms as an innovative teaching strategies or methods in educational institutions has the potential not only to improve, learning but also to empower people, strengthen governance and galvanize the effort to achieve the human developmental goal for the country and subsequently improve science and technological advancement for the country.

Summary of Review of Related Literature

Advancement in science and technology has created changes in all aspect of society. Therefore, educational systems around the world are under increasing pressure to use innovative teaching methods that will elicit thinking to teach students the knowledge and skills they need to function effectively in

the world. Essentially, the literature review covered conceptual framework, theoretical framework, and related empirical studies on concept mapping instructional strategies.

In conceptual framework, the researcher vividly discussed concept of teaching and learning, concept of science teaching, traditional method of teaching, innovative teaching strategies, concept of gender, achievement, and concept mapping instructional strategy, (collaborative and individualistic concept mapping). From the discussion, the results of the literature review however, indicated that concept mapping instructional strategy and its various form i.e. collaborative individualistic concept mapping is an excellent device which shows visually the hierarchical relationships between concept within the structure or segment of a discipline. The result further showed that concept mapping was developed by Novak and his graduate students and is based on Ausubelôtheory of cognitive learning.

In theoretical framework, psychological theories and learning related to concept mapping instructional strategies which was propounded by the following philosophers like Gagne hierarchical theory, Brunerôs theory and Ausubelôs theory was also discussed by the researcher. The theories showed that their principles have been adopted within the concept mapping approach, it also revealed that the use of concept mapping tactics is embedded within Ausubelôs learning theory which emphasized on meaningful learning. This allows learners

to consciously and explicitly tie new knowledge to relevant concepts or preposition already possessed.

Furthermore, under empirical studies, studies on concept mapping, studies on achievement, studies on gender in science and studies on innovative teaching strategies were also discussed. The study however, reported that concept mapping is a potent instructional tool for promoting meaningful learning. It has been adopted by several researchers who have employed it at all levels in different discipline. The question then is this, will two modes of concept mapping i.e. collaborative and individualistic concept mapping be a potent instructional tools for promoting or improving students achievement in biology? Similarly, genders gap in science achievement has been also reported. Girls generally score below boys in measure of science achievement. Many reasons have been attributed to many girls inability to do well in science. One of such reasons for genders difference in biology and science achievement in gender is attributed to the ways science is taught in our secondary schools and tends to contribute significantly to the gender-gap in science achievement. As a result of this, there has been an increasing low level of achievement in biology. In this regards, several studies have attributed this problem of low achievement in biology to poor teaching methods adopted by teachers, thus advocating for more viable methods and one of such method is the use of collaborative and individualistic concept mapping techniques.

To this effect, here lies the problem of teaching methods or strategies which this study intends to address. Therefore, the researcher tends to investigate the effect of two modes of concept mapping i.e. collaborative and individualistic concept mapping on students achievement in biology. Conclusively, it is obvious from the review of related empirical studies that, a lot of research has been conducted on concept mapping instructional strategies or method. However, to date, no studies within the reach of the research have compared studentôs achievement in Biology using two or different forms of concept mapping as an instructional teaching method in Nigeria. Therefore, the study on the effect of two modes of concept mapping in the comparison of studentôs achievement in Biology is necessary.

CHAPTER THREE

RESEARCH METHOD

In this chapter, the procedures adopted for the study are presented under the following sub-headings: design of the study, area of study, population of the study, sample and sampling technique, instrument for data collection, validation of the instrument, reliability of the instruments, method of data collection and methods of data analysis.

Design of the Study

The design of this study is quasi-experimental design. Specifically, the non-equivalent control group design was adopted. This is because intact classes were used for the study, so there was no randomization of the subjects. The design according to Ali (1996), is considered appropriate because it establishes a cause and effect relationship between independent and dependent variables.

According to Gall, Gall and Borg (2007), quasi-experimental design can be used when it is not possible for the researcher to randomly sample the subject and assign them to treatment groups without disrupting the academic programme of the school involved in the study.

The design of the study is represented symbolically as follows:

$E_1 = O_1 X_1 O_2$

$E_2 = O_1 X_2 O_2$

$C = O_1 O_2$

Where

E_1= Experimental group 1 treated with collaborative concept mapping

E_2= Experimental group 2 treated with individualistic concept mapping

O_1= pre-test for collaborative, individualistic concept mapping and lecture method group

O_2= post-test for collaborative, individualistic concept mapping and lecture method group

X_1= Treatment given to collaborative group using concept mapping (E_1)

X_2= Treatment given to individualistic group using concept mapping (E_2)

C = Control group

Area of the Study

This study was conducted in Apa Education zone of Benue State in Nigeria. Apa Education zone has total of 17 secondary schools. Apa Education zone was created from Otukpo Education zone in August, 1991. The zone is made up of Apa and Agatu Local Government Areas of Benue State and bounded as follow, to the North by Agatu Local Government Area, to the East by Gwer-West Local Government Area (all in Benue State) and to the west by Omalla Local Government Area of Kogi State.

Over the years it has observed that studentôs performance in biology in West African School Certificate (WAEC) in this area is usually very poor irrespective of the fact that this subject is a life science (WAEC Chief Examinerôs Report, 2002). This has therefore prompted the researcher to carryout this study in this area. This is the justification for the choice of the area.

Population for the Study

The population of this study consisted of all year two (SSII) senior secondary school biology students in Apa Education zone of Benue State for 2014/2015 academic session comprising 6,950 from the 17 senior secondary schools in Apa Education zone. The population of the students was obtained from the (office of vice-principal (Admin) in-charge of Admission of the 17 secondary schools in the zone).

Moreover, SS2 is not an external examination class and therefore, cannot be disorganized by the activities involved in external examination class. The choice of SS2 students is based on the fact too that they are much more settled and have spent sufficient time in terms of coverage of the syllabus. Furthermore, the topics to be used are found in SS2 biology curriculum of senior secondary schools.

Sample and Sampling Technique

A total of 360 SS2 students were involved in the study. The two local government areas that formed Apa Education zone are Agatu local government area and Apa local government area. Six schools out of seventeen schools in the two local government areas were selected using purposive sampling technique. The selection of these schools were based on the following criteria.

- Schools having biology teacher in SS2
- Schools with well equipped biology laboratory

Thus, the schools selected were classified into groups using simple random sampling technique to assign the classes into collaborative, individualistic and lecture groups respectively. In each of the six schools, one arms/streams of SS2 was randomly assigned to a treatment condition. In effect, the students from two arms/streams of SS2 in two schools constituted the collaborative group, students from the two arms/streams of SS2 from other two schools served as individualistic groups, while students from the two streams/arms in the remaining two schools formed the lecture groups.

Instrument for Data Collection

The instrument used for data collection in this study was Biology Achievement Test (BAT). The Biology Achievement Test covered the two units or topics taught during the study. These topics are skeletal system and excretory system. BAT is a multiple choice objective test developed by the researcher to measure students achievement on the unit covered during the study. In its final form, it contains 40 multiple choice objective test items with 4-options. The instrument is made up of two sections. A and B, section A contains demographic variables which include class, section, instruction, time while part B contains multiple choice objective question with its options. The test item in biology achievement test scored one mark for each question. A student scored a maximum of 40 marks and minimum of 0. Thereafter, the score of each child was calculated.

Validation of the Instrument

The Biology Achievement Test (BAT) was subjected to face and content-validation by three specialist, two in Science Education Department, University of Nigeria, Nsukka and one secondary school Biology teacher. Each validator was served with a copy of each of the instrument. Specifically, for face validation, the validator were required to examine and comment on the instruments in terms of structuring of the items (whether the items are clear or unambiguous), language level of the intended class SS2, clarity of the questions asked, appropriateness of the question, accuracy of the answers, arrangement of the items and appropriateness of the procedures.

Indeed, based on the comments of these experts necessary modifications were effected. Furthermore, the content validity of the instrument was established through the use of table of specification. The table of specification ensured adequate sampling of the content as well as objective levels. The table of specification for constructing the Biology Achievement Test (BAT) was developed by the researcher using the Biology curriculum. The table was used to specify the number of items that was developed in each of the two topics (skeletal system and excretory system). See appendix G page 160.

The lesson plans were also validated by three experts in the Department of Science Education in the Faculty of Education, University of Nigeria, Nsukka. The experts were specifically requested to examine the extent to which the lesson plans conform to the theoretical basis of the various teaching

methods. Furthermore, one secondary school Biology teacher took part in the validation of the lesson plans.

The teachers who took part in the validation of the lesson plans, were specifically requested to examine the lesson plans with respect to the extent to which:

- The lesson covered the units of study
- The lesson objectives were clearly stated.
- The objective were appropriate for the students level of study.
- Appropriate instructional materials were specified.
- The evaluation questions were intimately related to the contents and lesson objectives.

The comments of both experts and teacher were later used in rewriting the lesson plans.

Reliability of the Instrument

The instrument, Biology Achievement Test (BAT) was trial tested in Christ the King College, Ugbokpo. The researcher used the Christ the King College Ugbokpo, because the school was not among the schools to be used during the actual study. The research instrument was administered on 40 SS2 students of Christ the King College, Ugbokpo in Apa Education Zone. The data however collected from trial testing on BAT was used to calculate the reliability of the instrument.

For the purpose of determine the internal consistency of the instrument; the BAT was administered to 40 SS2 biology students during third term session. The reliability of the instrument was computed using Kuder-Richardson formula 20 (K-R_{20}). The estimate of internal consistency so computed for the instrument was 0.71. See appendix E page 157.

Kuder- Richardson 20 attempts to show whether each of the test items measures the same characteristics as every other items (that is homogeneity of test items). According to Nworgu (1992), this form of reliability was necessary since the score on the instruments would represent a composite attribute of the students. Secondly, K-R_{20} is applicable to items that are dichotomously scored such as BAT. Thirdly, the item are not of equal difficulty. Therefore, the use of K-R_{20} was considered necessary. Based on this figure 0.71, BAT was considered to be highly reliable.

Experimental Procedure

The pre-test was administered to all the groups (i.e. those that work collaboratively, individually and the control (group) on the same day with the help of research assistants. This is to know the level of achievement on the topics or units prior to the experimental intervention. The scripts were marked and recorded. The experiment was carried out by the research assistant who are their regular biology teachers in their various schools. Thereafter, the students in both experimental groups were taught skeletal system and excretory system using collaborative and individualistic concept mapping techniques, while the

control group were taught the same topics using the conventional lecture method. The experimental treatment lasted to last for six weeks of four periods per week. The experiment was carried out during normal school period. At the end of the experiment, the biology teachers also administered the post-test i.e. Biology Achievement Test to the subjects in the three groups.

Control of extraneous variables

The researcher adopted the following procedure in order to control some of the identified variables that may have effect on the dependent variables if left uncontrolled.

- *Experimental bias*: In order to control this variable, the researcher was not be involved in the teaching of both experimental group and control groups, the actual teaching was done by the regular Biology teachers under the supervision of the researcher.
- *Homogeneity of the instructional situation across all groups:* To ensure homogeneity of the instruction of the instructional situation across all groups, there was a training programme for all the teachers involved in the experiments.
- *Class instructions:* the research assistant was instructed not to give note or assignment to students so that the students will not exchange ideas outside the classroom.

Training programme for Teachers

The Biology lesson plans developed by the researcher were used in the training of teachers for the experimental group (collaborative and individualistic groups).

The training session was conducted in Christ the King College, Ugbokpo and lasted for 3 days. The session was in the evening from 4 ï 6pm to accommodate the teachersô working hours. There were 4 teachers for the experimental groups. The researcher handled the training.

The programme of activities for three (3) days were as follows:

Day One:

1. Short opening ceremony involving introduction of participants and the purpose of the training exercise.
2. Discussion focusing on teachers experience in teaching Biology.
3. Analysis of SSCE recent results and other evidences showing poor achievement in Biology.

Day Two:

4. Discussion with the researcher on the lesson plans.
5. Teaching skeletal system using collaborative and individualistic concept mapping strategies.
6. Teaching excretory system using collaborative and individualistic concept mapping strategies.

Day Three:

7. Continuation on the use of lesson plans for both experimental groups.
8. The procedures for administering the instrument (BAT).
9. Closing.

The researcher organized training workshops during which the four biology teachers from the sampled schools were taught on how to used collaborative and individualistic concept mapping techniques. The collaborative and individualistic concept mapping lesson plans developed by the researcher was used in the training of teachers for the experimental groups.

There were 4 teachers for the experimental groups (collaborative and individualistic groups) that participated in the training. Summarily, the teachers were instructed and trained on:

- The purpose of the research
- The skeletal system concepts taught
- The excretory system concept taught
- The use of the lesson plans for both conventional, collaborative and individualistic concept mapping techniques.
- The procedures for administering the instrument (BAT).

Method of Data Collection

The instrument was administered on the research subjects by regular Biology teachers. Similarly, at the end of the experiment, a post-test on Biology Achievement Test (BAT), was also administered on the same subject with the aid of Biology teachers. For each of the group, data for pre-test and post-test were recorded separately.

Method of Data Analysis

Data collected from pre-test and post-test were analyzed quantitatively. Mean and standard deviation were used to answer research questions, while Analysis of Covariance (ANCOVA) was used to testing the hypotheses at 0.05 level of significance.

CHAPTER FOUR
RESULTS

This chapter is concerned with the presentation of results from data analysis. The results are presented in tables according to the research questions and hypotheses that guided the study.

Research Question 1:

What are the mean achievement scores of students taught using collaborative concept mapping and those taught using conventional (lecture) method in biology?

Table 1: *Mean and Standard deviation of pretest and posttest scores of students taught using collaborative concept mapping and those taught using conventional (lecture) method in biology.*

Variable		Pre test		Posttest		Mean gain
Method of Teaching	N	□	SD	□	SD	
Collaborative Method	120	24.25	4.80	34.95	4.43	10.70
Lecture Method	94	19.13	7.96	23.63	7.03	4.50
Total	214	21.69	6.38	29.29	5.71	7.60

Result in Table 1 shows that the experimental group taught biology using collaborative concept mapping had a pretest mean score of 24.25 with a standard deviation of 4.80 and a posttest mean of 34.95 with a standard deviation of 4.43. The difference between the pretest and posttest mean for the experimental group was 10.70. The control group taught biology using lecture method had a pretest mean of 19.13 with a standard deviation of 7.96 and a posttest mean of 23.63 with a standard deviation of 7.03. The difference between the pretest and posttest mean for control group was 4.50. Results in table 1 also show that the total pretest mean score for both experimental and

control group was 21.69 with a standard deviation of 6.38 and a posttest mean of 29.29 with a standard deviation of 5.71. The difference between the pretest and posttest mean for the total group was 7.60. However, for each of the groups, the posttest means were greater than the pretest means with the experimental group taught biology using collaborative concept mapping having the highest mean gain. This is an indication that collaborative method of teaching has greater effects on studentsô achievement in biology than the conventional lecture method.

Research Question 2:

What are the mean achievement scores of students taught using individualistic concept mapping and those taught using conventional (lecture) method in biology?

Table 2: *Mean and Standard deviation of pretest and posttest scores of students taught using individualistic concept mapping and those taught using conventional (lecture) method in biology.*

Variable		Pre test		Posttest		Mean gain
Method of Teaching	N	□	SD	□	SD	
Individualistic Method	100	22.51	6.45	29.82	5.96	7.31
Lecture Method	94	19.13	7.96	23.63	7.03	4.50
Total	194	20.82	7.20	26.73	6.49	5.91

Result in Table 2 shows another experimental group taught biology using individualistic concept mapping had a pretest mean of 22.51 with a standard deviation of 6.45 and a posttest mean of 29.82 with a standard deviation of 5.96. The difference between the pretest and posttest mean for the experimental group was 7.31. The control group taught biology using lecture method had a pretest mean of 19.13 with a standard deviation of 7.96 and a posttest mean of 23.63

with a standard deviation of 7.03. The difference between the pretest and posttest mean for control group was 4.50. Results in table 2 also showed that the total pretest mean score for both experimental and control group was 20.82 with a standard deviation of 7.20 and a posttest mean of 26.73 with a standard deviation of 6.49. The difference between the pretest and posttest mean for the total group was 5.91. However, for each of the groups, the posttest means were greater than the pretest means with the experimental group taught biology using individualistic concept mapping having the highest mean gain. This is an indication that individualistic method of teaching also had greater effects on studentsô achievement in biology.

Research Question 3:

What is the comparative effect of collaborative and individualistic concept mapping on studentsô achievement in biology?

Table 3: *Mean and Standard deviation of pretest and posttest scores of students taught using collaborative concept mapping and those taught using individualistic concept mapping in biology.*

Variable		Pre test		Posttest		Mean gain
Method of Teaching	N	□	SD	□	SD	
Collaborative method	120	24.25	4.80	34.95	4.43	10.70
Individualistic Method	100	22.51	6.45	29.82	5.96	7.31
Total	220	23.38	5.63	32.38	5.19	9.00

Result in Table 3 shows the comparative effect of collaborative and individualistic concept mapping on studentsô achievement in biology. Result showed that the group taught biology using collaborative concept mapping had a pretest mean of 24.25 with a standard deviation of 4.80 and a posttest mean of

34.95 with a standard deviation of 4.43. The difference between the pretest and posttest mean for the experimental group was 10.70. The group taught biology using individualistic concept mapping had a pretest mean of 22.51 with a standard deviation of 6.45 and a posttest mean of 29.82 with a standard deviation of 5.96. The difference between the pretest and posttest mean for the experimental group was 7.31. Result in table 3 also showed that the total pretest mean score for both collaborative and individualistic group was 23.38 with a standard deviation of 5.63 and a posttest mean of 32.38 with a standard deviation of 5.19. The difference between the pretest and posttest mean for the total group was 9.00. However, for each of the groups, the posttest means were greater than the pretest means with the group taught biology using collaborative concept mapping having the highest mean gain. This is an indication that collaborative method of teaching using concept mapping has greater effects on studentsô achievement in biology than the individualistic method.

Research Question 4:

What is the effect of collaborative concept mapping on achievement scores of male and female students in biology?

Table 4: *Mean and Standard deviation of pretest and posttest scores of male and female students taught using collaborative concept mapping.*

Variable		Pre test		Posttest		Mean gain
Gender	N	?	SD	?	SD	
Male	66	24.18	4.63	35.26	4.77	11.08
Female	54	24.33	5.05	34.57	3.99	10.24

Result in table 4 shows that the male group taught biology using collaborative concept mapping had a pretest mean score of 24.18 with a standard deviation of

4.63 and a posttest mean score of 35.26 with a standard deviation of 4.77. The difference between the pretest and posttest mean scores for the male group was 11.08. The female group had a pretest mean of 24.33 with a standard deviation of 5.05 and a posttest mean of 34.57 with a standard deviation of 3.99. The difference between the pretest and posttest mean for female group was 10.24. Result showed that for each of the groups, the posttest mean scores were greater than the pretest means with the male group having higher mean gain. This is an indication that gender may have some influence on studentsô achievement in biology when taught using collaborative concept mapping in favour of male gender.

Research Question 5:

What is the effect of individualistic concept mapping on achievement scores of male and female students in biology?

Table 5: *Mean and Standard deviation of pretest and posttest scores of male and female students taught using Individualistic concept mapping.*

Variable		Pre test		Posttest		Mean gain
Gender	N	□	SD	□	SD	
Male	55	22.84	6.69	29.96	5.65	7.12
Female	45	22.11	6.18	29.64	6.38	7.53

Result in table 5 shows that the male group taught biology using individualistic concept mapping had a pretest mean score of 22.84 with a standard deviation of 6.69 and a posttest mean score of 29.96 with a standard deviation of 5.65. The difference between the pretest and posttest mean scores for the male group was 7.12. The female group had a pretest mean of 22.11 with a standard deviation of

6.18 and a posttest mean of 29.64 with a standard deviation of 6.38. The difference between the pretest and posttest mean for female group was 7.53. Result showed that for each of the groups, the posttest mean scores were greater than the pretest means with the male group having a slightly higher mean gain. This is an indication that gender may also have some influence on studentsô achievement in biology when taught using individualistic concept mapping in favour of male gender.

Hypotheses 1

H_{01}: There is no significant difference between the mean achievement scores of students in biology when taught using collaborative concept mapping and those taught using the conventional lecture method.

Table 6: Analysis of Covariance (ANCOVA) of studentsô Achievement in Biology taught using collaborative concept mapping and lecture method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6901.677[a]	4	1725.419	53.170	.000
Intercept	14936.500	1	14936.500	460.279	.000
Pretest Scores	3.425	1	3.425	.106	.746
Group	5804.257	1	5804.257	178.862	.000
Gender	128.458	1	128.458	3.959	.048
Group * Gender	41.036	1	41.036	1.265	.262
Error	6782.248	209	32.451		
Total	206044.000	214			
Corrected Total	13683.925	213			

The result in Table 6 shows that with respect to the achievement mean scores of students taught biology using collaborative concept mapping and those taught using the conventional lecture method, an F-ratio of 178.86 was obtained with associated exact probability value of 0.00. Since the associated probability value (0.00) was less than 0.05 set as bench mark for testing the hypothesis, the null hypothesis (H_{01}) was rejected. Thus, there was a significant difference between the mean achievement scores of students in biology when taught using collaborative concept mapping and those taught using the conventional lecture method. **Hypotheses 2**

H_{02}: There is no significant difference between the mean achievement scores of students in biology taught using Individualistic concept mapping and those taught using the conventional lecture method.

Table 7: Analysis of Covariance (ANCOVA) of studentsô Achievement in Biology taught using Individualistic concept mapping and lecture method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1995.949[a]	4	498.987	11.827	.000
Intercept	15086.698	1	15086.698	357.581	.000
Pretest Scores	1.995	1	1.995	.047	.828
Group	1735.425	1	1735.425	41.133	.000
Gender	92.745	1	92.745	2.198	.140
Group * Gender	54.043	1	54.043	1.281	.259
Error	7974.092	189	42.191		
Total	149566.000	194			
Corrected Total	9970.041	193			

The result in Table 7 shows that with respect to the achievement mean scores of students taught biology using individualistic concept mapping and those taught using the conventional lecture method, an F-ratio of 41.13 was obtained with associated exact probability value of 0.00. Since the associated probability value of 0.00 was less than 0.05 set as bench mark for testing the hypothesis, this means the null hypothesis (H_{02}) was rejected. Thus, inference drawn was that, there was a significant difference between the mean achievement scores of students in biology when taught using individualistic concept mapping and when taught using the conventional lecture method.

Hypotheses 3

H_{03}: There is no significant difference between the mean achievement scores of students in biology when taught using collaborative concept mapping and those taught using Individualistic concept mapping.

Table 8: Analysis of Covariance (ANCOVA) of studentsô Achievement in Biology taught using collaborative concept mapping and Individualistic concept mapping.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1542.495[a]	4	385.624	14.415	.000
Intercept	10443.180	1	10443.180	390.387	.000
Pretest Scores	90.631	1	90.631	3.388	.067
Group	1268.243	1	1268.243	47.409	.000
Gender	11.838	1	11.838	.443	.507
Group * Gender	2.916	1	2.916	.109	.742
Error	5751.432	215	26.751		
Total	241362.000	220			
Corrected Total	7293.927	219			

The result in Table 8 shows that with respect to the achievement mean scores of students taught biology using collaborative and individualistic concept mapping, an F-ratio of 47.41 was obtained with associated exact probability value of 0.00. Since the associated probability value of 0.00 was less than 0.05 set as bench mark for testing the hypothesis, this means the null hypothesis (H_{03}) was also rejected. Thus, inference drawn was that, there was a significant difference between the mean achievement scores of students in biology taught using Individualistic concept mapping and those taught using collaborative concept mapping with those students taught using collaborative method having a higher mean score in the posttest.

Hypotheses 4

H_{04}: There is no significant difference in the mean achievement scores of male and female students taught biology using collaborative concept mapping

The result in Table 6 shows that with respect to mean achievement scores of male and female students taught biology using collaborative concept mapping, an F-ratio of 3.96 was obtained with associated probability value of 0.048. Since the associated probability value of 0.048 was less than 0.05 set as bench mark for testing the hypothesis, this means that the null hypothesis (H_{04}) was also rejected. Thus, inference drawn was that, there was a significant difference in the mean achievement scores of male and female students taught biology using collaborative concept mapping with male students having a higher mean gain.

This result showed that collaborative method of teaching have some influence on studentsô achievement in biology with regards to gender.

Hypotheses 5

H_{05}: There is no significant difference in the mean achievement scores of male and female students taught biology using individualistic concept mapping.

The result in Table 7 shows that with respect to the mean achievement scores of male and female students taught biology using individualistic concept mapping, an F-ratio of 2.198 was obtained with associated probability value of 0.140. Since the associated probability value of 0.140 was greater than 0.05 set as bench mark for testing the hypothesis, this means the null hypothesis (H_{05}) was not rejected. Thus, inference drawn was that, there was no significant difference in the mean achievement scores of male and female students taught biology using individualistic concept mapping.

Hypotheses 6

H_{06}: There is no significant interaction effect of methods and gender on the mean achievement scores of students in biology.

Table 8 shows that an F-ratio of 0.109 with associated probability value of 0.742 was obtained for interaction between method of teaching and gender. Since the associated probability of 0.742 was greater than 0.05 level of significance, the null hypothesis (H_{06}) which stated that there is no significant interaction effect of methods and gender on the mean achievement scores of

students in biology was not rejected. Thus, the interaction effect of method of teaching and gender on studentsô mean achievement in biology was not statistically significant. Although, there was an improvement in male and female studentsô mean achievement score in biology when taught using collaborative and individualistic methods of teaching, there was no significant interaction effect between method of teaching and gender.

Summary of the Findings

1. The result of the study showed that there was a significant difference between the mean achievement scores of students in biology taught using collaborative concept mapping and those taught using the conventional lecture method with the students taught using collaborative method having a higher mean in the posttest.
2. There was a significant difference between the mean score achievement scores of students in biology when taught using individualistic concept mapping and those taught using the conventional lecture method with the students taught using individualistic method having a higher mean score in the posttest.
3. The finding of the study showed that there was a significant difference between the mean achievement scores of students in biology taught using collaborative concept mapping and those taught using Individualistic concept mapping with the students taught using collaborative method having a higher mean score in the posttest.

4. Result showed that there was a significant difference in the mean achievement scores of male and female students taught biology using collaborative concept mapping with the male students taught using collaborative method having a higher mean gain.
5. The finding showed that there was no significant difference in the mean achievement scores of male and female students taught biology using individualistic concept mapping.
6. The interaction effect of method of teaching and gender on studentsô mean achievement in biology was not statistically significant.

CHAPTER FIVE

DISCUSSION OF RESULTS, CONCLUSIONS, IMPLICATIONS, RECOMMENDATIONS AND SUMMARY

This chapter deals with discussion of results, conclusion, educational implications, recommendations and summary.

Discussion of Finding

The findings of the study were discussed in this chapter. The discussion was organised under the following sub-headings.

- Collaborative concept mapping and students achievement in Biology.
- Individualistic concept mapping and students achievement in Biology.
- Gender and students achievement.
- Comparative effect of collaborative and individualistic concept mapping on students achievement in Biology.
- Interaction effect of methods and gender on students achievement in Biology.

Collaborative concept mapping and students achievement in Biology

The result of this study showed that collaborative concept mapping had a significant effect on studentsô achievement in Biology. The experimental group which was exposed to collaborative concept mapping technique performed higher and better with mean achievement score of 34.95 than the control group that went through the conventional instructional technique with mean achievement score of 23.63. This result agrees with Leister and Kober (2008)

position that the use of collaborative concept mapping as a successfully teaching approach enhance the effectiveness of both short term learning in terms of subject or materials being studied and long term learning in terms of cognitive skills and self-esteem which help students perform better by increasing their ability to resolve problems and helping developing personality trait that benefits to them in both their academics and professional lives.

Furthermore, this result is not surprising because according to Keraro Wachenga and Orora (2007) collaborative concept mapping provides opportunity for active involvement of students in their learning process and hence enhances their thinking ability while cross questioning each other and thinking for seeking solution. Collaborative concept mapping facilitates and even stimulates imaginations of the learner thereby making the learning so exciting, purposeful and participatory (McAleese, 1999). Another significant feature of collaborative concept mapping which might have contributed to its relative efficiency is the increase in students ability to connect new information to existing relevant concept in the learnersô cognitive structure through the concept mapping technique which led to increase in students ability to solve biology problems. Therefore, the students active participation in the learning process through collaborative concept mapping techniques accounted for its superiority over the conventional instructional approach.

Individualistic concept mapping and students achievement in Biology

The overall mean scores of students taught Biology using individualistic concept mapping as shown in table 2 was 29.82 while those taught using the conventional instructional approach was 23.63. Hence individualistic concept mapping appeared to have facilitated the achievement in biology among the students than the conventional instructional strategy. This is consistent with Ezeliora (1999) and Moore (2002) views that teaching method is a major contributory factor to studentsô achievement in sciences. Individualistic concept mapping encourages the learners to become actively involved in the cognitive leaning process in which new information is linked to established concepts and ideal that would encourage better understanding, promotes creative thinking and aids in problem-solving thereby increasing academic achievement in Biology.

Therefore with concept mapping techniques students are exposed and subjected to various form of activities or learning that will aid academic achievement of students. This explains why the overall higher mean achievement score of students exposed to individualistic concept mapping over the conventional lecture method. The finding of this study are in line with those of Bello (1997) that the two forms of concept mapping instructional strategies greatly improved students achievement and reduced students misconceptions and alternative conceptions of the theory of evolution.

Comparative effect of collaborative and individualistic concept mapping on student Achievement in Biology

The result of the study indicated that there was a significant difference between the mean achievement scores of students in Biology taught using collaborative concept mapping and those taught using individualistic concept mapping. Result showed that the group taught biology using collaborative concept mapping had a mean score of 34.95 and those group taught biology using individualistic concept mapping had a mean score of 29.82. The significant difference in the achievement scores between students in the collaborative and individualistic learning groups may be explained with the active participation of students in the learning process and the cooperative activities which go on during instruction with the method. This may have influenced the students learning and understanding of the concepts of topics they were exposed to. The variations in achievement scores between these two groups may also be due to the variation in the teaching strategies adopted in each of the groups and subjects comprehension of the methods of instructions. These may again have translated into influencing subjects scores in the achievement test.

In collaborative learning, the success of one student help other students to be successful. This is in line with the suggestion by Nworgu (2009) that in collaborative teaching strategy, all members of the group seek mutual benefit so that every member gains enormously from each otherôs support. They work and

discuss the section to their problems, through listening, explanation and encouraging each by providing academic assistance. Collaborative concept mapping promotes cooperative learning where students work together in order to give solution to a common problem (Banu, 1992). Through collaborative concept mapping, students shared ideas together and supported each other which enabled them to perform well in Biology.

Gender and students Achievement

The study revealed that there was a significant difference in the mean achievement scores of male and female students taught biology using collaborative concept mapping with the male students taught using collaborative concept mapping having a higher mean gain of 11.08, while the female students having a mean gain of 10.24. This is an indication that gender have some influence on students achievement in biology when taught using collaborative concept mapping in favour of male gender as shown in table 4. This result agreed with Brandt et al. (2001) that concept mapping as a teaching-learning tools is more effective for the male students than female students with respect to achievement in biology and sciences. Hence, gender has moderating role in defining the effect of concept mapping on academic achievement of students in sciences. The effectiveness of the two forms of concept mapping in enhancing achievement of male and female students could be that students were given opportunity to make free contributions on what they know and understood in the lesson through collaborative concept mapping technique.

From the study, it could be deduced that male students developed a higher achievement because they developed greater enthusiasm and enjoyed the science lessons much more than the female students. This was made possible by concept mapping instructional strategies.

Interaction effect of methods and gender on students Achievement in Biology

Evidence from table 8 showed that there was no significant interaction effect between methods and gender on studentsô achievement in Biology. This implies that the effectiveness of the interaction was not dependent on gender. In other words, this simply means that the combination of studentsô gender and the method used for instruction does not influence achievement in biology. This therefore implies that the noticed significant differences in achievement scores among students taught with two forms of concept mapping may not be linked to gender but entirely to the methods of instruction. It therefore follows that the degree of achievement earned by students in the experimental groups maybe hinged on the effectiveness of the methods. This finding perfectly agrees with the recommendation of some science education researchers like Ugwuadu and Nzewi (2011) and Ajaja (2013) that whatever method that should be adopted for science teaching should be such that enable students to learn equally irrespective of gender. This finding is most relevant now that there is a deliberate effort to bridge the gap between males and females on representation in science. The result also seems to indicate that male and female students used

for the study benefitted equally from the treatment using the two modes of concept mapping as main effects. Therefore, the use of two modes of concept mapping in teaching biology is not gender bias. Gender has no influence on the use of concept mapping in teaching biology.

Conclusion

The following conclusions are made as a result of the findings of this study.

1. The use of collaborative and individualistic concept mapping techniques increase studentsô achievement in Biology. The experimental groups (collaborative and individualistic) exposed to the concept mapping technique performed better than the control group in the Biology achievement test.
2. The study also found that collaborative concept mapping technique is more effective in improving studentsô achievement in biology than individualistic concept mapping technique. This simply means that the effectiveness of collaborative methods on studentôs achievement in biology does not depend on the levels of gender. Hence, irrespective of gender, learners will records improved achievement when collaborative strategy is employed for teaching and learning of biology. It is a viable teaching method in biology.
3. Although male and female students in the experimental group (collaborative and individualistic) had grater gain in achievement than the control group,, the male students consistently performed better than the female students in

the achievement test. Thus, this study has shown that Biology is one such area where the use of concept mapping may be beneficial.

4. On the overall study, male students achieved better than the female students and students in the experimental groups (collaborative and individualistic) achieved more than in the control group. Thus, the two forms of concept mapping has a significant effect on student achievement in biology.
5. The interaction effect of method of teaching and gender on studentsô mean achievement in biology was not statistically significant. This reveals that achievement of students was not influenced by gender variable as well as the teaching method.
6. The use of two forms of concept mapping in teaching the biology students is not gender selective.

Educational Implications

The results of this study have some implications for biology teachers, teacher education institutions, curriculum developers, authors and writers.

The study indicated that the use of different forms of concept mapping techniques resulted in greater achievement. This implies that the use of collaborative and individualistic concept mapping techniques in teaching a biology content area is largely effective in improving studentôs achievement in biology. Thus, if this technique or strategy is adopted by biology teachers for use in our science and Biology classroom, studentsô achievement in Biology will be greatly improved.

It is a well known fact that a man cannot give what he does not have. Therefore, since the use of different forms of concept mapping (collaborative and individualistic) which is a new innovation produces greater results, it seems necessary that Biology teachers should be given adequate training on how to effectively use the technique. Hence, concept mapping technique should be included in the Biology special method courses of all teacher education institutions.

Again, since the use of different forms of concept mapping enhances studentsô achievement in Biology, it follows that curriculum planners or developers can create the awareness of this technique in teachers by including it in the Biology curricula as well as carrying out discussions on it during workshops.

Finally, the finding of this study also imply that authors and writers of textbook can now provide direction in their test, by giving examples and illustrations and provide proper application of this technique in different aspects of Biology.

Recommendations

The following recommendations were made based on the result of the research finding.

- Since the achievement of students improved by the use of two modes of concept mapping, teachers should use the concept mapping to facilitates studentsô learning during their biology teaching.

- The teacher training institutions should include the concept mapping technique in the biology method course content. This will ensure that teachers are adequately trained on how to use the technique.
- Textbooks should be written to illustrate more on the application of concept mapping on different content areas in biology.
- Curriculum developers should include the teaching of concept mapping techniques in the biology education curricula of teacher education institutions.
- In-service training, workshops and seminars should be organized by the federal and state ministry of education, professional associations like Science Teachers Association of Nigeria (STAN), Examination Boards like NECO; JAMB and WAEC to sensitize the Biology teachers on the benefits, derivable from using concept mapping technique. This will also help the practicing teachers to embrace the skills of different modes of concept mapping strategies for effective teaching of biology.
- Students should apply the knowledge of concept mapping on other topics in biology, in summarizing their notes or other works and in preparation for examination.
- Biology students should be introduced to concept map construction as a tool for meaningful learning. It would enable students to understand meaningfully the numerous interrelated biology concepts. Concept maps

could serve as a memory aid to: students and can be used for revision exercises and improve their achievement in biology.

- Biology education researchers may replicate and improve upon this study by conducting it among larger sample size and at other educational levels in the nationôs education system.

Limitations of the Study

This study is affected by the following limitations:

- Irregularities of some students during the conduct of the study. This is the reason why only three hundred and fourteen students participated from start to the end of the study out of three hundred and sixty students.
- The uncooperative attitude of some other subject teachers especially during evaluation.
- The researcher used only six schools in the entire population and this may affect the generalization of this study to other areas.
- School location factor may have affected the study. All the schools used are located in rural areas.

Suggestions for further Study

It is suggested that the following studies be carried out.

1. Further investigation should be carried out to determine the effect of two modes of concept mapping on other topics of Biology.

2. A similar study should be conducted using school location as a variable. For instance, schools from the urban and rural areas respectively should be used in the study.
3. Further studies might be conducted to compare the effect of concept mapping for low-achieving students, middle achieving students and high achieving students.
4. Further studies might be conducted to compare the effect of work group size (i.e. pairs versus small groups) on the quality of concept maps.
5. An investigation into effect of two modes of concept mapping on studentôs achievement in other biology classes and other local government area in Nigeria.

Summary of the Study

The study was carried out to determine the effect of two modes of concept mapping on students achievement in Biology. The study adopted quasi-experimental design. Purposive sampling and simple random sampling techniques were used to select 360 SSII students drawn from six schools in Apa Education zone of Benue State. The researcher sampled six secondary schools from about seventeen co-educational schools in Apa education zone. Out of these schools, two schools serve as collaborative groups, two schools constitute individualistic group, while the remaining two schools form the lecture group (control). In each of the six schools, one arm was assigned a treatment. The researcher used two topics in Biology curriculum namely skeletal system and

excretory system. These topic were taught for six weeks for three groups. One instrument was used for data collection namely Biology Achievement Test (BAT) which was developed by the researcher.

The instrument was subjected to face and content validation by two experts in science education department. A table of specification guided the development of the BAT. The BAT contained 40 test items with 4 options multiple choice objective test. The reliability of these instrument was established using Kudder-Richardson formula 20 ($K\text{-}R_{20}$) for BAT. The reliability indices was found to be 0.71 for BAT. These instrument was used for the pre-test and posttest of the study. Lesson plans were drafted for collaborative concept mapping, individualistic concept mapping and for conventional (lecture) method. Means and standard deviation were used to provide answers for the research questions, while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results of the study among others revealed that students exposed to collaborative and individualistic concept mapping techniques achieved more in the biology contents or topics than students who were not. It also revealed that male students in collaborative concept mapping achieved more in the achievement test than the female students. Based on the findings, the researcher among others recommended that biology teachers should be trained adequately in the use of these techniques and should therefore incorporate these techniques as one of the techniques used in teaching in the biology classrooms.

Also, government should organize regular in-service training for biology teachers which maybe in form of seminars, conferences and workshops. This will enable teachers acquire the use of concept mapping technique as well as other innovative teaching strategies.

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APPENDIX A

Sub-Department of Science Education,
University of Nigeria,
Nsukka.

Sir/Madam,

APPLICATION FOR FACE VALIDATION OF RESEARCH INSTRUMENTS

I am a Master Degree student carrying out research on the topic- Comparative effects of collaborative and individualistic concept mapping on achievement of mixed ability biology class.

I wish to apply for your assistance in the face validating of my research instrument Biology Achievement Test (BAT). They are meant for biology students in Apa Education zone of Benue state. The BAT covers such topics as skeletal system, excretory system and aquatic habitats.

Please scrutinize the instruments in terms of:

1. Structuring of the items
2. Language level of the intended class (SSII)
3. Clarity of the questions asked
4. Accuracy of answers
5. Appropriateness in terms of research question, purposes and hypotheses.

Attached are copies of the instruments, answers, purpose of the study, research questions and hypotheses.

Thanks for your cooperation.

Yours faithfully,

Abogonye Adisa

APPENDIX B

Biology achievement test (BAT) CLASS: SS2

TIME allowed 45 minutes

INSTRUCTION: CIRCLE THE CORRECT OPTION

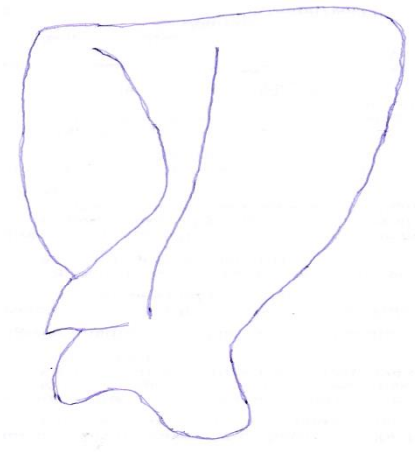
Name of school:

Age:

Sex: Male ☐ **Female** ☐

1. The axial skeleton is composed of the (a) Skull and vertebral column (b) Limbs and girdles (c) Atlas and axis (d) radius and Ulna.
2. Which of the following is the longest bone in the body? (a) Humerus (b) Femur (c) Scapula and (d) tibia
3. Which of the following is a function of the skeleton? (a) Digestion (b) Protection (c) Contraction (d) Relaxation.
4. The removal of waste products from the body through the skin, kidney and lung is call---?(a) Excretion (b) Digestion (c) Inhalation (d) Egestion.
5. Which excretory product is not found in Mammals? (a) Ammonia (b) Carbon (iv) oxide (c) Urea (d) Mineral salt.
6. The excretory system in mammals consist of the following except. (a) Two kidneys (b) Two ureters (c) Two bladders (d) One Urethra.
7. In man, the scapula can be found around the ---(a) Thigh (b) Wrist (c) Shoulder (d) Knee.
8. The bones of the palm are called (a) Carpals (b) Metacarpal (c) Metatarsals (d) Phalanges.
9. Which region of human body is the thoracic vertebrae found or located? (a) Abdomen (b) Chest (c) Neck (d)Tail
10. Spinal cords is protected by the --------(a) Rib cage (b)Cranium (c) Vertebral column (d) Phalanges.

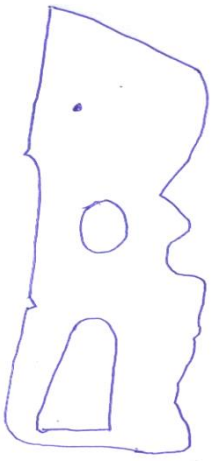
11. The kidney as an excretory organ, removes---------- from the blood
    (a) Carbon iv oxide (b) Oxygen (c) Bile pigment (d) Nitrogenous compound.
12. Which of the following definition describes excretions? (a) Liberation of energy from food (b) breakdown of food molecule (c) removal of waste products of metabolism (d) release of faeces from the body.
13. The liver excretes (a) Oxygen (b) mineral salts (c) Bile pigment
    (d) Carbon iv oxide.



14. The diagram represents (a) Clavicle (b) Ulna (c) Humerus (d) Scapula.
15. Urea formation occurs in the (a) heart (b) kidneys (c) Liver (d) Pancreas.
16. Which of the following is excreted by the human skin? (a) Carbon iv oxide (b) Serum (c) Sweat (d) Urine.
17. Which of the following vertebrae is of the same number in man and rabbit? (a) Caudal (b) Cervical (c) Thoracic (d) Lumbar
18. The glomerular filtrate contains the following substances except?
    (a) Water (b) Urea (c) Blood corpuses (d) glucose.
19. Which of these vertebrae has an odontoid process? (a) Atlas (b) Axis
    (c) Lumbar (d) Thoracic.
20. The mechanism by which useful materials in the glomerular filtrate are taken back into the blood is known as (a) Filtration (b) reabsorption
    (c) Heterolysis (d) Osmosis.

21. The conversion of excess amino-acid into urea occurs in (a) Kidney (b) Liver (c) Pancreas (d) Spleen.
22. The appendicular skeleton is composed of the (a) pectoral girdle, pelvic girdle and fore limbs (b) Pelvic girdle, forelimbs and handlings (c) Lumbar vertebrae and pelvic girdle (d) Lumber vertebrae forelimb and hind limb.
23. Which of the products from analyzing sweat from skin is not an excretory products? (a) Water (b) Salt (c) Faeces (d) Urea.
24. Metabolic product of urea is carried out in the (a) Urinary bladder and kidney (b) liver (c) Pancreases (d) Kidney and malpighian tubule.
25. Which of the following is the correct order of the vertebrae along spinal cord?(a) Axis-> Atlas -> Thoracic -> Cervical -> Sacral. (b) Atlas -> Cervical ->Axis -> thoracic -> lumbar (c) Atlas -> Axis -> Cervical -> Thoracic -> Lumbar (d) Lumbar-> Cervical -> Thoracic -> Lumbar.
26. The neural spine found in the Thoracic vertebrae is (a) Short and forked (b) Long and slender (c) thick and board (d) Short and thin.
27. Which of the following possess vertebraterial canal? (a) Cervical (b) Lumbar vertebra (c) Sacral (d) Caudal vertebra.
28. The neural canal of the vertebral column encloses the (a) Ventral root (b) Cerebellum (c)Spinal cord (d) Cerebrospinal fluid.
29. Which of the following systems removes metabolic waste from the body?(a) Circulatory system (b) Egestion (c) Excretory (d) Respiratory.
30. The following are excretory organs except (a) Kidneys (b) Liver (c) Lungs (d) nose.
31. Which of these is not an excretory waste? (a) Carbon iv oxide (b) Dissolved salt (c) Urine (d) faeces
32. Another name for the bones of the spine is --------(a) Cartilage (b) Skill (c) Scapula (d) Vertebrae

33. Which of the following is not a function of kidney? (a) Production of urine (b) Osmo-regulation (c) Production of bile (d) Maintenance of acid-base balance in the body:.
34. Two bones are joined together by (a) Tendon (b) cartilage (c) Ligament (d) synovial fluid.
35. Which of the substances is a common excretory product in both plants and animals? (a) Urine (b) Oxygen (c) Mineral salt (d) Carbon iv oxide.
36. The cup-shaped of the Bowmanôs capsule contains the (a) Loop of henle (b) (b) Glomerulus (c) Nephron (d) Convoluted tubule.
37. Which of the following is the difference between cervical and lumbar vertebrae? (a) Presence of verterbraterial canal (b) Scapula (c) Sternum (d) Ilium.
38. The three bones that composed the pelvic girdle are: (a) Carpals, tarsals and phalanges (b) Scapula, ribs and sternum (c) Patella, radius and tibia (d) ilium, ischium and pubis.
39. Which part of the nephron is associated with ultra filtration (a) Distal convoluted tubule (b) Proximal convoluted tubule (c) Collecting duct (d) Bowmanôs capsule.



40. the diagram above represents (a) Femur (b) Scapula (c) Carpals (d) Pelvic girdle

APPENDIX C

LESSON I

Lesson plan for the experimental Group I (Collaborative concept mapping) on mammalian skeletal system.

Subject: Biology

Class: SS2

Topic: Tissues and supporting systems

Specific topic: mammalian skeletal system

Average:15 years

Duration: 90mins

Instructional objectives: At the end of the lesson students will able to:

i. Define skeleton
ii. Identify the major parts of mammalian skeleton
iii. State the function of skeleton in animal
iv. Mention the major bones of appendicular and axial skeleton

Instructional materials: concept map on part of mammalian skeleton, chalkboard, students text.

Entry behaviour: The teacher asks the students to describe the type of bones they have seen in slaughtered cow and chicken.

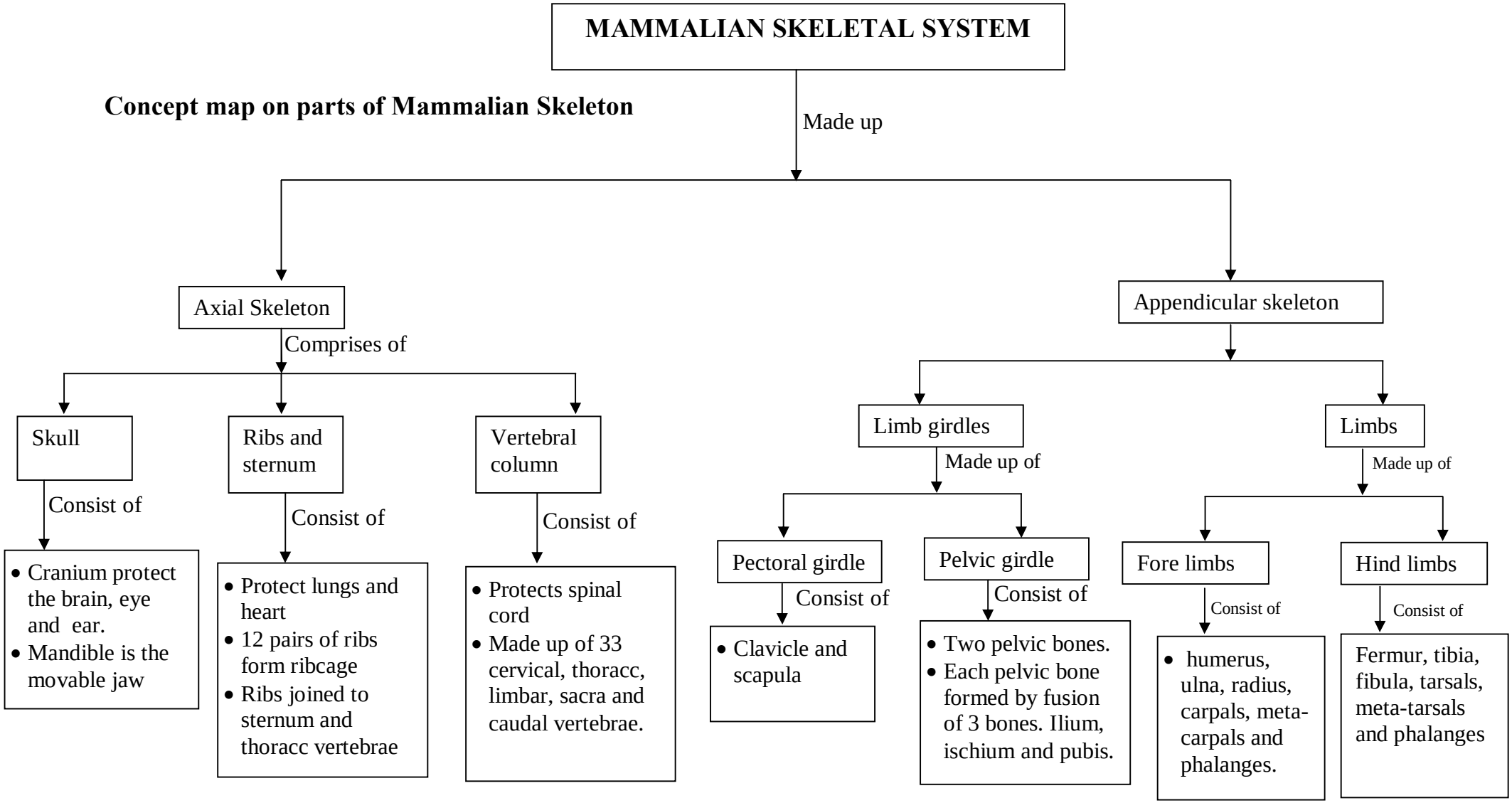
Instructional procedure:

Content	**Teachers' activities**	**Students activities**	**Strategies**
Introduction	The teacher asks the students in collaborative group to define the concept of skeleton.	They define the concept of skeleton as the bony framework of the body which provides support, shape, and protection to the soft tissues and organs in animals.	set induction

Identify the major parts of mammalian skeleton	The teacher asks the students in collaborative groups to identify the major parts of mammalian skeleton.	Students reason together in groups and identify the major parts of mammalian skeleton.	Collaborative learning.
State the function of skeleton in animals	The teacher asks the students in collaborative groups to state the function of skeleton in animals.	Students in collaborative groups then states the functions of skeleton which include, protection, support, muscle attachment, manufacture of red blood cells, aids in breathing and shape to the body.	Questioning explanation and collaboration.
Major bones of axial and appendicular skeleton.	The teacher asks the students in group to mention the major bones of appendicular and axial skeleton.	Students then mentions the major bones of axial and appendicular skeleton. Skull, ribs, sternum and vertebral column are axial skeleton, while limbs and limb girdles are appendicular skeleton.	Discussion, explanation.
Evaluation	The teacher evaluates the student	Students in collaborative groups	

	understanding of the lesson by asking the following questions: • What is skeleton • Identify the major bones of mammalian skeleton. • State 2 functions of skeleton.	answer the teacherôs questions.	
Summary	The teacher review the entire lesson.	Students in group pay attention.	
Assignment	Teacher dictates, practice assignment to students.	Students pay attention and or jot notes.	

Concept map on parts of Mammalian Skeleton



Sources: New system Biology for Senior Secondary Schools. Lam, et' al (2011) Modified.

LESSON I

Lesson plan for the experimental Group I (Individualized concept mapping) on mammalian skeletal system.

Subject: Biology

Class: SS2

Topic: Tissues and supporting systems

Specific topic: mammalian skeletal system

Average:15 years

Duration: 90mins

Instructional objectives: At the end of the lesson students will able to:

i. Define skeleton
ii. Identify the major parts of mammalian skeleton
iii. State the function of skeleton in animal
iv. Mention the major bones of appendicular and axial skeleton

Instructional materials: concept map on part of mammalian skeleton, chalkboard, students text.

Entry behaviour: The teacher asks the students to describe the type of bones they have seen in slaughtered cow and chicken.

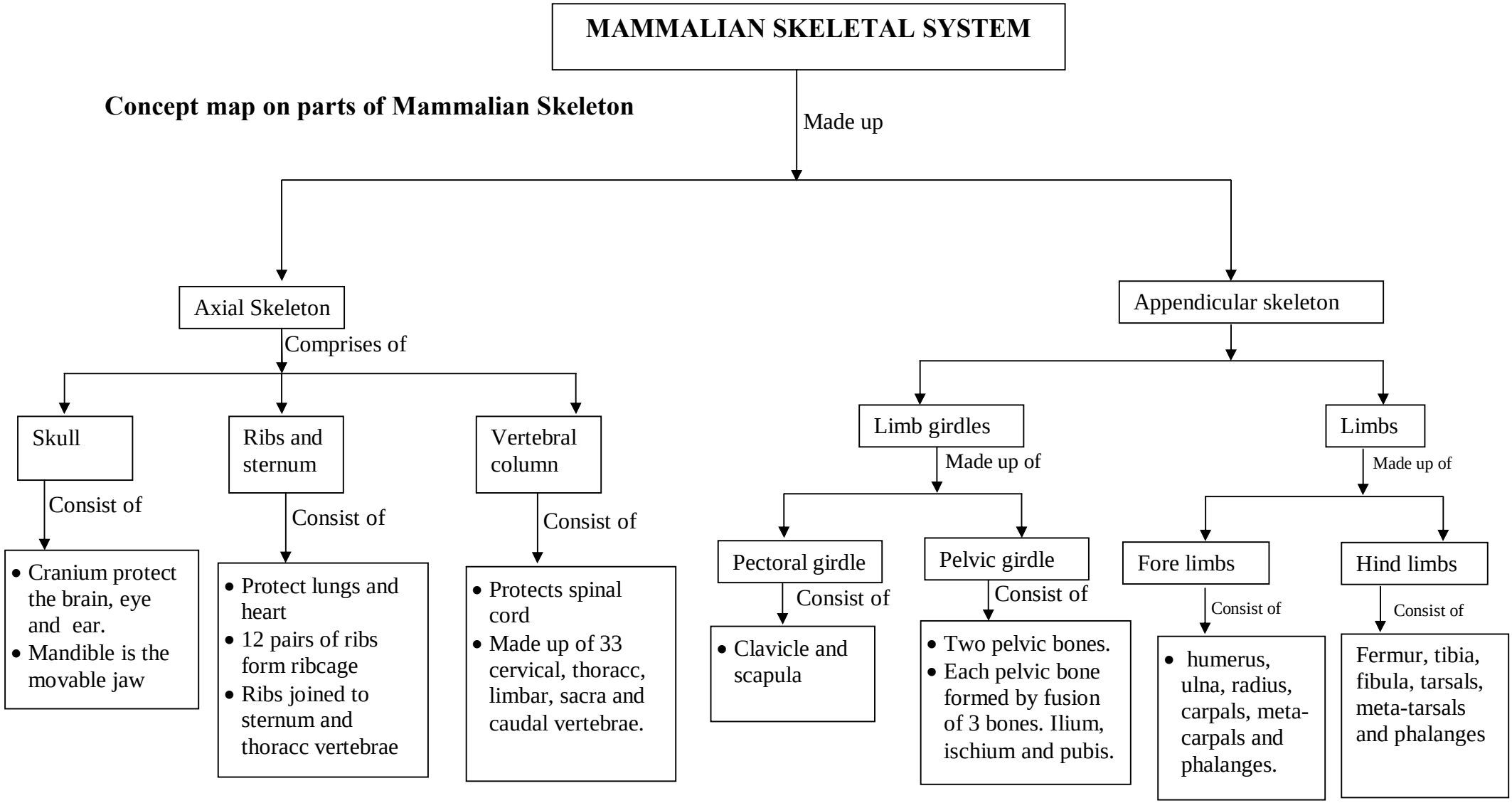
Instructional procedure:

Content	**Teachers' activities**	**Students activities**	**Strategies**
Introduction	The teacher asks the students in individualized groups to mention different types of skeleton.	The students individually mention different types of skeleton.	Set induction.

Define concept of skeleton.	The teacher asks the students in individualized group to define skeleton.	The student defines the concept of skeleton by following the teachers direction.	Explanation discussion.
Identify the major parts of mammalian skeleton.	The teacher ask the students in individualized group to identify the major parts of mammalian skeleton.	The students then individually identify the major parts of mammalian skeleton as appendicular and axial skeleton.	Questioning, explanation and guided discover.
Function of skeleton in animals.	The teacher asks the students in individualized group to state the functions of skeleton.	The students then states the function of skeleton as protection, support, aids, in breathing, production of red blood cells etc.	Questioning, Discussion.
Major bones of axial and appendicular skeleton.	The teacher asks the students in the individualized group to mention the major bones of axial and appendicular skeleton.	The students individually mention the major bones of axial and appendicualr skeleton.	Discussion.
Evaluation	The teacher evaluates the lesson by asking the students the following questions:	The students then answer the teachers question.	

	• What is skeleton? • State two functions of skeleton. • Mention bones of appendicular skeleton.		
Summary	Teacher review the entire lesson.	Students pay attention.	
Assignment	The teacher dictates practice assignment to students.	Students pay attention.	

Concept map on parts of Mammalian Skeleton



Sources: New system Biology for Senior Secondary Schools. Lam, et' al (2011) Modified.

LESSON I

Lesson plan for Control Group (lecture method) on mammalian skeletal system.

Subject: Biology

Class: SS2

Topic: Tissues and supporting systems

Specific topic: mammalian skeletal system

Average:15 years

Duration: 90mins

Instructional objectives: At the end of the lesson students will able to:

i. Define skeleton

v. Identify the major parts of mammalian skeleton

vi. State the function of skeleton in animal

vii. Mention the major bones of appendicular and axial skeleton

Instructional materials: Textbook, charts and model of human skeleton

Instructional techniques: Use of discussion, questioning and explanation.

Instructional procedure:

Presentations	**Teachers activities**	**Students activities**
Step I	The teacher defines the concept of skeleton as the bony framework of the body which provides support, shape, protections to soft tissues and organs in animals.	Students then pay attention to the teachers taking down notes.
Step II	The teacher identify the major parts of mammalian skeleton to the students. These are appendicualr and axial skeleton.	Students pay attention busy taken down the key points.

Step III	The teachers states the functions of skeleton to the students. The functions include protection, aids in breathing, support, shape and production of red blood cells.	The students pay attention to the teachers.
Step IV	The teacher then mentions the major bones of axial and appendicualr skeleton to the students. The axial skeleton consists of the skull, vertebral column and limbs and sternum, while appendicualr skeleton consists of limbs and limb girdles.	Students are busy listeining to the teacher and jots down notes.
Evaluation	The teacher evaluates his lesson by asking the following questions: • What is skeleton? • Mention two major parts of skeleton. • State two functions of skeleton.	Students attempts the question by providing answers.
Summary	The teacher summarizes his lesson by review the entire lesson.	Students are busy taken down notes from the chalkboard.
Assignment	The teacher gives the following assignment to the students. • State two functions of skeleton. • Identify two major parts of appendicular and axial skeleton.	

LESSON II

Lesson plan for the experimental Group I (Collaborative concept mapping) on mammalian excretory system.

Subject: Biology

Class: SS2

Topic: Excretory system

Specific topic: Mammalian excretory system

Average:15 years

Duration: 90mins

Instructional objectives: At the end of the lesson students will able to:

i. Define excretion
ii. State the importance of excretion
iii. Name four organs used by mammals in excretion.
iv. List four excretory products of mammals
v. Mention the substances contained in urine

Instructional materials: Concept mapping on excretion in mammals, charts, Biology textbooks.

Entry behaviour: Students have been taught skeletal systems of mammal and observed the excretory system in a dissected rat.

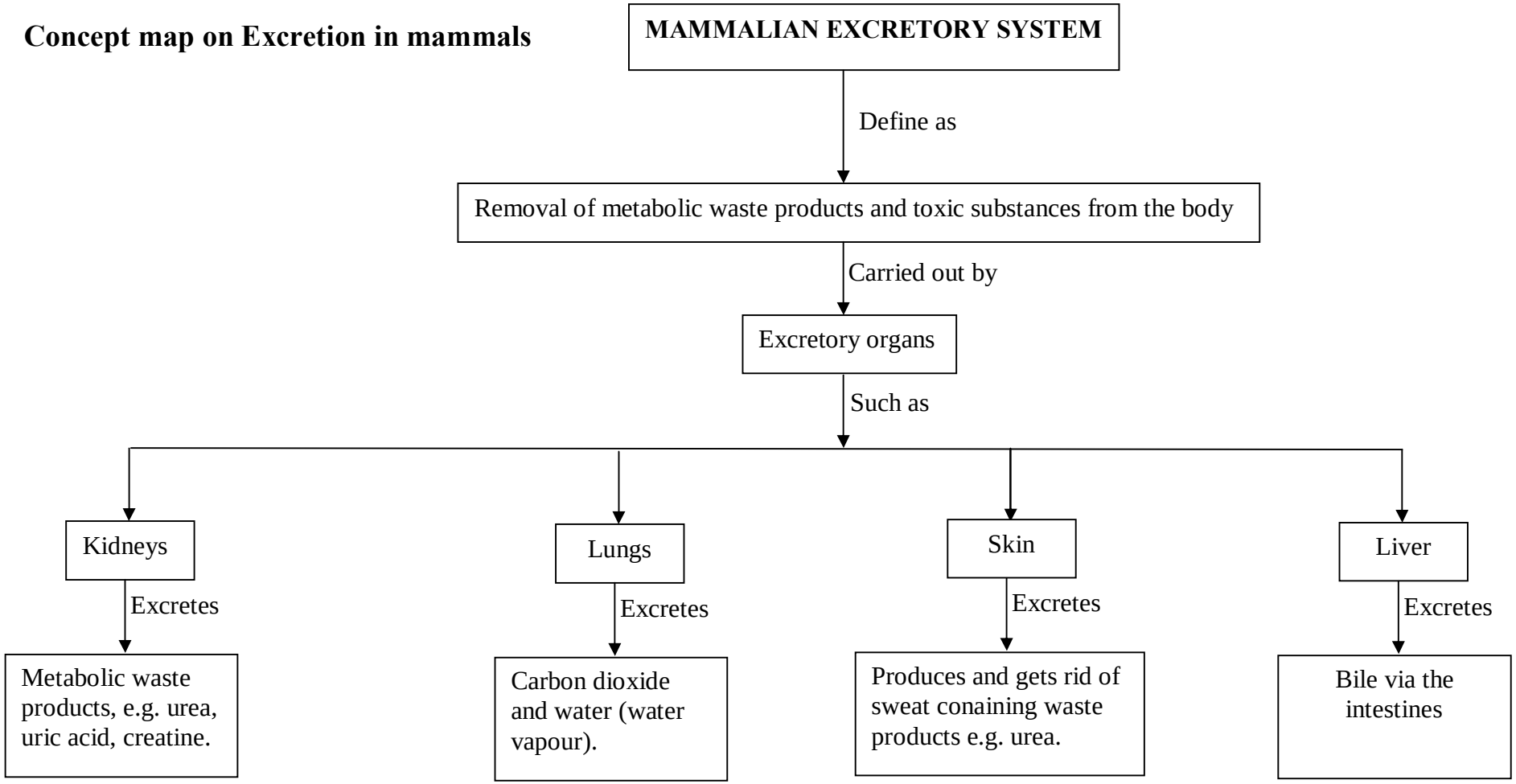
Instructional procedure:

Content	**Teachers' activities**	**Students activities**	**Strategies**
Introduction	The teacher asks the students in collaborative group the following questions: • Mention two composition of urine.	Students in group answer the teachers question.	Set induction.

Defining the term excretion	The teacher asks the students in collaborative groups to define excretion.	They answer the teachers questions and listening to his explanation.	Questioning, Explanation.
State importance of excretion.	The teacher also asks the students in groups to state the importance of excretion.	The students in group states the importance of excretion as to includes maintain salt balance in the body. • Removal of poisonous substances from the body. • Water balance in the body.	Discussion.
Organs of excretion.	The teacher asks the students in groups to name the major organs used by mammals in excretion.	The students in collaborative groups answer the question as follows, kidney, skin, lungs and bile pigment.	Discussion
Excretory products of mammals.	The teacher asks the students to list four excretory products of mammals.	Students in group lists the following: carbon (iv) oxide, urine, mineral salts and water as excretory products.	Explanation.

Composition	The teachers finally asks the students in collaborative group to mention the substance that are contained in urine.	Students in collaborative groups mention water, mineral salt, uric acid, nitrogenous compound as the substances found in urine.	Discussion
Evaluation	The teacher evaluates the understanding of the lesson by asking the following questions: • Define excretion • List four excretory substances in mammals. • Mention two substances found in urine.	Students with their new experiences answer the questions.	
Summary	The teacher review the entire lesson.	Students pay attention.	
Assignment	Teacher dictates practice assignment to students.	Students pay attention in groups.	

Concept map on Excretion in mammals



Source: New system Biology for Senior Secondary Schools. Lam, et' al (2011) Modified.

LESSON II

Lesson plan for the experimental Group I (Individualized concept mapping) on mammalian excretory system.

Subject: Biology

Class: SS2

Topic: Excretory system

Specific topic: Mammalian excretory system

Average:15 years

Duration: 90mins

Instructional objectives: At the end of the lesson students will able to:

i. Define excretion
ii. State the importance of excretion
iii. Name four organs used by mammals in excretion.
iv. List four excretory products of mammals
v. Mention the substances contained in urine

Instructional materials: Concept map on excretion in mammal, chalkboard and Biology textbooks.

Entry behaviour: Students have been taught skeletal systems of mammal and observed the excretory system in a dissected rat.

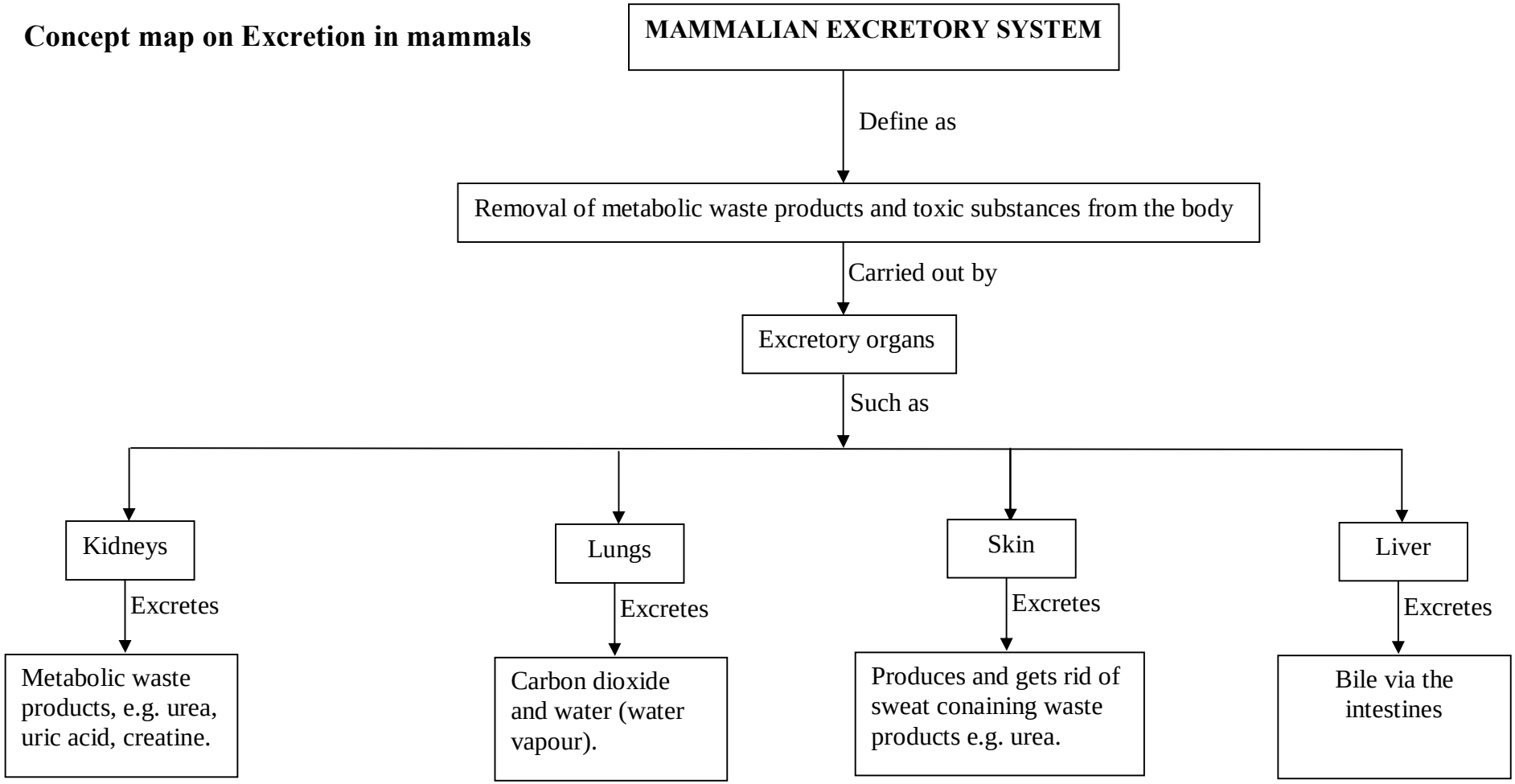
Instructional procedure:

Content	**Teachers' activities**	**Students activities**	**Strategies**
Introduction	The teacher asks the students in individualized group the following question: • Mention the composition of urine.	Students individually answer the teacherôs question.	Set induction.

Definition of excretion.	The teacher asks the students in individualized group to define excretion.	Students in individualized group defines excretion as the removal of waste products of metabolism.	Explanation
Importance of excretion.	The teacher asks the students to state the importance of excretion.	Students in individualized group states the importance of excretion as to: • Promote osmo-regulation in animals • Removal of poisonous wastes from the body.	Explanation, listening.
Organs of excretion	The teacher asks the students in individualized groups to name the organs used by mammals excretion.	Students in individualized groups name the organs used by mammals in excretion as kidney, liver, lungs and skin.	Listening, Explanation.
Excretory products of mammals	The teacher further asks the students in individualized group to list four excretory products of mammals.	Students in the groups list four excretory products in mammals as water, mineral salt, Coz, nitrogenous compound.	Discussion

Substances contained in urine	The teacher finally asks the students to mentions the substances that are contained in urine.	Students in the group finally mention the substances that are contained in urine to includes water, uric acid, mineral salt.	Listening
Evaluation	The teacher evaluates his lesson by asking the following questions: • What is excretion? • List four excretory organs in mammals.	Students with their new experience answer the questions.	
Summary	The teacher review the entire lesson.	Students pay attention.	
Assignment	Teacher dictates practice assignment to students.	Students pay attention.	

Concept map on Excretion in mammals



Source: New system Biology for Senior Secondary Schools. Lam, et' al (2011) Modified.

LESSON II

Lesson plan for Control Group (lecture method) on mammalian excretory system.

Subject: Biology

Class: SS2

Topic: Excretory system

Specific topic: Mammalian excretory system

Average:15 years

Duration: 90mins

Instructional objectives: At the end of the lesson students will able to:

i. Define excretion
ii. State the importance of excretion to living organism.
iii. Name four organs used by mammals in excretion
iv. List four excretory products.
v. Mention the substances contained in urine

Instructional materials: Charts of human excretory system, Biology textbook.

Instructional techniques: Use of discussion, explanation and questioning technique.

Instructional procedure:

Presentations	**Teachers activities**	**Students activities**
Step I	The teacher defines the concept of excretion of wastes product of metabolism from the body.	Students pay attention to the teacher taking down notes.
Step II	The teacher states the importance of excretion to living organisms to includes: • Promotion of osmo-regulation, removal of waste products of	The students busy listening and taking down notes.

	metabolism, control heat of the body.	
Step III	The teacher then name four organs used by mammals in excretion. The organs are kidney, lungs, liver and skin.	Students are busy taken down notes.
Step IV	The teacher lists four excretory products in mammal. This includes carbon(iv)oxide, water, mineral salt and uric acid.	The students listening and pay attention taking down the key points.
Step V	The teacher mention the substances that are found in human urines as mineral salts, water, uric acid.	Students listening and jots down some key points.
Evaluation	The teacher evaluates his lesson by asking the following questions. • What is excretion? • Name two excretory substances found in urine.	Students answer the question correctly.
Summary	The teacher summarizes his lesson on the chalkboard for students to copy.	Students jot down the summary on their notebook.
Assignment	The teacher gives the following assignment to the students. • Define excretion. • State two function of excretion. • Name two excretory organs in mammals.	Closure

APPENDIX D

VALIDATED INSTRUMENT

Biology achievement test (BAT) CLASS: SS2

TIME allowed 45 minutes

INSTRUCTION: CIRCLE THE CORRECT OPTION

Name of school:

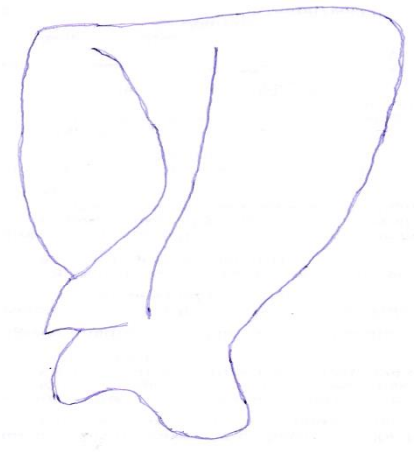
Age:

Sex: Male ☐ **Female** ☐

1. The axial skeleton is composed of the (a) Skull and vertebral column (b) Limbs and girdles (c) Atlas and axis (d) radius and Ulna.
2. Which of the following is the longest bone in the body? (a) Humerus (b) Femur (c) Scapula and (d) tibia
3. Which of the following is a function of the skeleton? (a) Digestion (b) Protection (c) Contraction (d) Relaxation.
4. The removal of waste products from the body through the skin, kidney and lung is call---?(a) Excretion (b) Digestion (c) Inhalation (d) Egestion.
5. Which excretory product is not found in Mammals? (a) Ammonia (b) Carbon (iv) oxide (c) Urea (d) Mineral salt.
6. The excretory system in mammals consist of the following except. (a) Two kidneys (b) Two ureters (c) Two bladders (d) One Urethra.
7. In man, the scapula can be found around the ---(a) Thigh (b) Wrist (c) Shoulder (d) Knee.
8. The bones of the palm are called (a) Carpals (b) Metal-carpal (c) Metal-tarsals (d) Phalanges.
9. Which region of human body is the thoracic vertebrae found or located? (a) Abdomen (b) Chest (c) Neck (d)Tail
10. Spinal cords is protected by the --------(a) Rib cage (b)Cranium

(c) Vertebral column (d) Phalanges.

11. The kidney as an excretory organ, removes---------- from the blood
    (a) Carbon iv oxide (b) Oxygen (c) Bile pigment (d) Nitrogenous compound.
12. Which of the following definition describes excretions? (a) Liberation of energy from food (b) breakdown of food molecule (c) removal of waste products of metabolism (d) release of faeces from the body.
13. The liver excretes (a) Oxygen (b) mineral salts (c) Bile pigment
    (d) Carbon iv oxide.



14. The diagram represents (a) Clavicle (b) Ulna (c) Humerus (d) Scapula.
15. Urea formation occurs in the (a) heart (b) kidneys (c) Liver (d) Pancreas.
16. Which of the following is excreted by the human skin? (a) Carbon iv oxide (b) Serum (c) Sweat (d) Urine.
17. Which of the following vertebrae is of the same number in man and rabbit? (a) Caudal (b) Cervical (c) Thoracic (d) Lumbar
18. The glomerular filtrate contains the following substances except? (a) Water (b) Urea (c) Blood corpuses (d) glucose.
19. Which of these vertebrae has an odontoid process? (a) Atlas (b) Axis
    (c) Lumbar (d) Thoracic.

20. The mechanism by which useful materials in the glomerular filtrate are taken back into the blood is known as (a) Filtration (b) reabsorption (c) Heterolysis (d) Osmosis.
21. The conversion of excess amino-acid into urea occurs in (a) Kidney (b) Liver (c) Pancreas (d) Spleen.
22. The appendicular skeleton is composed of the (a) pectoral girdle, pelvic girdle and fore limbs (b) Pelvic girdle, forelimbs and handlings (c) Lumbar vertebrae and pelvic girdle (d) Lumber vertebrae forelimb and hind limb.
23. Which of the products from analyzing sweat from skin is not an excretory products? (a) Water (b) Salt (c) Faeces (d) Urea.
24. Metabolic product of urea is carried out in the (a) Urinary bladder and kidney (b) liver (c) Pancreases (d) Kidney and malpighian tubule.
25. Which of the following is the correct order of the vertebrae along spinal cord?(a) Axis-> Atlas -> Thoracic -> Cervical -> Sacral. (b) Atlas -> Cervical ->Axis -> thoracic -> lumbar (c) Atlas -> Axis -> Cervical -> Thoracic -> Lumbar (d) Lumbar-> Cervical -> Thoracic -> Lumbar.
26. The neural spine found in the Thoracic vertebrae is (a) Short and forked (b) Long and slender (c) thick and board (d) Short and thin.
27. Which of the following possess vertebraterial canal? (a) Cervical (b) Lumbar vertebra (c) Sacral (d) Caudal vertebra.
28. The neural canal of the vertebral column encloses the (a) Ventral root (b) Cerebellum (c)Spinal cord (d) Cerebrospinal fluid.
29. Which of the following systems removes metabolic waste from the body? (a) Circulatory system (b) Egestion (c) Excretory (d) Respiratory.
30. The following are excretory organs except (a) Kidneys (b) Liver (c) Lungs (d) nose.
31. Which of these is not an excretory waste? (a) Carbon iv oxide (b) Dissolved salt (c) Urine (d) faeces
32. Another name for the bones of the spine is --------(a) Cartilage (b) Skill

(c) Scapula (d) Vertebrae

33. Which of the following is not a function of kidney? (a) Production of urine (b) Osmo-regulation (c) Production of bile (d) Maintenance of acid-base balance in the body:.

34. Two bones are joined together by (a) Tendon (b) cartilage (c) Ligament (d) synovial fluid.

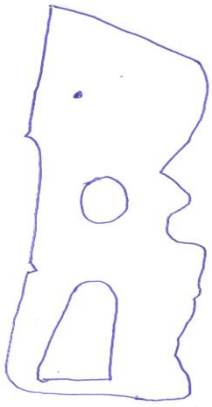
35. Which of the substances is a common excretory product in both plants and animals? (a) Urine (b) Oxygen (c) Mineral salt (d) Carbon iv oxide.

36. The cup-shaped of the Bowmanôs capsule contains the (a) Loop of henle (b) (b) Glomerulus (c) Nephron (d) Convoluted tubule.

37. Which of the following is the difference between cervical and lumbar vertebrae? (a) Presence of verterbraterial canal (b) Scapula (c) Sternum (d) Ilium.

38. The three bones that composed the pelvic girdle are: (a) Carpals, tarsals and phalanges (b) Scapula, ribs and sternum (c) Patella, radius and tibia (d) ilium, ischium and pubis.

39. Which part of the nephron is associated with ultra filtration (a) Distal convoluted tubule (b) Proximal convoluted tubule (c) Collecting duct (d) Bowmanôs capsule.



40. the diagram above represents (a) Femur (b) Scapula (c) Carpals (d) Pelvic girdle

APPENDIX E

COMPUTATION OF THE INTERNAL CONSISTENCY OF BAT USING KUDDER – RICHARDSON FORMULA (K-R_20)

TRIAL TEST SCORES

24, 24, 24, 25, 25, 26, 26, 26, 26, 27, 29, 29, 29, 29, 30, 30, 30, 30, 30, 34, 34, 34, 34, 35, 35, 35, 36, 36, 36, 37, 37, 37, 37, 37, 38, 40, 40, 40, 40, 40.

X	F	Fx	$X - \overline{X}$	$(X - \overline{X})^2$	$F(X - \overline{X})^2$	$\frac{(X - \overline{X})^2}{N} = PQ$
24	3	72	-8.33	69.39	208.17	1.73
25	2	50	-7.33	53.73	107.46	1.34
26	4	104	-6.33	40.07	160.28	1.00
27	1	27	-5.33	28.41	28.41	0.71
29	4	116	-3.33	11.09	44.36	0.28
30	5	150	-2.33	5.43	27.15	0.14
34	4	136	1.67	2.79	11.16	0.07
35	3	105	2.67	7.13	21.39	0.18
36	3.	108	3.67	13.47	40.41	0.34
37	5	185	4.67	21.81	109.05	0.55
38	1	38	5.67	32.15	32.15	0.83
40	5	200	7.67	58.83	294.15	1.47
	40 $\sum f = 40$	**1293** $\sum fx = 1293$			**1084.14**	**8.64** $\sum PQ = 8.64$

Mean score $\bar{x} = \frac{\sum fx}{\sum f} \quad \sum fx = 1293, \sum f = 40$

$\therefore \bar{x} = \frac{1293}{40} = 32.33$

Variance = $\frac{\sum f(x-\bar{x})^2}{n} = \frac{1112.40}{40}$

$= \frac{1112.40}{40} = 27.80$

Variance = 27.80

$S.D = \sqrt{\frac{\sum f(x-\bar{x})^2}{n-1}} = \sqrt{27.80} = 5.27$

The variance is expected to be 27.80. Hence the standard deviation for the score is 5.27. So if you square it you get 27.772.

Next, then apply the formula and necessary substitutions.

$K - R_{20} = \frac{n}{n-1}\left[\frac{SDt^2 - \sum pq}{SDt^2}\right]$

Where n = number of items

t^2 = total variance

PQ = summation of items scored correctly multiplied by the proportion of items scored wrongly.

n = 40

$SDt^2 = 27.80$

$\sum PQ = 8.64$

$K - R_{20} = \frac{n}{n-1}\left[\frac{SDt^2 - \sum pq}{SDt^2}\right]$

$= \frac{40}{40-1}\left[\frac{27.80 - 8.64}{27.80}\right]$

$= \frac{40}{39}\left[\frac{19.16}{27.80}\right] = 0.6892$

$= 1.0256 \text{x} 0.6892$

$= 0.71$

Reliability of BAT = **0.71**

APPENDIX F

List of schools used for the study

Methodist high school, Obagaji Agatu

Government secondary school, Ugbokpo

St, Benard secondary school, Aila Agatu

Muslims, community college, Ogwule

St. Johnôs secondary school, Amoke

King and queens college, Oshigbudu, Agatu

Achema community secondary school, Igah-Okpaya

El-shaddai secondary school, Ugbokpo

APPENDIX G

TABLE 1: TABLE OF SPECIFICATION FOR SS2 BIOLOGY ACHIEVEMENT TEST (BAT)

Cognitive Levels

CONTENT	KNOW. 40%	COMP. 20%	APP. 15%	ANA. 10%	SYN. 10%	EVA . 5%	TOTAL 100%
Skeletal system 50%	8 (1,7,8,9,10, 22, 26,34)	8(2,3,17, 19,25,27, 37,38)	4(14,28, 32,40)	-	-	-	20
Excretory system 50%	11(4,6,11,12, 13,15,18,21,24,30,36)	9(5,16,20, 23,29,31,33,35,39)	-	-	-	-	20
Total 100%	19	17	4	-	-	-	40

APPENDIX H

General Linear Model

RESEARCH QUESTION ONE AND TWO AND THREE

Between-Subjects Factors

		Value Label	N
Group	1.00	Collaborative Group	120
	2.00	Individualistic Group	100
	3.00	Control Group	94

Descriptive Statistics

	Group	Mean	Std. Deviation	N
PretestScores	Collaborative Group	24.2500	4.80764	120
	Individualistic Group	22.5100	6.44714	100
	Control Group	19.1277	7.96799	94
	Total	22.1624	6.72858	314
PosttestScores	Collaborative Group	34.9500	4.43411	120
	Individualistic Group	29.8200	5.96180	100
	Control Group	23.6383	7.03272	94
	Total	29.9299	7.41393	314

General Linear Model

RESEARCH QUESTION FOUR AND FIVE

Between-Subjects Factors

		Value Label	N
Gender	1.00	Male	166
	2.00	Female	148
Group	1.00	Collaborative Group	120
	2.00	Individualistic Group	100
	3.00	Control Group	94

Univariate Analysis of Variance

HYPOTHESES ONE AND FOUR

Between-Subjects Factors

		Value Label	N
Group	1.00	Collaborative Group	120
	3.00	Control Group	94
Gender	1.00	Male	111
	2.00	Female	103

Tests of Between-Subjects Effects

Dependent Variable: PosttestScores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6901.677[a]	4	1725.419	53.170	.000
Intercept	14936.500	1	14936.500	460.279	.000
PretestScores	3.425	1	3.425	.106	.746
Group	5804.257	1	5804.257	178.862	.000
Gender	128.458	1	128.458	3.959	.048
Group * Gender	41.036	1	41.036	1.265	.262
Error	6782.248	209	32.451		
Total	206044.000	214			
Corrected Total	13683.925	213			

a. R Squared = .504 (Adjusted R Squared = .495)

Univariate Analysis of Variance

HYPOTHESIS TWO AND FIVE

Between-Subjects Factors

		Value Label	N
Group	2.00	Individualistic Group	100
	3.00	Control Group	94
Gender	1.00	Male	100
	2.00	Female	94

Tests of Between-Subjects Effects

Dependent Variable: PosttestScores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1995.949[a]	4	498.987	11.827	.000
Intercept	15086.698	1	15086.698	357.581	.000
PretestScores	1.995	1	1.995	.047	.828
Group	1735.425	1	1735.425	41.133	.000
Gender	92.745	1	92.745	2.198	.140
Group * Gender	54.043	1	54.043	1.281	.259
Error	7974.092	189	42.191		
Total	149566.000	194			
Corrected Total	9970.041	193			

a. R Squared = .200 (Adjusted R Squared = .183)

Univariate Analysis of Variance

HYPOTHESES THREE AND SIX

Between-Subjects Factors

		Value Label	N
Group	1.00	Collaborative Group	120
	2.00	Individualistic Group	100
Gender	1.00	Male	121
	2.00	Female	99

Tests of Between-Subjects Effects

Dependent Variable: Posttest Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1542.495[a]	4	385.624	14.415	.000
Intercept	10443.180	1	10443.180	390.387	.000
PretestScores	90.631	1	90.631	3.388	.067
Group	1268.243	1	1268.243	47.409	.000
Gender	11.838	1	11.838	.443	.507
Group * Gender	2.916	1	2.916	.109	.742
Error	5751.432	215	26.751		
Total	241362.000	220			
Corrected Total	7293.927	219			

a. R Squared = .211 (Adjusted R Squared = .197)