EFFECTS OF TWO CONCEPT-MAPPING STRATEGIES ON RETENTION AND ACADEMIC PERFORMANCE IN ECOLOGY AMONG SECONDARY SCHOOL STUDENTS IN ZONKWA,KADUNA STATE, NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER DEGREE IN SCIENCE EDUCATION.

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NOVEMBER, 2017

DECLARATION

I hereby declare that this dissertation entitled "Effects of two concept-mapping strategies on Retention and Performance in Ecology among Secondary School Students in Zonkwa Education Zone of Kaduna State, Nigeria," has been carried out by me Alex Akomaye AGABA Registration number P13EDSC8030 and in the Department of Science Education. The information derived from the literature has been duly acknowledged in the text and list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

Alex Akomaye AGABA
P13EDSC8030 _____ Signature _____ Date

DEDICATION

This dissertation is dedicated to my beloved son, Desire Anashi Agaba, and to all those who have contributed immensely towards the success of this dissertation and my Education.

CERTIFICATION

This dissertation entitled "Effects of Two Concept-Mapping Strategies on Retention and Academic Performance in Ecology Among Secondary School Students in Zonkwa Education Zone, Kaduna State Nigeria" by Alex AGABA (P13EDSC8030) meets the regulations governing the award of the degree of Master of Science Education of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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LIST OF ABBREVIATIONS

In the course of this study, some words were abbreviated because of their frequent use. The abbreviated words are:

AMC Achievement Motivation Scale

BAT Biology Achievement Test

BSAT Biology Students Achievement Test

CPT Cognitive Preference Test

EAT Ecology Achievement Test

E C P T Ecology Concepts Performance Test

E C R T Ecology Concepts Retention Test

FRN Federal Republic of Nigeria

HCM Hierarchical Concept Mapping Strategy

PAT Physic Achievement Test

PSATC Problem Solving Achievement Test in Chemistry

SCM Spider Concept Mapping Strategy

OPERATIONAL DEFINITION OF TERMS

Concept Maps: Are graphical tools for organizing and representing knowledge which are usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts.

Concept Mapping Instructional Strategy is a general method that can be used to help students to describe ideas about some topics in a pictorial form.

Ecology Concepts Performance Test: A test designed by the researcher which was administered to both experimental and control groups after teaching ecology concepts using spider and hierarchical concepts-mapping strategies to experimental groups 1and 2 only.

Ecology concepts Retention Test: A test designed by the researcher which was administered to both experimental and control groups after 3 weeks of Ecology Concepts Performance Test was administered

Hierarchical Concept Map: This is a type of concept map that show concepts in descending order of importance showing relationship between terms inclusively.

Performance: Is the display of knowledge attained or skills developed in school subject designated by test and examination scores or marks assigned by the subject teacher.

Retention: Is the ability to recall things experienced or learned.

Spider Concept Map: This is a type of concept map that show key concepts literally sprouting from a central topic and detailed branch to form each concept.

Teaching Strategy: Is defined as a process oriented model that allows teachers to present ideas and concepts at many different levels to meet the need of a variety of learners.

ABSTRACT

This study investigated the Effects of Two Concept Mapping Strategies on Retention and Academic Performance in Ecology Among Senior Secondary School Biology Students. The total population for the study was 2,958 students; a sample size of 196 students was purposively selected from three secondary school in Zonkwa Education Zone in Kaduna State. A Quasi-experimental pretest posttest, research design was used for the study which featured three groups (Experimental groups 1&2 and Control group). The experimental group 1 was exposed to spider concept-mapping strategy and experimental group 2 was exposed to hierarchical concept mapping strategy, while the control group was taught using lecture method. The Instrument developed for the study, Ecology Concept Performance Test (ECPT) with a reliability coefficient of 0.82 was used to collect data. Two research questions were raised and Two null hypotheses were also formulated, one of which included: what is the difference in the academic performance among students taught ecology concepts using spider concepts mapping strategy, hierarchical concepts mapping strategy, and lecture method. Ho there is no significant difference in the academic performance among students taught ecology concepts using spider concept mapping strategy, hierarchical concept mapping strategy and lecture method. The data collected were analyzed using t-test Statistic, ANOVA, and Scheffe's test at $P \leq 0.05$ level of significance. Result indicated that; the experimental groups performed significantly better than the control group in their academic performance after undergoing experimental treatments with two types of concept mapping strategies. Based on these findings, it was recommended that; teachers should incorporate spider and hierarchical types of concept mapping strategies into the main stream of pedagogy in the teaching of ecology at Secondary School level. Spider and hierarchical concept mapping strategies were effective in improving students learning outcomes with significant increase in students' knowledge construction which enhances retention of learnt materials.

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CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science as an area of knowledge or an academic discipline has received tremendous support across the globe, particularly by Nigerian government after independence in 1960. Statement of government intention and input was documented in National Policy on Education (FRN, 2013). To maintain a high level of scientific literacy, science education at all levels of education in Nigeria was stressed. The emphasis placed alongside with the important role it plays towards national development, makes it pertinent and practically necessary for science to be taught in an organized and well-structured pattern, involving activities for both teachers and students (Ibrahim, 2012).

Shaibu (2014) defined science as a human activity that leads to production of a body of universal statements called laws, theories or hypotheses which serve to explain the observable behavior of the universe or some aspect of the universe. It is an organized body of knowledge in search for meanings and explanation to events in nature. Conant (1951) viewed science as an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation. The above definitions showed that science is not just collection of data and facts, neither is it an assembly of sterile body of knowledge but that, it involves engaging in certain activities as well (Usman, 2000). However scientific activities are not the same to all practitioners of the discipline, each scientist proceed according to the nature of the problem is concerned with. Biology is one of the science subjects at the senior secondary school level; it is the study of life and structure of plants and animals. It is the branch of science that unraveled most of the major discoveries of the 20th century and still have continue to do so in the 21st century as emphasis moves towards understanding of biological approaches and more eco-friendly synthetic systems such as

forensic biology, environmental, soil and water biology Nwana (2011). Modern biology is a rapidly changing and interesting discipline which aim at presenting biology not as a body of scientific facts related to living things , but as a continuing activity in which man tries to find solution to his never ending problems.

The importance of biology to modern society cannot be over emphasize, few among its benefit includes: preparing individual to challenge superstition, enlightening on body parts and their function, maintenance of good health and hygiene, exposing students on varieties of careers. Biology occupies a unique position as core subject in the senior secondary curriculum in Nigeria serving as pre-requisite for the study of many science-related courses such as Medicine, Pharmacy, Nursing, Microbiology and a host of others. It is therefore pertinent to study biology to derive these benefits. Abubakar (2012) observed that Biology as a discipline has contributed tremendously to financial, physical and aesthetic benefits of mankind and to nation building. Biology education is designed to help the students achieve the following: Ability to demonstrate sufficient knowledge of the concept of the interdependence of life, appreciate continuity of life through reorganization, inheritance and evolution.

Despite the popularity of biology as a science subject, Nurudeen (2011) opined that the statistics of grades obtained by candidates in the West African Examination Council (WAEC) especially in Biology examination in recent years have not been encouraging. Science teachers are key factors to be considered for the development of science education of any nation. Kola (2013) observed that there are shortages of science teachers in Nigerian schools, and most of these so called science teachers are not professionally qualified; some may have the knowledge of the subject but lack the method. Science teachers should use different strategies as there is no single universal approach for specific class. Olorukooba (2002) observed that many science teachers still hold on to chalk and talk method which is

not appropriate for teaching of science in this age. Inability to utilize good and effective strategies in the teaching of biology affects students' performance in Examination. Methods adopted by teachers in the of teaching Biology which is mostly lecture method and is not recommended for teaching science (James 2000).This is because lecture method entails a one way flow of communication from the teacher to the students and it is teacher centered approach where by most of the talking is carried out by the teacher while the students remain passive listeners taking notes, thereby denying the students the opportunity to develop the required manipulative skills (Okeke, 2006). The used of lecture method was attributed to the fact that the school calendar in Nigeria is often interrupted by both teaching and non teaching staff industrial actions, public holidays, political unrest and the need for completion and coverage of the syllabus to prepare students for both external and internal Examinations, hence the use of lecture method which is less time consuming and its use to teach large and small class sizes (Ashaolu, 2014) These secondary school students' low performances at external examinations contribute to the snail movement of both technological and economic development in Nigeria.

According to National Policy on Education (FRN,2013), the broad objectives of senior secondary education is: preparation for useful living in the society and preparation for higher education. Biology as a science subject is very necessary for the realization of this objective, as it prepared professionals such as Medical Doctors, Pharmacists, Biology Teachers, Zoologist, Botanists, Ecologist, and Bio-Engineers with the requisites skills to practice these professions. Biology is also very useful for living in the society its therefore, equips individuals with necessary knowledge, skills and attitudes to enable, him/her interact meaningfully with the environment, and solve life problems relating to ecology in the society. Cirfat (2011) defined ecology as a branch of biology that concern itself with the scientific study of interactions of organisms with one another and with the physical and

chemical environment. Ecology emphasizes that no organism can live in isolation, instead it must interact with the biotic or abiotic components in its environment. Nzewi, (1990) opined that it is necessary to create the awareness of ecology early in students. Certain aspects of basic ecological concepts like ecological system, environment, biosphere habitat, food chain, food web, population density, habitat, that are expected to be taught at the senior secondary school level, requires some basic units of measurement, graphs, experiments, application of ideas and practical activities. James (2000) observed that some students and teachers have a natural phobia for anything that have to do with calculations, such teachers and students would prefer the theoretical aspect in the teaching and learning of ecology concepts. This trend has contributed to the unsatisfactory performance of candidates in questions that deals with ecological concepts in both internal and external examinations (Oyedokun,2002).However, as important as Ecology is to Biology, the performance in it's at the senior secondary school certificate level is a matter that requires prompt intervention (Ahmad, 2014). Students' performances are still below average in external examinations like West Africa Senior Secondary School Certificate Examination (WASSCE) and National Examination Council (NECO). Research effort have been made to diagnose the problems associated with teaching and learning of ecology in other to give solution that lead to better performance and retention (Bawa,2011).

One is expected after studying biology at the senior secondary school level to be self reliant and help to build the Nigerian nation, by been self employed and employers of labour, Owning schools; fisheries and other businesses for themselves where people work and earn their living (Kola, 2013). The knowledge of the subject should help the recipients go into manufacturing and processing industries. Adedawara and Tayo (2007) defined academic performance as the display of knowledge attained or skills developed in school subject designated by test and examination scores or marks assigned by the subject teacher.

Academic performance could be considered as how well the knowledge attained or skilled developed during teaching and learning process was effective. Studies have identified some of the variable that affects student's academic performance to include weak academic background, students low intelligence, lack of aptitude and poor interest for the subject, students bad habits and poor study skill, lack of qualified teachers for the subject, students weakness in comprehension and inability to express themselves, teaching method and its applications (Adeyemi and Adeyemi 2014, NECO Chief examiners report 2013, Okebukola, 2002). Performances in Biology over the years, just like other science subjects, have been low (Obamanu & Adaramola, 2011).

The consistent student's unsatisfactory performance in Biology at the senior secondary school certificate leaves one in doubt about the effectiveness of the teaching methods popularly used by Biology teachers for teaching the subject Similarly, Francisco (2007) posited that prevailing teaching practices do not actively involve the learners in the learning process and seem to deprive the learners of taking charge of their learning, thus, affecting their performances in examination. In line with this, therefore this study adopted the spider and hierarchical types of concept mapping strategies in teaching and learning of ecology to investigate whether it will improve performance and retention of ecology concepts among secondary school students. Teaching is effective when the approach used brings about a desirable change in the behavior of the learner. If learning strategies and students' performance have to improve, then the students have to be introduced to more effective, efficient and appropriate teaching approaches. Concept mapping instructional strategies seems to be an answer to a purposeful and meaningful understanding of difficult concepts in ecology to enhance students' performance and retention

Concept maps are schematic devices for organizing and representing knowledge structures as a set of concept meaning related to one another Novak (1984). Novak and Canas

(2006) defined concept map as graphical tool for organizing and representing knowledge, with concepts enclosed in circles or boxes of some type, and relationship between concepts indicated by a connecting line linking two concepts. Lawal (2004) view concept map as Schematic device (of a diagram) outlining the main features for representing set of concept meanings with corrected and revised text in a frame work of preposition. Concept maps are graphic displays that make use of labeled nodes to represent relationships between concepts.

Experts in learning and cognition such as Novak and Gowin (1984), Lawal (2004) Jegede ,Alayemola and Okebukola (1990) recommend concept mapping strategy, to be used by educators at all levels of education. Meaningful learning and retention of information occurs when students encounter information in both verbal and visual-spatial modalities. According to Novak and Alberto (2006), the human brain remembers information by organizing it into hierarchical structures. Hence concept mapping requires the intentional construction of this scaffold, helping students to learn better and remember more. It is also an effective way to get students practice higher-order thinking skills like synthesis and evaluation. The formats of concept maps are influenced by the types of information in the presentation, concepts that require classification need a map that shows categorization and others, these types include linear, flow, spider/ web, cyclical, and hierarchical concept maps. In this study spider and hierarchical concept mapping strategies were used to investigate their effectiveness on retention and performance in ecology concepts, other types such as flow, web and hierarchical concept maps have also been used to investigate performance in chemistry physics and genetics in biology at the secondary school levels

The use of spider and hierarchical concept maps were justified through identification of the most general concept and more specific concepts; relating them with linking words from general to the most specific concepts; seeking and developing cross-links among different knowledge domains of the maps. Therefore this study examined the effects of spider

and hierarchical concepts mapping strategies on retention and performance in ecology concept among secondary school students

According to Olarewaju (2009), retention is the ability to store information which can be easily recalled from the short and long term memory. Retention is the ability to recall things experienced or learned. It can also be described as a form of reaction which has been presented in the past. Bawa (2011).retention is a result of orientation or attitude which marks an ongoing perception He further observed that retention can hardly be exact even in the rudimentary case of rote learning. Appropriate coding of information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane (Saidou, 2013). Retention according to Isah (2014), Wachanga (2013) and Agbeyaku (2011) has been found to improve the academic performance of students in Mathematics, Chemistry and Biology. Therefore, this study investigated the effects of two types of concept mapping strategies on retention and performance in ecology concepts.

1.1.1 Theoretical Framework

This research work was hinged on Gagne's theory of learning hierarchy (1968); and on Bruner's model of learning by discovery process (1960). According to Gagne (1968), the learning of new concepts depends upon the mastery of pre-requisite concepts which are hierarchically arranged. The focus of this theory was on the retention and horning of intellectual skills; through identification of the most general concept and more specific concepts; relating them with linking words from general to the most specific concepts; seeking and developing cross-links among different knowledge domains of the maps, which were critical for this study. Gagne (1968) stressed, that cumulative nature of learning depend primarily on mastery of lower order concepts, which were represented visually in form of concept maps. This also implies that materials meant for learning were sequentially structured from simple to complex or from known to unknown.

The theoretical framework for this study was also anchored on learning theory as proposed by Bruner (1960), which promotes acquisition of knowledge through discovery-learning; which also belief that learners construct new ideas or concepts based upon existing knowledge. This theory falls under the cognitive domain, where learners are considered to be creators and thinkers through the use of information and opportunities at their disposal. This theory hold that learning always builds upon prior knowledge called schema, because learning is filtered through pre-existing schemata, discovery is used according to this theory as all forms of obtaining knowledge for one self by use of mental process. He suggested that learning is more effective when learners are actively engaged in the learning process rather than attempting to receive knowledge. The significance of this theory to this study was to build meaningful learning using Bruner's approach by facilitating the learning process through actively involvement of students in concepts maps production. Esiobu and Soyibo (2006) Bruner' theory has served as the underpinning theory for many of the current reforms efforts in science education and has been one of the most influential themes in science teaching. This study adopted the Gagne's theory of learning hierarchy (1968), and discovery learning theory as proposed by Bruner (1960), therefore with an understanding of these learning theories, the researcher investigated the effects of two concept-mapping strategies (spider and hierarchical) on retention and performance in ecology among secondary school students.

1.2 Statement of the Problem

The performance trends, observed in biology according to the West Africa Examination Council's Chief Examiner's Reports of 2010-2015, showed an unstable trend from 2010 and fluctuated over the period of four years. This unsatisfactory performance of candidates over the four year period is indicative of inadequate and perhaps declining quality of education at the secondary school level (WAEC Chief Examiners Report 2015). This in

particular has become issues of great concern to scholars and educationists. Top on the list of factors identified by researchers such as Olajide, (2010), Alake, (2014) for this state of affairs is the method of teaching adopted by teachers, which is not in line with modern methods that involve the use of information technology and some other new and interesting methods that can enhance students to learn meaningfully and poor attitude of students towards the subject. Evidence for this can be observed in the WAEC Chief Examiners' report 2010-2015 in Table 1.1.

Table 1.1: Performance of Students in Biology at SSCE 2010-2015 in Kaduna State

Years	No. Registered	No. passed	% Passes at Credit Level (Grades A1-C6)	No Failed	% Failure (Grades D7-F9)
2010	1,300,418	427,644	33.90	872,774	66.01
2011	1,505,199	579,432	38.50	925,767	61.50
2012	1,646,150	587,044	35.66	1,059,106	64.34
2013	1648,363	852,717	51.73	795,646	48.73
2014	1,365,384	766,971	56.17	598,413	43.83
2015	1,014,573	694,983	68.5	319,590	31.5

Source: Ministry of Education, Kaduna State (2015)

Table 1.1 shows percentages of student's performance in biology from 2010- 2015. 2015 recorded the highest percentage of pass at credit level 68.5%, which was considered unsatisfactory as reported by chief examiners report 2015. Therefore it became imperative to look for alternative teaching strategies to find out whether it can enhance students performance. Specifically this study investigated the effects of two concepts mapping strategy on performance and retention of ecology concepts among secondary school students.

1.3 Objectives of the Study

The following objectives were outlined for the study, they include to:

i. determine whether there are differences in the mean scores of students taught ecology using spider and hierarchical concept mapping strategies..

ii. investigate the effects of spider and hierarchical concept mapping strategies on academic performance of students in ecology concepts among secondary school students in Zonkwa Education Zone

iii. investigate the effects of spider and hierarchical concept mapping strategies on retention ability in ecology concepts among secondary school biology students in Zonkwa Education Zone.

iv. examine the differences in mean scores of students :

(i) taught using spider concept mapping strategy

(ii) taught using hierarchical concept mapping strategy and

(iii) students in the control group

1.4 Research Questions

The following research questions were formulated for answering in the study:

1. What is the difference in the academic performance of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy, and Lecture method?

2. What is the difference in the retention ability of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy, and Lecture method?

1.5 Null Hypotheses

Based on the research questions stated the following null hypotheses were formulated and tested at $p \leq 0.05$.

H_{O1} There is no significant difference in the mean academic performance scores of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy, and Lecture method

Ho_2 There is no significant difference in the mean retention ability scores of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy, and Lecture method.

1.6 Significance of the Study

The findings of this study were beneficial to the following:

Students: The findings of this research work were helpful to science students in making effective use of concepts maps in learning ecology and biology in general. It also helped them learnt about their knowledge structure and the process of knowledge construction, and how to learn meaningfully.

Biology Teacher: The findings of this research work were helpful to biology teachers at the secondary school to recognize the uniqueness of spider and hierarchical concept mapping strategies in facilitating teaching and learning of ecology concepts. Through organization of learning experiences in ways that determine the nature of students existing ideas, making evident key concepts learnt and also suggested linkages between information learnt during ecology lessons.

Curriculum Planners and Administrators: To the curriculum planners and administrators the findings of this study provided relevant information during curriculum reviews and evaluation of students' performance in biology in senior secondary biology students. Curriculum planners may use the result to measure the performance of secondary school biology students

Professional Organizations and Bodies: The findings of the research work were also useful to professional organizations and bodies such as Science Teacher Association of Nigeria (STAN) West African Examination Council (WAEC) National Examination Council (NECO) to recognize the use of concepts maps as an instruction as well as an evaluation tools in science education.

Educational Agencies: the findings of this research work were also relevant to Educational Agencies, such as Federal Education Resource Center and States Education Resource Centers in the improvement of teaching and learning of science at the secondary schools level.

Authors and Publishers: students are often, faced with the ultimate challenge of extracting meaning from textbooks / content, the findings of this research provided relevant information to textbook/ instructional materials publishers and authors on vocabulary, text pattern and structures applications, adding spider and hierarchical concept maps in their publications.

Researchers: Furthermore, the findings were of assistance to researcher in similar area of study and other science subject, making enormous contributions to existing literature in the area of science teaching strategies.

1.7 Scope of the Study

The study was limited to all Government Senior Secondary Schools in Zonkwa Education Zone of Kaduna State, Nigeria. There were 32 Senior Government Secondary Schools, of which twenty eight (28) were coeducation schools, two (2) boys and two (2) girls' schools. Senior Secondary School II (SSII) students were used in this study, because they were adequately exposed to the learning of Biology, SSI and SSIII were not used because the former have not yet stabilized in the school system while the latter were busy preparing for their final examination. SSII biology curriculum was used, and focus was on the following:

i. symbiotic interactions of plants and animals.

ii. food chains and food web.

iii. trophic levels; energy flow in the ecosystem.

The choice of these topics was due to the unsatisfactory performance in both internal and external examination at the secondary school level and also these topics were on for the term.

1.8 Basic Assumptions

The following assumptions were made for the study.

1 Teachers have been using activity-based strategies other than concept mapping strategy in the classrooms.

2 That teaching ecology concepts using concept mapping strategy would be able to measure the required data for the study.

3 That all the students are at the same level, and using the same curriculum.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This study investigated the Effects of Spider and Hierarchical Concept Mapping Strategies on Retention Ability and Performance in Ecology Concepts Among secondary school students, in Zonkwa Education Zone of Kaduna State Nigeria. This chapter reviews the literature relevant to the study and is presented under the following sub-headings:

2.2 Teaching Biology as a Core Subject at Secondary Schools

Biology as a separate science was developed in the nineteenth century as scientists discovered that organism shared fundamental characteristics. Biology is a standard subject of instruction at schools and universities around the world, over a million papers are published annually in wide array of biology and medical journals, (Nzewi 2013). Most biological sciences are specialized disciplines, traditionally, they are grouped by the type of organism being studied: Botany (study of plant); Zoology (study of animals); Microbiology (study of microorganism) the fields within biology are further divided based on the scale of at which organisms are studied and the methods used to study them (Adeniyi, 2004).

Biology is a very important part of everyday life, whether we realized it or not. Any advances in medicine, dealing with environmental issues, or biotechnology depend on an understanding of living organism of living organisms (Kalu & Ndokwo 2006). Even if mankind main goal is simply ensuring the survival of the human race, humans still must be able to understand and sustain the biosphere. The greenhouse effects and global warming are both threats that concern the biosphere (Nzewi, 2013). According to Okeke (2007), it will be utterly hopeless to try to sustain the diversity of life on earth in the future without a decent knowledge of biology. In order to maintain the delicate balance of life on earth, humans first must understand that man is not alone on this planet. We need to learn about the effects we have on the environment and other living things. The value of many species can not be predicated. Many plants may contain chemicals that could prove useful in treating illness, among others things. Also, the extinction of any species can disturb the equilibrium of an ecosystem. Therefore there is need to understand that all human actions have effects on other organisms and the environment (Nwana, 2011).

Biological concepts such as physiology, ecology, molecular biology, biochemistry chemical biology and others require more than one method or strategies to teach for effectiveness. For example, lecture method can be used along side with indoor laboratory teaching strategy in the teaching of physiology which examines the physical and chemical functions of the tissue and organ system of an organism. The concept ecology deals with the science of the interrelationship between organisms and their environment. The teaching and learning of ecology need strategies that require direct observation of organisms in natural environment and relating the observed events and phenomenon into cognitive structure, this strategy is called concept mapping. Concepts mapping strategy may help the students to use the process skills and study things in their natural environment. Therefore, the present study

investigated the effects of two types of concept mapping strategies (spider and hierarchical) on retention and performance in ecology concept among secondary school students.

2.2.1 Problems of Teaching Ecology at Secondary School Levels

Ecology literary Means study of living things in their natural surrounding or habitat Usman, (2000), described ecology as the study of the relationship of organisms with one another and their environment. And as such view ecology as being concerned with populations of organisms. Ajaja, (2010) define ecology as the study of the relationships of living organisms with each other and their non-living or physical surroundings. With these definitions, all are pointing to the physical environment in which the organisms lives and their biotic environment. It denotes that no organism can live in isolation instead it must interact with its environment. The undoubted interest which students have in living things is an advantage and a trap to the teachers of Biology (Jean 2001). The teacher must make sure that the learners understand the ecology of the specimens under study and that they have some appreciation of its fellow species and possibly its place in the food chain. Since ecology has to do with interactions of living organisms and the non- living components of the environment, it is necessary to create the awareness of ecology as a subject early in the life of the students (Nzewi, 2008). Certain aspects of basic ecological concepts like population density, habitat and others, expected to be taught at secondary schools require some basic measurements and calculations. Students and teachers have a natural phobia for anything that has to do with calculations. Such teachers and students would prefer a theoretical aspect require weighing and measuring. This trend has contributed to the general poor performance of candidates in question that deal with ecological concepts in the West African Senior Certificate Examinations (Oyedokun, 2002). The senior secondary school biology curriculum places the basic ecological concepts to be studied under year one. And some include the ecological system, environment, biosphere, habitat, biome, food web, food chain, measuring

instruments and others. The curriculum specified the performance objectives to be achieved as well as the activities to be carried out in the course of teaching and learning to facilitate understanding of the concepts being taught (Nzewi, 2008).Therefore, this study investigated the effects of spider and hierarchical concepts mapping strategies on retention and performance in ecology concept among secondary school students, offering the student opportunity to actively engage in the teaching and learning process.

2.3 Methods of Teaching Science at Secondary Schools

Several strategies and techniques that have been used for effective teaching and learning of biology at the secondary school level include: Discovery approach, field trip, project method, Demonstration, lecture, discussion questioning, inquiry, expert group discussion, activity approach games approach, cooperative learning strategy, and computer assisted instruction (CAI) teaching strategy. Below are the explanations of some of the teaching methods.

a. Lecture Method

The conventional lecture method is a traditional talk and chalk method of teaching in which the teacher does most of the talk while the students listen and write notes. This is the method of teaching that emphasizes talk and chalk to the teaching of science subjects. Science teaching embraces this method for easy converge of the school syllabus (Stanley 2008 Duniya, 2009 Obeka, 2009).

According to Okpala (1996), guidelines for the use of lecture method are follows:

i. state the class and the time available for the lesson.

ii. state the lesson topic or subject matter.

iii. state the objective of the lesson.

iv. state the previous knowledge

v. introduction: the teacher state the background of the new lesson.

vi. evaluation: the teacher revises the lesson with the students and asks them proven questions to test their abilities and knowledge.

vii. presentation: the teacher present the new lesson in a logical sequences

Usman (2000) describe lecture method as teacher centered method, and further stressed that the method involves acquisition of subject matter, which is usually by memorization with close supervision of the student's teacher.

Lawal (2009) advantages and disadvantages are numerous. This includes: It saves time and thus does not task the students, this method it is less tedious as it provides fascinating and aesthetically stimulating experience especially for the new students on the topic of interest. Its disadvantages include; it is teacher centered, as it views the student as "tabula rasa" clean slate with nothing to offer, but to sit down and listen to the teacher. (Without any knowledge) thus, he is incapable of making value judgment or input in a lecture. This encourages redundancy among students especially the low achievers. It is dull and less challenging. The method does not create opportunity for creativity and self discovery for learner to rationalize and explore and do not promote excellence and hard work, thus it leads to failure. Usman (2000)Lecture method, therefore is a talk chalk method, teacher centered and a traditional ancient approach, which did not promote creativity and academic excellence, thus a need to review other strategies toward promoting academic excellence in science education.

However, teacher's qualification, experience and skills acquired before certification are not put to practice. The method of teaching adopted by the teacher affects the level of interest and in general, performance of students in biology. In this study the lecture method would be adopted to teach students on the control group to compete with students on the experimental group using concept mapping strategy. Therefore this study investigated the effects of two types of concept mapping strategies (spider and hierarchical) on academic

performance of secondary school students in ecology concept of biology. Another method that teachers used in teaching and learning of biology is the discussion method.

b. **Discussion Method**.

It is a method of instruction which gives the students the opportunity to express their views or opinions orally on certain issues one speaks at a time, while others listen. To a large extent it is students centered since students participate actively. The teacher in a discussion class acts as a moderator, discussion method of teaching science increased curiosity about the subject, it enhances more positive perception of students about value of the subject, to get information on what to contribute during discussion students spend more time reading (Mayo,2011). Students seem to attend to class more regularly since they usually enjoy the lesson especially when it is less formal. Discussion facilitates higher levels of thinking, accommodates conflict, negotiation and consensus, enhance learning and longer retention. Although the discussion method is effective, it could be time consuming and the classroom could appear noisy. Oyarole (2014) states that if discussion is not well moderated by the teacher the discussion could be dominated by a few outspoken ones and sometime the teacher may want to impose his own ideas on the class. This method of teaching can be used in the teaching and learning of a few concepts in biology, example living things and non living things particularly in the classroom. But most of the concepts in biology require the process skills therefore, field work is very vital. Another method used in the teaching and learning of biology is the project method.

c. Project Method

Teachers using the project method act as guide or facilitators. In the use of the project method in teaching the teacher selects a central theme, or an idea. The task is broken into sub-units so as to be easily understood and worked upon. The students are allowed to work independently or in groups. Allowing students to work in groups is most effective, this bring

about co-operative learning among members of the group (Nzewi, 2013). During project students are expected to make observation, collect data discuss ask questions and clarification, manipulate instruments and variables, collect and interpret result. This method is not the most appropriate with senior primary and secondary school classes (Ivie 2006). However, students in the lower primary can undertake projects like the making of paper kits, fans, drawing objects and making simple shapes and models. This method can be used in the teaching and learning of biology but can not be used effectively in the teaching and learning of ecology which require real observation of the organism's natural environment. Demonstration is another method of teaching and learning of biology.

d. Demonstration Method.

This involves showing students how to carry out particular activities or do certain things to illustrate science concepts and ideas. Demonstrations are usually carried out when the resources are limited or when the activity is prone to accident; otherwise students are expected to carry out their own experiment after demonstration (James, 2000). He further states that during a demonstration the teacher should note the following.

i. The teacher should state the purpose of the demonstration and this must be clear to all students participating in the activity.

ii. All students should be able to see every aspect of the demonstration clearly.

iii. Explanation should be very clear and unambiguous.

iv. Involve the students as much as possible, and should be called upon to do things and explain their observations.

v. Simple and readily available apparatus and instruments should be used for demonstration.

This method can be used in the teaching and learning of some concepts in biology, but it does not require seeing things in their natural environment. Other methods used include

problem solving strategy, discovery teaching strategy, activity based teaching strategy, questioning technique and field trip teaching strategy etc.

e. Problem Solving Strategy

Problem solving strategy is an instructional strategy that has been increasingly emphasized in recent years. It combines the advantages of several other science teaching methods. It encourages inquiry, gives room for discovery, and facilitates process skills acquisition and knowledge. When children are engaged in problem solving activities they inevitably get involve in the inquiry, discovery, explore and perform various process of science (Bichi 2008). Bichi, (2013) suggested four guidelines for teaching science through problem solving approach.

i. Encourage the learner to tackle the problem by adopting scientific approach. (Observation, hypothesis, experimentation and conclusion).

ii. Encourage learners to keep track of their activities always by jotting down major steps in the activities they carried out.

Problem solving strategy can be used to teach cell (plant and animal cell) effectively in biology.

f. Questioning Technique.

Questioning is an act of making statement which requires respondents(s) to make responses(s).in teaching and learning ,questions are used to determine student's readiness to learn new skill/concept (Adeniyi,2004). When questions are properly used in biology classrooms, they encourage the learner to be at alert, active, thinking and seek alternative to responses. Basically there are two types of questions adopted in teaching and learning process in the class room are narrow questions and broad questions. Examples of narrow questions are (a) how many colours are has a rainbow? (b) What is the SI unit of mass? An example of

broad question on the other hand gives scientific explanation to the saying that what goes up must come down.

g. Discovery Approach

Discovery approach is a method which offers learner the opportunity to discover scientific facts, concepts and principles for themselves rather than being told. It allows learner the opportunity to discover and learn science, (Eneh, 2000). Discovery is in essence a matter of re-arranging or transforming evidence in such a way that one is enabled to go beyond the evidence and reassemble additional new knowledge. Discovery approach teaching strategy can be used to teach ecology (succession).

h. Activity Based Teaching Strategy

Activity based approach is an approach to the teaching of biology concepts that involve s hands-on mind-on engagement of both the teacher and the learners. It involves the manipulation of tools, materials accurate measurement, accurate recoding of observation, analyzing of results and drawing inferences. It also involves exchange of ideas and provides answer to questions asked by teacher (Eneh 2000) argued that activity approach promotes learning. This strategy can be used to teach basic ecological principles. Research in science education has continued to seek better ways of teaching science to maximize meaningful learning and improve academic achievement (Usman, 2008). There is no single instructional strategy that is best for science teaching, but educators are in agreement that any strategy that would involve active learner participation, hand-on, mind-on. Laboratory activities, group work, field trip, concept mapping and others, would ensure meaningful leaning and improved academic performance in science (Lawal, 2004).

i. Field Trip Teaching Strategy

Field trip is an outdoor or field work learning exercise undertaken by teachers and students in certain aspects of a subject to give students the opportunity to acquire knowledge.

It may be refer to a trip to various places to obtain information directly by seeing things as they really are (Nwezi, 2013). Field trips can connect school work with the world, making it tangible and memorable. Field trips stimulate questions and ideas at the beginning or end of a unit. Field trips also provide an experimental 'text' for students to study and interrogate. Therefore this study investigated the effects of two types of concept mapping strategies (spider and hierarchical) on performance and retention of ecology concept among secondary school students.

2.4 Concept Mapping Strategy and Science Teaching

Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts. Bamidele and Oloyede (2013), define concept as a perceived regularity in events, objects, records of events or objects, designated by a label. The labels for most concepts are words, although symbols can use. Propositions are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement. Novak and Gowin (1984) state that linking phrase should join concepts to form meaningful learning proposition, which are basic unit of knowledge according to the theory of meaningful learning and Ausubel's Assimilation Theory (1968). An example of concept map is presented in Figure 2.1

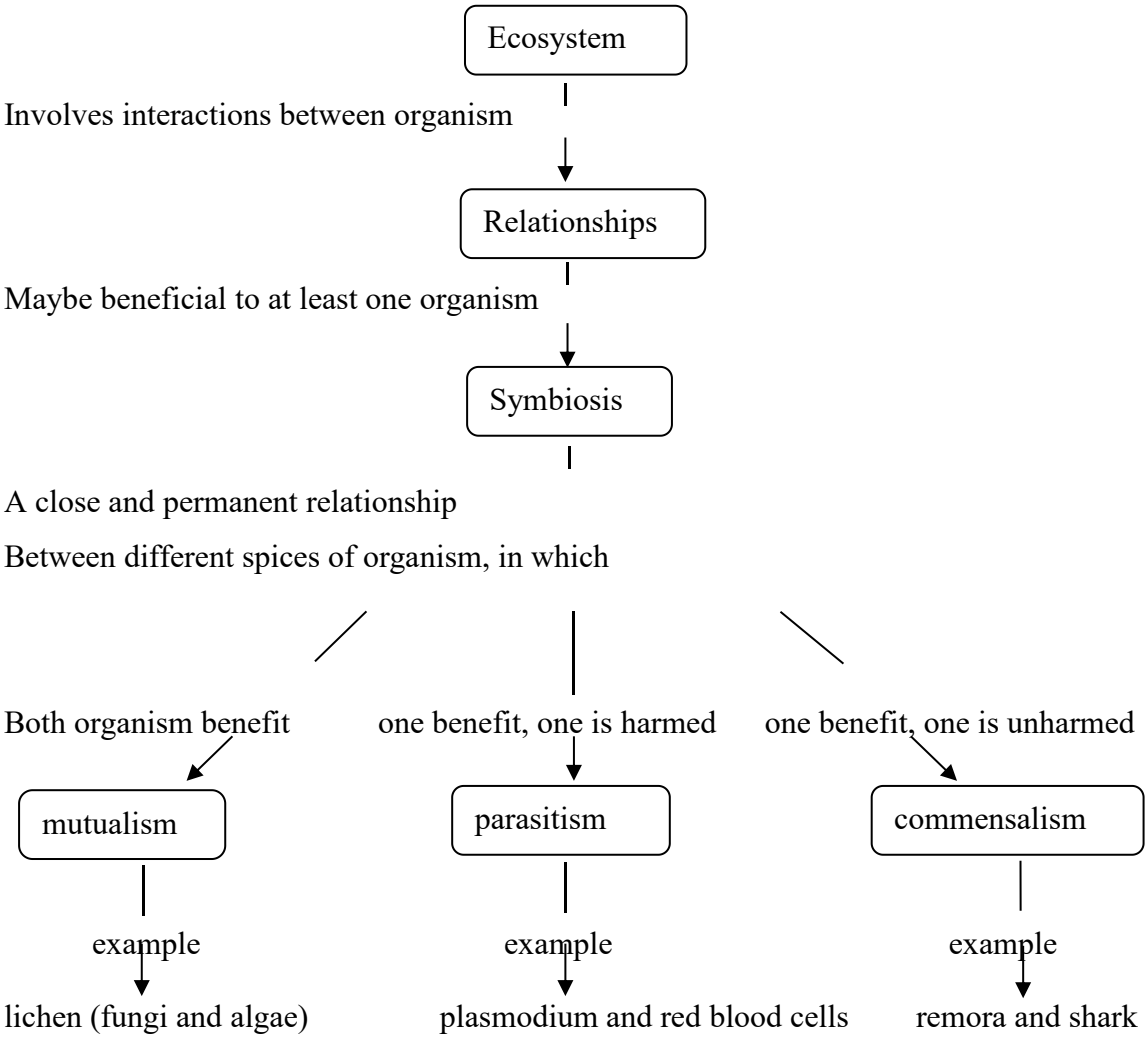

Figure 2.1: Concept Map for Symbiotic Interactions

Source(adapted from Novak1994)

Another characteristic feature of concept mapping strategy is the basic motivation for the hierarchical arrangement of concepts in concept maps which comes from Ausubel's notion of subsumption, that more general superordinate concepts subsume more specific detailed concepts. A distinctive characteristic of concept maps is the inclusion of cross-links. These are relationships or links between concepts in different segments or domains of the concept map. Cross-links enable students see how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer (Kothe, 2009). There are two features of concept maps that are

important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links. A final feature that may be added to concept maps is specific examples of events or objects that help to clarify the meaning of a given concept. Normally these are not included in ovals or boxes, since they are specific events or objects and do not represent concepts.

Concept mapping strategy in science education is parallel with the movement from teacher to learner-centered method which has the power to improve academic performance (Peterson & Snyder, 2008). Concept mapping has been widely recommended and used in a variety of ways. It has been used to help the science teacher and students build an organized knowledge based on a given discipline or a given topic(Blackwell & Pepper, 2008).it has also been used to facilitate middle level students learning of science content (Novak & Gowin, 1994; Adloan, 2012 & Dhaaka, 2012), findings from these indicated that concept mapping is an effective tool for aiding students comprehension and retention of science materials.

2.4.1 Types of Concept Maps

A concept map is a tool that engages students in active learning, serving as instruments which help students highlight and connect core component of concepts. These connections aid students to develop organizational and problem solving skills (Pitcher, 2011). The formats of concept maps are influenced by the types of information in the presentation. The concepts that require classification need a map that shows categorization. Maps for processes or sequence of events allows for stages and sub stages. Meyers (2014) regardless of the type of information being presented, all concept maps have a central idea. Depending on the relationship type, a concept can illustrate a sequence of events, a cycle a step or process. Concept map are visually appealing and convey information quickly.

Flow / Linear Concept Map: Flow maps graphically depict a sequence of events in order which they take place chronologically. They can be used to represent complex processes and

can help students identify various stages and sub stages of an event. Any concept that has a distinct order can be displayed in this type of concept map. It can be used to compare two concepts, themes or events. It is also an excellent tool for teaching students the final steps necessary to reach the final point, serving as procedure section in a scientific process.

Spider / Web Concepts Map: Oloyede (2010), spider concept map can be organized by placing the central them or the unifying factor in the center of the map, Outwardly radiating sub-themes surrounding the centre of the map. This type of map show key concepts literally sprouting from a central topic and detailed branch to form each concept. it is an organizer that can be used for organizing and classifying,(Lee , 2007), It also enable students to focus on a concept, theme or topic, identify the secondary categories related to the big idea and then add all the significant dimension related to those secondary categories. It can be used to assess how well students have organized data.

Hierarchical Concept Map: Bamidele and Oloyede (2013), view hierarchical concept maps as a list of information in descending order of importance showing relationship between terms inclusively, with the most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore, it is best to construct concept maps with reference to some particular question we seek to answer.

Cyclical / Sequential Concepts Maps: illustrates the general characteristic of a concept in a circular form with those characteristic that show relationship in a step wise manner. It is one of the beneficial tools in the teaching and learning of biology. This is because it can be used to study the impact of nutrients cycles in the ecosystem.

2.4.2 Concept Mapping Strategy and performance in Science.

As the problem of improving the teaching and learning of science preoccupies educators' concept mapping strategy has been widely recommended and used in a variety of context **(**Boujaoude, 2008). Each context reflects an alternative theory of knowledge acquisition. On one hand, the rationalist theory of learning suggested that the disciplines have inherent structures that should be conveyed to the learners. On the other hand; constructivist highlighted the uniqueness of each individual's representation of concept leading them to devise various mechanism to evaluate students' concepts maps. Novak (1984) concept map are useful in science curriculum planning for separating significant from trivial content.

In an attempt to identify more conceptually based teaching and learning method in science, Researchers have investigated the use of concept maps in many content areas such as biology, physics, and chemistry. Horton, McConnney, Galio, Wood, Senn, and Hathelin (1993) conducted a meta-analysis study in which they found out that there were many more studies using concept mapping in biology than in physical sciences and that, although most results showed positive effects on attitude and achievement, these effect were more obvious in biological than the physical science, with conflicting result. Zoller (1990), question the effectiveness of concept mapping in chemistry because many chemistry concepts are abstract, non-intuitive, and not directly interrelated. In contrast, Novak (1994) argues that problem the is not due to abstractness of any science content, the problems rather arise from the fact that students learn science by rote learning and do not recognize key concept and their relationship. Differences in results could also arise from the fact that studies have focused on the use of concept maps as an instructional Strategy, curriculum development, and assessment tools but not as study skill especially in homework assignments (Ajaja, 2011). However research has demonstrated that concept mapping is a study skill that require time for mastery, a mental analysis conducted by Horton et al, (1993) has shown that positive effect

were achieved in studies than the range in length from 2 to 22 weeks, with an average duration of six weeks.

Science educators reported the downtrend in academic performance of Nigeria students in science (Oyarole 2014). Biology is among the science subject and in fact the failure rate in biology is even more alarming compared to chemistry and physics despite the fact that it is the popular science subjects whose pass at credit level determine the admission of students to study major professional science based courses at the university (lawal 2009). The failure rate in biology at SSCE has continued to be a source of worry to curriculum planners, educationist's, parents and the entire society at large. This is as a result of using an ineffective teaching method (Ahmad 2014). Some of the factors identified as opposing effective teaching in Nigeria secondary schools includes; rote learning (Usman 2008), lack of appropriate learning environment under which science teaching can take place (Bichi 2008); inadequate equipment and facilities (Okafor 2002) lack of opportunity for the child to have direct experience with learning materials (Bajah 2002), and inappropriate use of teaching strategies (Adeniyi 2004). To minimize the failure rate in biology, teachers should be armed with various teaching strategies which can be used along side lecture method for the teaching of different concepts in biology. Therefore, this study investigated the effects of two types of concept mapping strategies (spider and hierarchical) on performance and retention in ecology concept among secondary school students in Zonkwa Education Zone.

2.5 Retention Ability and Academic Performance in Science

Retention is defined by Kundu and Tutoo (2002) as a preservative factor of the mind. The mind acquires the material of knowledge through sensation and perception. These acquired materials in the mind need to be preserved inform and images for knowledge to develop. Whenever a simulating situation occurs, retained images are received or reproduced to make memorization possible. Agbeyanku (2011) explained that Retention of concept learnt

would help in reflective thinking and the use of the retained concepts in creative way to solve day to day problem. Goldstain (2010) associated Retention with long term memory according to him retention focus not only on its functionality but on its duration as well because long term memory is involved with the long storage of manipulation and efficient processing of information. Martins (2000) conceived retention as a process in which information is encoded, saved and retrieved. Encoding or registration allow information that is from outside world to reach our senses on the form of chemical and physical stimuli, it involves receiving, processing and containing of received information.

Retention was seen by Beer (2010) as tools employed by learners to assist them perform efficiently and effectively in all aspect of life and particularly in the school. This essential tool is needed by learners to maintain and manipulate information in the mine for a brief and long period of time. Bawa (2011) posited that Retention is the ability to actively hold information in the mind needed to the complete task such as active thinking comprehension and learning. Ochonogor (1997) explained that the in depth retention and achievement in science, technology and mathematics is an important need that is becoming highly felt by the Nigerian populace. Baddeley (2000) suggested that retention is related to academic performance on the domain of physical sciences and used academic achievement in enhanced by a number of abilities, storage, capacities, processing efficiency, the ability to combine storage and processing the ability to inhibit irrelevant information, the quality of knowledge representation and the ability to use efficient strategies in the face of interfering processes and distraction.

The level of retention is determined by the nature of material coded (Bichi, 2002; Agbeyenku, 2011). This appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory (Bichi, 2002). The Retention according to Cano (2005) takes place when learning is coded

into memory and that understanding and retention are produced of meaningful learning. So when teaching is effective and meaningful to the student, it inclines to build and maintain memory for a task. This memory according to him is characterized by a large capacity; it can hold and accept a large amount of now information at one time the capacity of the memory makes it convenient to assimilate a large chunk of information simultaneously (Martins 2000). Learners at school need this memory on a daily basis for varieties of task that may assist in remembering task, irrelevant information and improve performance on cognitive task. Novak and Canas (2006) observed that teaching students to use memory strategies by employing appropriate teaching strategy will not only improve student thinking skill on complex task of production, modeling, experimentation and evaluation, but will also assist learners to attain deep understanding of conceptual knowledge and will result in developing cognitive facilities domain. Harrey (1993) as cited in Agbeyenku (2011) outlined the following factors affecting student's retention in relation to their academic achievements in sciences as:

- Thinking style of the individual learners,
- The age of the learners,
- Nature of materials to be learn and
- Teacher's method of teaching.

Hence ecological concepts need to be presented to learners in a way or method that touches their sub consciousness which can trigger quick recalling of concepts being taught or learnt. This study therefore, intends to employ the use of spider and hierarchical concept mapping strategies to determine its effects on students' retention and performance in ecology concepts among secondary school students.

2.6 Overview of Similar Studies

Ajaja (2011) conducted a study on the use of concept mapping as a study skill and its effects on students' academic achievements in biology among secondary school students in

Abavo, Delta State Nigeria. Population of the study consisted of 280 SSII students, and120 students were selected as sample for the study. Research design employed was quasi experimental, Five research questions were raised and three hypotheses stated, which were tested at 0.05 level of significance. Sample of research question and hypothesis include: Is there any difference in biology achievement test scores of students who used concept mapping as study skill and those who did not? Ho: There is no significant difference in mean biology achievement test scores of students who used concept mapping as a study skill and those who did not. The instruments used were Biology Achievement Test (BAT) and oral interview. Statistical tool used for data analysis was Analysis of Covariance (ANCOVA). Some of the findings include: A significant increase in test scores of students who used concept mapping as study skill; and a significant difference in estimated retention between students who used concept mapping as study skill and those who summarized after review. This present study used two types of concept maps as an instructional strategy, not as a study skill among secondary school biology students as reported, and also focused on performance and retention in ecology concepts rather than in biology as a whole.

Akeju, Rotimi and Kenni (2011) studied the Effects of Concept-Mapping Instructional Strategy on Retention and Academic Achievement among Secondary School Physics Students in Ekiti State, Nigeria. The research design was quasi-experimental, with 168 SS II Physics students as sample for the study. The instruments used for data collection was physics achievement test (PAT). Three research questions were raised and three hypotheses stated, which were tested at 0.05 level of significance. Sample of research question and hypothesis include: what is the effect of concept mapping instructional strategy on students' academic achievement. H_O: There is no significant effect of treatment on students' learning achievements. The findings of the revealed that: (a). Concept Mapping Instructional strategy contributed to learning achievement in physics; (b). There was a

significant effect on students' retention of learned materials. Although this report is on concept mapping strategy, this present study examined the effects of two types of concept map (spider and hierarchical) on performance and retention ability in ecology.

Bawa (2011) conducted a study on Effects of Problem Solving Instructional Strategy on Academic Achievement and Retention in Ecology among Senior Secondary School Students with Different Cognitive Preferences in Kaduna State Nigeria. Population for the study consisted of all SSII biology students, 240 SSII students were used as for the study. The research design was quasi experimental, seven research questions were raised and seven hypothesis were stated at 0.05 level of significance. Two instruments were used for data collection, ecology Achievement Test (EAT) and Cognitive Preference Test (CPT). Statistical tool used for data analysis were t-test comparison for pre and post test mean scores and ANOVA test for the two groups for significant differences. Findings from the study include: there was a significant difference between the posttest mean scores of the experiment and control groups in favor of the experimental group. This present study investigated the effects of spider and hierarchical concept mapping strategies on retention and performance in ecology rather than problem solving instructional strategy as reported by Bawa (2011).

Otor (2011) studied the Effect of Concept-Mapping Strategy on Students' Achievement on Difficult Chemistry Concepts among secondary school students in Benue State Nigeria. Research design procedure was quasi-experimental pretest-posttest groups, Data were collected from 1,357 SSII chemistry students using a stratified random sampling technique. Two research questions were raised and two hypotheses were formulated to guide the research. Samples of research questions and hypothesis include. To what extent is the difference between the mean achievement scores of chemistry students taught using conventional method and those taught using concept mapping strategy? H_O: There is no Significance difference in the mean achievement scores of senior secondary school chemistry

students taught using concept mapping and those taught using the conversional method. The instrument used for data collection was Chemistry Achievement Test (CAT). The research questions were answered using mean and standard deviation scores, while the hypotheses were tested at 0.05 significance level using Analysis of Covariance (ANCOVA). Findings of the study were: Students taught using concept mapping strategy achieved higher and significantly better than those taught using conventional method. There was also a better performance in favour of female students compared to their male counterparts using this method. Although both studies were on effects of concepts mapping strategies, this study was on Students' Achievement on Difficult Chemistry Concepts, while this present study investigated students' retention abilities and performance in ecology concept.

Ajayi (2012) investigated the Comparative Effectiveness of Concept Mapping; Instructional Strategy, Cooperative Learning and Learning Cycle Strategies on Retention and Achievement among Senior Secondary School Biology Students in Ika South, Delta State, Nigeria. Population for the study consisted of all SSII students, 259 SSII students were used as sample for the study. The research design was quasi experimental Five research questions were raised and five hypotheses were stated and tested at 0.05, level of significance. Sample of research questions and hypothesis include; (a) is there any effect of the experimental and control methods of instruction on student's achievement?; $H_{O:}$ there is no significant effect on the use of concept mapping, cooperative learning, learning cycle and lecture method of teaching on achievement. The instrument used for data collection was Biology Achievement Test (BAT). Statistical tools used for data analysis were t-test comparison for pre and post test mean scores and ANOVA test for the three groups for significant differences. Findings from the study include: (a) A significant effect of the three instructional methods on achievement and retention; (b) students in the learning cycle and cooperative learning groups significantly out scored those in the concept mapping group on achievement and retention

tests; (c) students in learning cycle and cooperative learning groups did not significantly differ on achievement and retention tests. This present study investigated the effects of two types of concept mapping strategies on retention and academic performance in ecology, rather than on effectiveness of three instructional strategies (Concept Mapping; Instructional Strategy, Cooperative Learning and Learning Cycle Strategies) on achievement and retention in biology as reported.

Bamidele and Oloyede (2013) conducted a study on the Relative Effectiveness of Three Concept Mapping Strategies (hierarchical, flowchart and spider) on Performance in Chemistry among Senior Secondary School students in Ife , Osun State, Nigeria, The population for the study consisted of all SSII students,146 students were purposively selected from three schools to form sample for the study. Research design was quasi experimental, Two research questions were raised and two hypotheses were formulated to guide the research. Samples of research questions and hypothesis include; Are there any differences in the performance of students taught chemistry using hierarchical; flow; and spider concept mapping strategies?, Ho1: There is no significant difference in students' performance when hierarchical; flowchart and spider concept mapping methods were used to teach Chemistry. Instrument used was a Problem Solving Achievement Test in Chemistry (PSATC). Statistical tool used for data analysis was ANOVA test for the three groups for significant differences. The findings of the study indicated that there were no significant difference in the performances of the students in the three groups with respect to the type of concept map used. They all produced similar effect on the student's performance in Chemistry. Although both studies examined the effects of various types of concept mapping strategies, this report was focused on performances among chemistry students in Osun state while, this present study examined performance and retention of ecology concepts in Kaduna State Nigeria.

Jaya (2015) investigated the Effect of Concept Mapping on Achievement in Chemistry of IX Grader in Relation to Achievement, Motivation in Government Schools of Ludhiana District Punjab, India. The study adopted a quasi-experimental pretest-posttest group design. Sample for the study consisted of 302, ninth grade students randomly selected. Five research questions and five hypotheses were formulated and tested at 0.05, level of significance. Two Instruments were used for data collection. Achievement Motivation Scale (AMC) and Chemistry Achievement Test (CAT). The statistical tool used for data analysis was t-test statistical tool. The major findings of the study revealed that concept mapping is the strategy that leads to higher academic achievement in students. This present study investigated the effects of two types of concept mapping strategies on performance and retention in ecology concepts in Nigeria secondary schools as opposed to this report on effects of concepts mapping strategies on academic achievement in relation to motivation among ninth grade chemistry students in Government Schools in Punjab District, India.

Sakiyo and Waziri (2015) Effect of Concept Mapping and Inquiry Teaching Strategies on Secondary School Students' Academic Achievement in Biology Adamawa state, Nigeria. Population for the study comprised of all SSII students in Adamawa, offering biology. Purposive sampling technique was used to select 176 students as the study sample. Research design was quasi experimental. Two research questions were raised and two hypotheses were formulated to guide the study. Sample of research questions and hypothesis stated and tested at 0.05 level of significance include; what are the effects of concept mapping and inquiry instructional strategies on academic achievement in biology? H_O1:There is no significant effects on academic achievement in biology when taught biology using concept mapping, inquiry and lecture method. The instrument used for data collection was biology Students Achievement Test (BSAT). Statistical tool used for data analysis was a Two-way Analysis of Covariance (ANCOVA). The findings from the study reveal that, there

was a significant difference between concept mapping, inquiry and lecture method, and that the use of students centered teaching method like concept mapping and inquiry method in biology makes it possible to have and interactive lesson. This present study examined the effects of concept mapping strategies, while this report focused on two instructional strategies (concept mapping, and inquiry method,) and its effects on students' academic achievements in biology. And also statistical tool used as reported was a two way ANCOVA, this present study used ANOVA for data analysis.

2.7 Implications of Literature Reviewed for the Present Study

Relevant literature, have been reviewed and findings from the overview of similar studies indicated that academic performance are highly related to teaching methods and ability of students to understand and retain facts. An appropriate teaching method influence positively the performance and make easy the retention of concepts and their connection. While many researchers such as (Akeju, Rotimi & Kenni 2011; Otor 2011 and Jaya 2015; Sakyo & Waziri 2015), indicated that concept maps enhance and promotes meaningful learning, others research study like Ajayi (2012) concluded that it has no effects on achievement and retention, when compared to other teaching and learning strategies such as learning cycle and cooperative learning .

Among the similar studies reviewed, study conducted by Bamidele and Oloyede (2013) revealed that there was no significant difference in the performance of the students with respect to the type of concept map used. This implies that there were no differences in their superiority, with all producing the same effects on students' performance. This make it pertinent to design a study involving traditional lecture method along side with spider and hierarchical concept map, to help in identifying which of these strategies, greatly enhance retention and performance in ecology concepts among secondary school students. Findings from the overview also revealed the advantages of using concept mapping strategies in

science education using physics and chemistry (Akeju, Rotimi & Kenni 2011; Otor, 2013; Bamidele & Oloyede, 2013; Jaya, 2015) with the exception of ecology concept in biology. Therefore, it is also pertinent to conduct a research on the effects of concept mapping strategies on academic performance and retention in ecology concepts. This is because of the inconsistency in students performances in ecology and biology.

Most of the literatures reviewed were conducted in locations outside Kaduna state, also most literatures reviewed were on either one or three types(flow, spider, hierarchical) of concepts mapping strategies in chemistry, therefore the need to design and conduct a research on effects of two types of concepts mapping strategies (spider and hierarchical) on retention and performance on ecology concepts among secondary school students in Zonkwa Education Zone of Kaduna State, Nigeria became pertinent.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The purpose of this study was to investigate the effects of spider and hierarchical concepts mapping strategies on retention and performance in ecology concepts among secondary school students. In this chapter the methodology that was used for data collection is described under the following sub- headings:

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Techniques

3.5 Instrumentation

3.5.1 Validation of instruments

3.5.2 Pilot Testing

3.5.3 Reliability of the Instrument

3.5.4 Item Analysis

3.6 Administration of Treatment

3.7 Data Collection Procedures

3.8 Procedure for Data Analysis.

3.2 Research Design

This study adopted a quasi-experimental design involving pretest, posttest, postpost tests experimental and control group design. The design involved three schools which were randomly selected from the population of public senior secondary schools in zonkwa education zone. Intact classes were used in this research work, the subjects were pre-tested to determine their equivalencies in ability and using drawing from the hat they were placed in three groups, experimental group one (EG_1); experimental group two (EG_2) and control group

respectively. The experimental group one (EG_1) were exposed to spider concept map and experimental group two (EG_2) were also exposed to hierarchical concept mapping instructional strategy for a period of six (6) weeks, while the control group were taught using lecture method for the same period. The instrument for this study was Ecology Concept Performance Test (ECPT) which consisted of 25 multiple choices Biology test item adopted from the West African Examination Council (WAEC) pass questions

The students were then post-tested using the same instrument to determine whether treatment have any effects on the subjects. The illustration of the design for the study is presented in Figure 3.1.

EG 1 $\longrightarrow$ O_1 $\longrightarrow$ X_1 SCM $\longrightarrow$ O_2 $\longrightarrow$ O_3

EG 2 $\longrightarrow$ O_1 $\longrightarrow$ X_2 HCM $\longrightarrow$ O_2 $\longrightarrow$ O_3

CG $\longrightarrow$ O_1 $\longrightarrow$ X_0 $\longrightarrow$ O_2 $\longrightarrow$ O_3

Figure 3.1: Research Design

Source: Adopted from Sambo (2008)

KEY: **EG_1**- Experimental Group 1

EG_2- Experimental Group 2

CG- Control Group

O_1-Pretest Administration

O_2-Posttest Administration

O_3-Postposttest Administration

X_1SCM- Treatment using Spider Concept Mapping Strategy

X_2HCM- Treatment using Hierarchical Concept Mapping Strategy

X_0- Teaching using Lecture Method

3.3 Population of the Study

The population of the study consisted of all Senior Secondary School students (SSII) in 2015/2016 session in Zonkwa Education Zone of Kaduna State Nigeria offering biology. This Zone consists of thirty two (32) Government own senior secondary schools. out of these schools twenty eight (28) are coeducation schools while two (2) are boys schools and the other two (2) are girls schools. Although these schools are physically different in terms of locations, they are same in terms of administration, staffing, infrastructure and criteria for admission. Population for the study was 2,958 comprising of 1,532 boys and 1,426 girls. The population description is presented in Table 3.1

Table 3.1: Population of the Study

S/N	Schools	Nature	Male	Female	Total
1	G.S.S Zonkwa	Boys	35	-	25
2	G.S.S Fadan kaje	Boys	245	-	245
3	G.G.C Zonkwa	Girls		320	402
4	G.G.S.S Zonkwa	Girls	-	210	210
5	G.S.S Fadan Kamantan	Coeducation	57	32	89
6	G.S.S Kamuru Ikulu	Coeducation	68	54	122
7	G.S.S Anchuna Sarki	Coeducation	27	23	50
8	G.S.S Farman	Coeducation	43	20	63
9	G.S.S Bale	Coeducation	34	29	63
10	G.S.S Fanjim	Coeducation	44	26	70
11	G.S.S Goragan	Coeducation	127	94	221
12	G.S.S Gora-bafai	Coeducation	34	21	55
13	G.S.S Ziti	Coeducation	89	54	143
14	G.S.S Kurimi Bi	Coeducation	51	30	81
15	G.S.S Aduwan Gida	Coeducation	30	28	58
16	G.S.S Akupal	Coeducation	44	39	83
17	G.S.S Ashafa	Coeducation	28	13	41
18	G.S.S Bakin Kogi Kitibi	Coeducation	35	41	76
19	G.S.S Boto	Coeducation	86	87	173
20	G.S.S Tudun Wada Fadia	Coeducation	92	51	143
21	G.S.S Jankasa	Coeducation	30	27	57
22	G.S.S Kabam	Coeducation	49	35	84
23	G.S.S Kangun	Coeducation	36	27	63
24	G.S.S Kigudu	Coeducation	34	21	55
26	G.S.S Kurdan	Coeducation	46	31	77
27	G.S.S Kurmi Marsa	Coeducation	24	19	43
28	G.S.S Mabushi Kataf	Coeducation	26	21	47
29	G.S.S Madakiya	Coeducation	32	17	49
30	G.S.S Maganiya	Coeducation	32	17	49
31	G.S.S Sako	Coeducation	21	13	34
32	G.S.S Samaru Kataf	Coeducation	33	26	59
	Total		**1,532**	**1,426**	**2,958**

Source (Zonkwa Educational Zonal Office, 2015)

3.4 Sample and Sampling Techniques

Simple random sampling method was employed in the selection of three schools, because schools samples were drawn from coeducation schools. The schools selected included school A, B and C, Purposive sampling method was used to select three intact classes for the study. because only SS II science classes offer biology in the sampled schools .Simple random sampling was employed to assigned these intact classes into control and experimental groups.(Three students from each school were asked to hand pick pieces of already folded papers with names of groups)

Sample sizes of at least 30 cases were required in each group for quasi experimental research (Mugenda & Mugenda, 2003). This number was considered viable given the design of the study as conceded to by Roscoe (1976) who stated that 10% of the study population up to 500 is a viable sample size for an experimental research

Table 3.2: Sample for the Study

Schools	Group	Boys	Girls	Total
A	EG 1	43	20	63
B	EG 2	44	26	70
C	CG	34	29	63
Total		120	75	196

3.5 Instrumentation

The instrument for the study included:

- Ecology Concepts Performance Test (ECPT) and
- Lesson Plans

3.5.1 Ecology Concepts Performance Test (ECPT)

The ECPT consisted of 25 multiple choice questions with four options each for students to choose the correct options. These questions were adopted from past WAEC/NECO question papers of 2005-2015. The test items covered all the topics taught during the duration of the research. These topics are: Symbiotic interactions of plants and animals; Food chains; Food web; trophic levels and energy flow in the ecosystem. . (See Table 3.3) for specification of instruments based on topic and Blooms (1965) cognitive taxonomy. The choice of these topics was due to the fact that many environmental issues are contemporary issues, which needed to be addressed at the secondary school level and also these topics were on for the term and students performance level at both internal and external examination were not satisfactory.

E C P T which consisted of 25 multiple choice questions with four options each, were rearranged to represent the Ecology Concept Retention Test (ECRT) which was administered to both the control and experimental groups to determine the retention ability of the students. The test was conducted two weeks after the administration of ECPT as recommended by Tukman (1975) and Sambo (2005), who proposed a minimum of two weeks interval for test-retest method.

Lesson plans containing topics taught during the duration of the research were developed with specification according to the three groups that were involved in the study, (EG1, EG2 and CG). The experimental group one (EG1) lesson plan adopted the spider concept mapping instructional strategy plan, and the experimental group two (EG2) lesson plan adopted the hierarchical concept mapping instructional strategy plan, while the control (CG) lesson plan was based on lecture method plan. (See Appendices A, B and C)

Table 3.3: Table of Specification and Distribution of Items Based on Bloom Cognitive Taxonomy for (ECPT)

Contents	Weight %	Knw.	Comp.	Appl.	Anal.	Synth.	Eval.	Total
Symbiotic interactions of plants and animals	40%	1,2,6,12 24,18	3,15,16	-	25	8	-	11
Food chain	21%	13,14	10	-	11	19	20	6
Food web	22%	22	9	4,5	-	7	-	5
Tropic level	17%	21	-	17	-	23	-	3
Total	100%							25

Source: Researcher's field work

3.5.2 Validation of Instruments (ECPT and Lesson Plan)

In an attempt to establish the validity of the Ecology Concepts Performance Test (ECPT) with the marking scheme in relation to the aim of the study, thirty (30) test item were subjected to scrutiny by two Senior Lecturers of Ph.D status in the Departments of Science Education, Ahmadu Bello University Zaria, and one Secondary School biology teacher with B.Sc (Ed) in biology (Kaduna State).The validation criteria were focused on clarity of the items statement, appropriateness of the items for their aims, Criticize and make valuable suggestions necessary for improving the instrument. The experts made constructive criticisms and corrections on basis of content and face validity of the instrument. After which discrepant items were selected out of the 30 items presented leaving 25 items that made the test instrument. The Marking Scheme and lesson plans for the there groups were also subjected to scrutiny to ensure there were no ambiguity in the lesson plans. Also corrections and suggestions were made, which includes: rearrangements of the items options in the marking scheme, which was design with a sum total mark of 50 marks as shown in Appendix E. The inclusion of a concepts maps on each lesson plan for EG1 and EG2. These suggestions and corrections were effected as reflected in appendices A, B and C.

3.5.3 Pilot Testing

The pilot test was carried out using the instrument, Ecology Concept Performance Test (ECPT) on thirty (30) SS II, Biology students of Government Day Secondary School, Goningora, in Sabon Tash Education Zone of Kaduna State. The trial school is not part of the sample school of the study to prevent the students from having an idea of the instrument. The purpose of the pilot test was to ascertain the feasibility and reliability co-efficient of the instruments constructed through a trial run. Data collected from the pilot study was used for Reliability of the instrument and item analysis. The ECPT consisting of 25 questions were administered to the students, instructions on how to answer the questions were read and explained verbally by the researcher and students were allowed ask questions for further clarification. A period of 1hour 30mins was allocated for the test to ensure that students answer the questions carefully. From this also, the actual time for the CPT was obtained by observing the time duration it took majority of the student to finish. After collecting the test items of the CPT, answer sheets were marked and scored over 50marks according to the marking scheme designed to help in uniformity of scores awarding.

3.5.4 Reliability of the Instrument (ECPT)

The data obtained were analyzed to establish the reliability of the instrument. Thus the coefficient of the ECPT was calculated to be 0.82.

The test-retest method was used to test the reliability of the instrument (ECPT) within the interval of two weeks in line with Tuckman, (1975) and Pearson Product Moment Correlation (PPMC) was used to determine the reliability of the instrument and test items. The reliability coefficient of the instrument was found to be r = 0.82, which indicate high correlation between the test. The result obtained therefore shows the suitability of the test item for the study. The pilot test provided data for item analysis. The collected data were analyzed to determine the difficulty and discriminating indices of each of the 25 test items.

3.5.5 Items Analysis

Items analysis was carried out on the scores obtained from the pilot test to determine the facility and difficulty indices of the items in the ECPT.

Facility index: The facility index (FI) according to Wood (1990) is the percentage of students that gets an item right. And was determine by using formula

$$\text{F.I.} = \frac{R}{T} \times 100$$

Where R= Number of correct responses.

T = Total Number of students.

Agbeyenku (2011) recommended values within the range of 0.029 to 0.71. For goal test items value in assessing achievement for this study ranges from 0.3 to 0.7.

Discrimination index: indicates the discriminating power of each of the test items or is the ability to sort between high and low ranking students in the whole test. This was done using the scores of the top 27% and bottom (27%) of the total respondents, and was calculated using formula given by (Furst in Olorukooba, 2001).

$$D_I = \frac{R_U - R_I}{D}$$

Where D = Discrimination index value

Ru = Number among upper 27% of respondent

Ri = Number among lower 27% of respondent

N = total Number of respondents

The D.I, which ranges from 0.029 to 0.71 is regarded as moderately positive and is good for selecting the items of the ECPT.

3.6 Administration of Treatment

The procedures for treatment administration was as follows.

The study sample from the three schools, the experimental group1(EG1), Experimental Group 2 (EG2) and control group (CG)were pre-tested using Ecology Concept Performance Test (ECPT) to ensure groups equivalents. Training for concept map construction for EG1 and EG2 was conducted for a period of one week, while the control group were not exposed to concept mapping strategy. Training was as follows:

- The EG1 were trained on how to construct spider concept maps using set of cut cards with the names of concept to be mapped. Subjects were trained on how to sort, relate and arrange these cards, placing the central theme or unifying factor in the center of the map, outwardly radiating sub-themes surrounding the centre of the map with relevant examples.
- The EG2 were also trained on how to construct hierarchical concept maps using set of cut cards with the names of concepts to be mapped. These subjects were trained on how to sort, relate and arrange these cards in descending order of importance showing relationship between terms inclusively, with the most general concept at the top of the map and the more specific, less general arranged hierarchically below.

The experimental groups were taught ecology concepts for five weeks using spider and hierarchical concepts mapping strategies, while the control group were taught for the same period using lecture method. After a period of five weeks of treatment, a posttest was also administered to both experimental and control groups (Tuckman, 1975). The data collected were used to answer research questions and test the hypotheses formulated in chapter one. Flow-chart illustrating procedures for treatments and control forEG1, EG2 and CG is shown in Figures 3.2 and 3.3

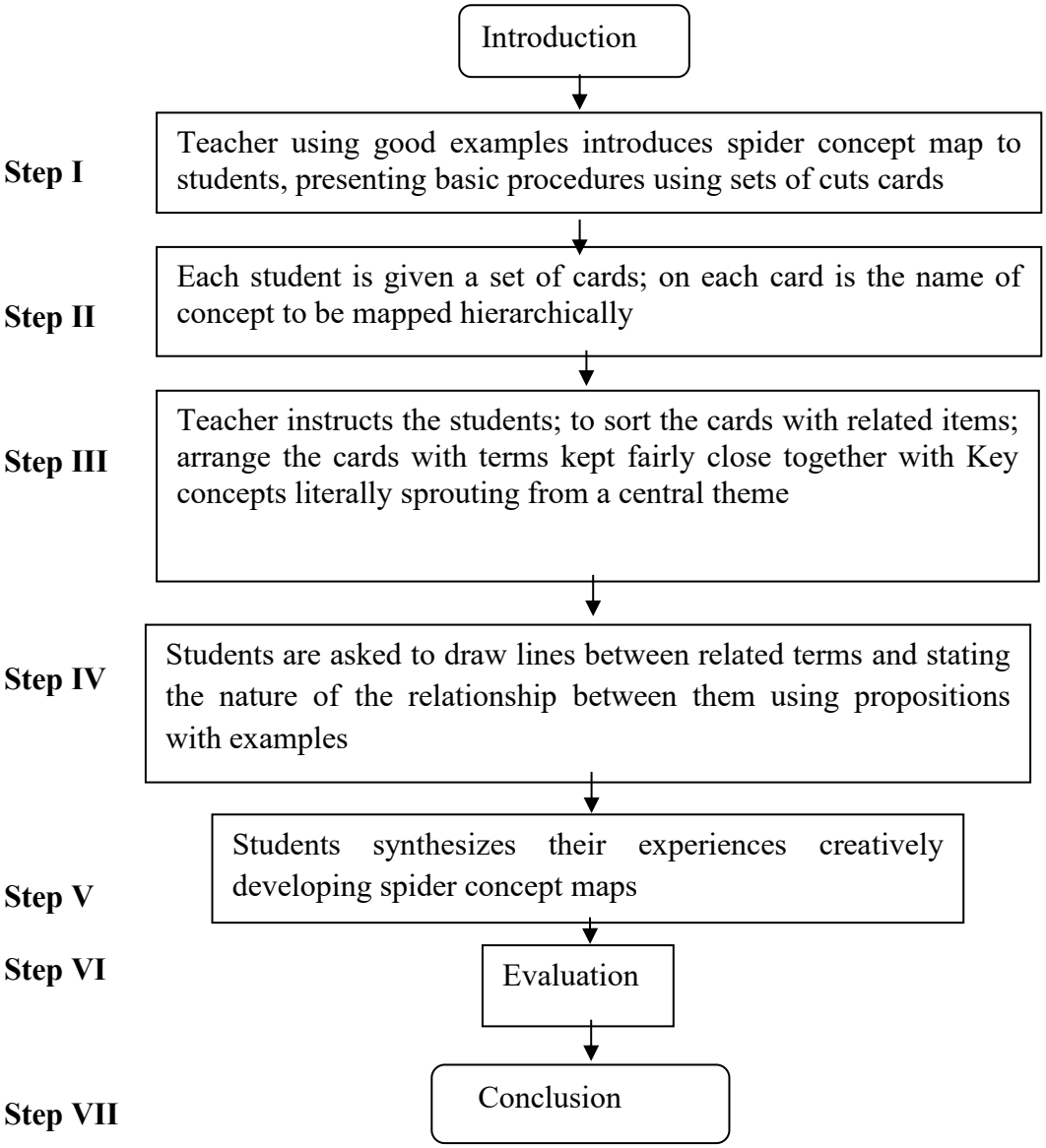

Figure 3.2: Flowchart for Experimental Group 1 (spider)

Source : Bamidele and Oloyede (2013)

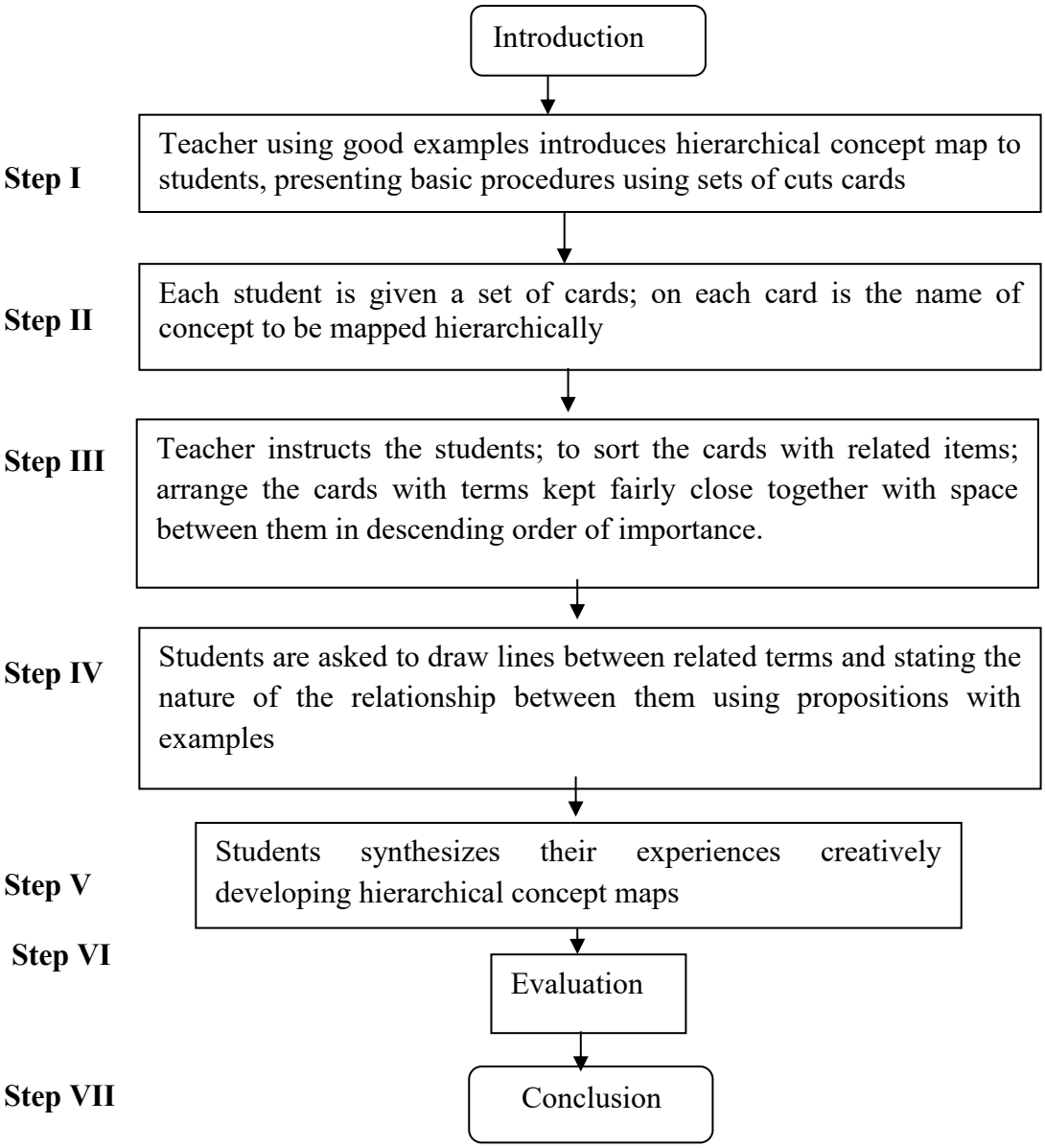

Figure 3.3: Flowchart for Experimental Group 2 (hierarchical)

Source : Bamidele &Oloyede (2013)

3.7 Data Collection Procedure

The ECPT was administered to the subjects first, as pre-test by the researcher. After five weeks period of instruction by the researcher, this is to ensure that teaching procedures is followed as required by the research work and remove teacher bias. The ECPT was then administered to the three (3) groups in form of examination as a post-test. The ECPT item was graded by the teacher and the scores were used to determine the level of students'

performance. After 3 weeks duration (ECRT) Ecology Concept Retention Test as a post post-test was administered by the researcher to find out the retention ability level of the students.

3.8 Procedure for Data Analysis

Mean and standard deviation were used to answer the research questions formulated for answering in this study, which include;

1. What is the difference in the academic performance of students taught ecology concepts using: Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method?
2. What is the difference in the retention ability of students taught ecology concepts using: Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method?

Each of the hypotheses was restated along with the appropriate statistical tool for testing at significance level of $P \leq 0.05$ as follows;

H_{O1} There is no significant difference in the mean academic performance of students taught ecology concepts using: Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method

The null hypothesis was analyzed using ANOVA.

Ho_2 There is no significant difference in the mean retention ability of students taught ecology concepts using: Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method.

The null hypothesis was analyzed using ANOVA.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This study is titled "Effects of two Concept-Mapping Strategies on Retention and Performance in Ecology Among Secondary School Students in Zonkwa Education Zone of Kaduna State, Nigeria. In this chapter, the result obtained from the analysis of the data collected and the discussions of the results are presented. The Statistical Package of Social Science (SPSS) IBM 20th Edition was used for the analysis. The chapter is presented in the following sub-headings;

4.2 Data Analysis and Results Presentation.

4.3 Summary of Findings

4.4 Discussion of the Findings.

4.2 Data Analysis and Result Presentation

The data collected from the study using the instrument (ECPT) were analyzed, the result obtained were used to answer the following research questions and hypotheses testing's.

4.2.1 Answers to Research Questions

Research Question One What is the difference in the mean academic performance scores of students taught ecology concepts using: Spider concept mapping strategy; Hierarchical concept mapping strategy and Lecture method? The result is presented in Table 4.1.

Table 4.1: Means and Standard Deviations of post test scores of the Control and Experimental Groups

Variables	N	Mean	SD	MD
Experimental Group 1	63	25.94	4.44	
				6.03
Experimental Group 2	70	31.97	4.54	
				9.21
Control	63	22.76	4.21	

Table 4.1 shows the mean scores of student's academic performance between experimental groups and the control group. The experimental group 1 recorded mean score of 25.94 and experimental group 2 with mean score of 31.97, while the control group recorded means score of 22.76. The mean difference of 6.03 between EG1 and EG2 experimental groups compared to that of the EG2 and CG 9.21, indicate that spider and hierarchical concept mapping strategies enhanced academic performance of the students in the experimental groups, therefore, the higher mean score of experimental groups is attributed to the treatment administered.

Research Question Two: What is the difference in the retention ability of students taught ecology concepts using: Spider concept mapping strategy; Hierarchical concept mapping strategy and Lecture method? The result is presented in Table 4.2.

Table 4.2: Means and Standard Deviations of the post-posttest Scores for the Control and Experimental Groups

Variables	N	Mean	SD	MD
Experimental Group 1	63	23.52	4.04	
				5.12
Experimental Group 2	70	28.64	4.50	
				7.62
Control	63	21.02	3.48	

Table 4.2 shows the mean scores of student's retention abilities between experimental groups and the control group. The EG1 recorded mean score of 23.2 and EG 2 had 28.64, while the CG recorded 21.02. The mean difference of 5.12 between EG1 and EG2 experimental groups compared to that of the EG2 and CG 7.62, indicate that spider and hierarchical concept mapping strategies improved the retention abilities of students in the experimental groups, therefore, higher mean score of students in the experimental groups is attributed to the treatment administered.

4.2.2 Hypothesis Testing

For the purpose of this study the following null hypotheses were tested at $P \leq 0.05$ as follow.

HO_1: There is no significant difference in the mean academic performance scores of students taught ecology concepts using: Spider concept mapping strategy; Hierarchical concept mapping strategy and Lecture method.

To test HO_1, a one-way Analysis of Variance at $P \leq 0.05$ was used to determine if there was any significant difference in the mean scores of students in the experimental groups and that of the control group in their academic performance after exposure to ecology concepts using spider, hierarchical and lecture methods. A summary of analysis of variance is presented in Table 4.3.

Table 4.3: Summary of Analysis of Variance for the Academic Performance Mean Scores of Experimental and Control Groups

Source	Sum of squares	DF	Mean square	F-Value	P-value	R
Between Groups	2931.88	2	1465.94	75.59	0.01	S
Within Groups	3743.12	193	19.39			

*Significant at $P \leq 0.05$

Table 4.3, the result showed that the calculated p-value of 0.01 is lower than the 0.05 level of significance with the F-calculated at 75.59, with DF of 2 and 19.3 from the result, this revealed that the study subjects who were exposed to spider and hierarchical concept mapping strategy in the experimental groups performed significantly better in academic performance than those in the control group taught with lecture method.

This implies that the treatment with concept-mapping strategies significantly enhanced the academic performance of the students in the experimental group compared to their courter-part, in the control group. Therefore, the null hypothesis which states that there is no significant difference in the academic performance among students taught ecology concepts using: Spider concept mapping strategy; Hierarchical concept mapping strategy and Lecture method is hereby rejected. To determine the group that was significantly different in their ecology concept performance test, the groups' means were further subjected Scheffe's procedure. The result of the test is presented in Table 4.4.

Table 4.4 Summary of Scheffe's Tests for Mean Scores of Academic Performance for EG1, EG2 and CG

(I) Factor	(J) Factor	Mean Difference (I-J)	Std. Error	Sig.	R
Spider	Control	3.17460*	.78466	.000	S
					S
	Hierarchy	-6.03492*	.76479	.000	S
Hierarchy	Control	9.20952*	.76479	.000	S
	Spider	6.03492*	.76479	.000	S
Control	Spider	-3.17460*	.78466	.000	S
	Hierarchy	-9.20952*	.76479	.000	S

*. The mean difference is significant at the 0.05 level.

The result of the mean separation test as indicated in Table 4.4 showed that students taught ecology concepts using hierarchical concept mapping strategy were significantly different with mean difference of (9.20952) from the control group with mean difference of (3.17460) and their counterpart in the spider concept mapping strategy group with (6.03492) Table 4.3 showed that the experimental groups (EG1 and EG2) and control group are statistically significant pair-wisely.

HO_2: There is no significant difference in the mean retention ability scores of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method.

To test HO_2, one way analysis of variance at $P \leq 0.05$ was used to determine if there was any significant difference in the retention ability of students in the experimental groups

and that of the control group in their academic performance after exposure to ecology concepts using spider, hierarchical concept mapping strategies and lecture method. A summary of analysis of variance is presented in Table 4.5.

Table 4.5: Summary of t-test Analysis for Postposttest Scores of Experimental and Control Groups

Source	Sum of squares	DF	Mean square	F-Value	P-value	R
Between Groups	2184.82	2	1092.41	66.67	0.01	S
Within Groups	3162.18	193	16.38			
Total	5347.00	195				

*Significant at $P \leq 0.05$

The results from Table 4.5 shows F-values of 66.67 and P-values of 0.01 at $P \leq 0.05$, with the degree of freedom of 2 between the groups and 193 within groups. The sum totals square were 5347.00 and the mean square between and within the groups were 1092.41 and 16.38 respectively. This shows that the retention ability in the experimental groups and control group were significantly different one from the other at $P \leq 0.05$. The experimental groups have high retention ability than the control group, hence the null hypothesis that there is no significant difference in the retention ability of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method is therefore rejected. To determine the group that was significantly different in their retention ability level from the others in their ecology retention scores the means were further subjected to a mean separation test using the scheffe's procedure. The result of the test is presented in Table 4.6

Table 4.6 Summary of Scheffe's Tests Result for Mean Scores on Retention Ability for EG1, EG2 and CG

(I) Factor	(J) Factor	Mean Difference (I-J)	Std. Error	Sig.	R
Spider	Control	2.50794*	.72121	.003	S
	Hierarchy	-5.39048*	.70295	.000	S
Hierarchy	Control	7.89841*	.70295	.000	S
	Spider	5.39048*	.70295	.000	S
Control	Spider	-2.50794*	.72121	.003	S
	Hierarchy	-7.89841*	.70295	.000	S

*. The mean difference is significant at the 0.05 level.

Table 4.6 shows that the students in the EG2 were significantly different with retention scores, mean difference of 7.89841 from those in the control group with mean difference of 2.50794 and like wise those in the EG 1 were significantly different with 5.39048 from their counterpart in the experimental group, showing a P-value of 0.003 which is less than p-value of 0.05 indicating that there is significant difference. This was observed in the control and experimental groups as shown in the means and standard deviations of the postposttest mean scores in Table 4.2

4.3 Findings

Based on the result of this study, the following findings were made.

1. There was a significant difference in the academic performance among students taught ecology concepts using: Spider concept mapping strategy; Hierarchical concept mapping strategy and Lecture method. The hierarchical concept mapping strategy performed significantly better than the spider concept mapping strategy group and the control group.
2. There was also a significant difference in the retention ability of students taught ecology concepts using Spider concept mapping strategy, Hierarchical concept mapping strategy and Lecture method. The hierarchical concept mapping strategy retained significantly higher than the spider concept mapping strategy group and the control group.

4.4 Discussion of the Findings

The findings of the results are been discussed as follows;

From the findings in Table 4.3, the experimental groups performed significantly better than the control group. This shows that the spider and hierarchical concept mapping strategies were effective in promoting meaningful learning and positively influence retention and performance of ecology concepts. The findings supports the observation by Sakiyo and Waziri (2015) that concepts mapping strategies stimulates discovery learning and construction of new concepts from existing knowledge. Findings from Akeju, Rotimi and Kenni (2011), have also shown that concept mapping strategy contributed to meaningful learning and enable students to obtain higher performance in science. The findings are also in line with that of Ajaja (2011), who stated that concept mapping strategy; improve students learning outcomes with significant increase in students' knowledge construction, helping them boost their final exams performance. This is also in agreement with the findings of Otor

(2013) that revealed that concept mapping strategies increase higher and significant performance better than any conventional method

The suitability of spider and hierarchical concept mapping strategies as a means of promoting retention and performance in ecology concepts may be attributed to the nature of the instruction which is discovery based and student-centered, which provides a wide range of activities for the students to control, take responsibility for their action in the process of learning and form their own idea from already existing facts. This is also in line with observations made by Oloyede 2013 that Concept mapping strategy actively involves students in the learning process and allows the learner to gain a deeper understanding of the concepts and become better critical thinker. The relatively poor performance of the subjects in the control group is an indication that the lecture method adopted in teaching science by science teachers is not effective in promoting meaningful in students, learning at the Senior school levels as observed by Ajaja (2011), Akeju, Rotimi, and Kenni (2011) and Otor (2013) that unless concerted efforts are made to identify and used instructional strategies that will improve academic performance and lecture method does not as it is not student centered.

The result in Table 4.4 shows that there is a significant difference at $p \leq 0.05$, between the mean scores of the two experimental groups and control group in their academic performance test in favour of EG 2 after exposure to treatment. This implies that hierarchical concept mapping strategy was potentially effective in influencing students' academic performance. Thus this provides students with an opportunity to organize learning experiences in ways that facilitates learning (Novak, 1994). It purposively provide a structure that help the students develop link between terms inclusively in descending or ascending order of importance, thereby making the learning to be more meaningful and this enhanced higher mean scores than their counterpart in EG I exposed to spider concept mapping strategy. This is not in line with the findings of Bamidele & Oloyede (2013)that there was no

significant difference in the academic performances of the students with respect to the types of concept mapping strategies, they all produced similar effect.

The result in Table 4.5 shows that at significant level of P ≤0.05, there was significant difference in the retention abilities of subjects in the two experimental groups and the control group in favour of the experimental groups. This shows that spider and hierarchical concept mapping strategies were effective in enhancing retention of ecology concepts. This finding is similar to that of Akeju, Rotimi, and Kenni (2011) which reported a significant effect on students' retention of learnt materials in science when exposed to concept mapping strategy.

The result in Table 4.6 shows that at significant confidence of P ≤ 0.05, there was asignificant difference in the retention abilities of the subjects within the experimental groups and between the experimental groups and control group in favour of subjects in EG 2 with the highest retention test scores. This implies that treatment with hierarchical concepts mapping strategy produce more effects than spider concept mapping pair wise.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The aim of this study was to investigate the effect of spider and hierarchical concept mapping strategies on retention and performance in ecology among Senior Secondary School students in zonkwa, Kaduna state, Nigeria. In this chapter, the summary of the procedure for data collection, the findings, conclusions and recommendations are presented under the following sub-headings.

5.2 Summary of Study

5.3 Summary of Major Findings

5.4 Conclusion

5.5 Contribution to Knowledge

5.6 Recommendations

5.7 Limitations of the Study

5.8 Suggestions for Further Studies

5.2 Summary of Study

This study investigated the effect of spider and hierarchical concept mapping strategies on retention and performance in ecology among Senior Secondary School students. A total of 196 subjects (63 in the experimental group I, 70 in the experimental group 2, and 63 in the control group) were used for the study. The experimental group I was exposed to spider concept mapping strategy and experimental group 2 exposed to hierarchical concept mapping strategies for (6) six weeks. Three schools were randomly sampled using balloting method. Similarly purposive sampling method was used to select three intact classes.

The three sampled schools were;

- School A
- School B and
- School C

Simple random sampling was employed to assigned these intact classes into control and experimental groups respectively. The instrument used was Ecology Concept Performance Test (ECPT) This was used to collect data as pretest and posttest which was also used in answering the research questions and to test the stated null hypothesis. The ECPT were 25 multiple choice items with options A-D covering all six levels of Bloom's cognitive taxonomy. The ECPT with a reliability coefficient of 0.82 was used to collect relevant data which were analyzed using t-test, One way ANOVA, and Scheffe's test at significant confidence of 0.05 (was adopted) for retaining or rejecting the hypothesis. The SPSS package was used to analyze the data obtained. The distribution of the scores at the pretest and posttest reveals that spider and hierarchical concept mapping strategies were responsible for improved test score, when compared to the conventional lecture method, which can be said might be the cause of unsatisfactory academic performance at SSCE. At SSS 2, and at an average age of 16 years, they were theoretically expected to actively engage in the learning process, constructing new ideas from existing ones, using the appropriate teaching method.

Three types of data were collected using the ECPT as follows;

1. Pretest was administered to students in the three selected schools; the data collected were analyzed using one way ANOVA to establish groups' equivalency academically before commencement of treatments.
2. Posttest performance scores of the three groups obtained were analyzed using one way ANOVA to establish significant difference in the mean scores of the three groups, which could be attributed to treatment effects. And also to determine significant

difference in the academic performance among the three groups, which of the groups is most significant.

3. Postposttest performance scores of the three groups were also analyzed using one way ANOVA to establish a significant difference in their retention ability when exposed to treatment. The result of data analysis were presented and discussed, contributions to knowledge were identified, conclusions were drawn from the results obtained and recommendations were made for further studies.

The following findings were obtained, that:

1. There was a difference between subjects in EG1 exposed to the treatment with spider concept mapping strategy and EG 2 exposed to the treatment with hierarchical concept mapping strategy and those taught with lecture method in favour of the EG 2. Hierarchical concept mapping strategy was found to be more effective in enhancing academic performance in the posttest mean scores of biology students at the Senior Secondary School level.
2. There was also a significant difference in the retention ability between subjects in EG1 exposed to the treatment with spider concept mapping strategy and EG2 exposed to the treatment with hierarchical concept mapping strategy and those taught with lecture method in favour of the EG2. Hierarchical concept mapping strategy was found to be more effective in enhancing academic performance in the postposttest mean scores of biology students at the Senior Secondary School level.

5.3 Conclusion

Based on the findings of study, the following conclusions are made;

1. Spider and hierarchical concept mapping strategies were effective in improving students' academic performance in ecology concepts at secondary school level
2. Hierarchical concept mapping strategy was more effective in enhancing academic performance in ecology concept at the secondary school level.
3. Spider and hierarchical concept mapping strategies were effective in improving student's retention ability of ecology concept at the secondary school level.
4. Hierarchical concept mapping strategy was more effective in improving student's retention ability in ecology concept at the secondary school level.

5.4 Contributions to Knowledge

This research work was initiated to determine the most effective ways to improve students' retention and performance in dealing with ecology concept in the classroom and examination through the use of spider and hierarchical concept mapping strategies. It was observed that;

a. The researcher was able to establish that, Spider and hierarchical concept mapping strategies employed had effects on students' academic performance in ecology concepts and also enhanced the subjects' retention abilities. The implication of this shift on academic performance of student in senior secondary school was very significant as obtained from finding hence the method is discovery based approach which is student centered meant to improve retention and performance among science students.

b. The researcher was able to establish that, Spider and hierarchical concept mapping strategies used for this study encourages students' in constructing their own

knowledge from pre-existing knowledge. This implies that, the treatment with concept mapping encourage students' to actively engage in the learning process.

c. In this area of study, that is zonkwa education zone in Kaduna state, this study is relatively the first of its kind, especially on spider and hierarchical concept mapping strategies.

d. Also the finding of this study has added new information to the frontier of knowledge in the existing literature such as ecology education.

e. Most researchers used only one type of concept mapping strategy but in the case of this research two types of concept mapping strategies were used and hierarchical concept mapping strategy performed better.

f. The models of the concepts maps used were adopted and which can be used by other researchers.

5.5 Recommendations

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

1. There is a need for the improvement of ecology teaching and practices existing in Nigerian secondary school through the use of different effective teaching and learning methods such as concept mapping strategy, which is a discovery based approach to teaching and learning instead of the conventional lecture method.
2. Since knowledge construction and students retention abilities affect academic performance, there is therefore the need for science teacher to use hierarchical and spider concept mapping strategies with a view to improve performance at secondary school level.
3. Nigerian universities and colleges of education as well as secondary school educational planner should be encouraged to design educational programs that will

equip students and teachers in training with skills for the use of concept mapping strategies for effective teaching and learning of ecology and biology in general.

4. The researcher instrument, Ecology Concept Performance Test developed for this study can be employed as a credible instrument for testing the ecology concept performance of students. The instrument can also be adopted or adapted for use in similar studies or other science education based researches to move forward the frontier of knowledge.

5.6 Limitations of the Study

The following limitations were noted in the course of this study;

1. The study was limited to only three government secondary schools and also to ecology concepts in biology. A widen scope of the study might influence the study. The geographical coverage in zonkwa education zone of kaduna state only thus limiting generalization made from the study.
2. The communal clash between farmer and Fulani herdsmen in zonkwa and environ during the courses of the study affect the timely collection of data and subsequent completion.
3. Language was a problem as the researcher often, had to resort to the native dialect (Hausa) to explain some concept to the study subject.
4. Large sample size due to the use of intact classes in the sample schools.

5.7 Suggestions for Further Studies

1. Similar studies could be carried out at tertiary institutions such as Colleges of Education, Polytechnics, Mono-technics and Universities.
2. It is needful to extend the study over a period of two or three years to ascertain the effects of spider and hierarchical concept mapping strategies in improving retention and performance in ecology concepts. This will also help to establish, if a long period

of exposure to concept mapping strategy will help to remedy poor academic performance in science.

3. The use of other teaching method such as Demonstration Method, Science Process Teaching Approach, Discovery Methods, Problem Solving Methods and Practical Methods should be employed to determine it effects on retention and performance in science students.
4. This study can be replicated in single sex schools to determine if spider and hierarchical concept mapping strategies are gender friendly.
5. This type of study would also be conducted in other branches of biology such as genetic and science disciplines such as Physics, Chemistry Agricultural Science, and Basic Science among Others.

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APPENDIX A

LESSON PLAN FOR EXPERIMENTAL GROUP 1(SPIDER) LESSON 1 (WEEK 1)

Date –

School-

Subject – Biology

Time – 40 minutes

Topic –Types of association

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards showing different concepts on association.

Previous Knowledge – Students have been taught the Basic ecological concepts in SS 1 class.

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- identify some of the different types of association existing between different species
- Construct a spider concept map on beneficial; harmful and neutral forms of association among organisms.
- Differentiate between the various types of associations
- Deduce the mode of life of a given organism from observed characteristics

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

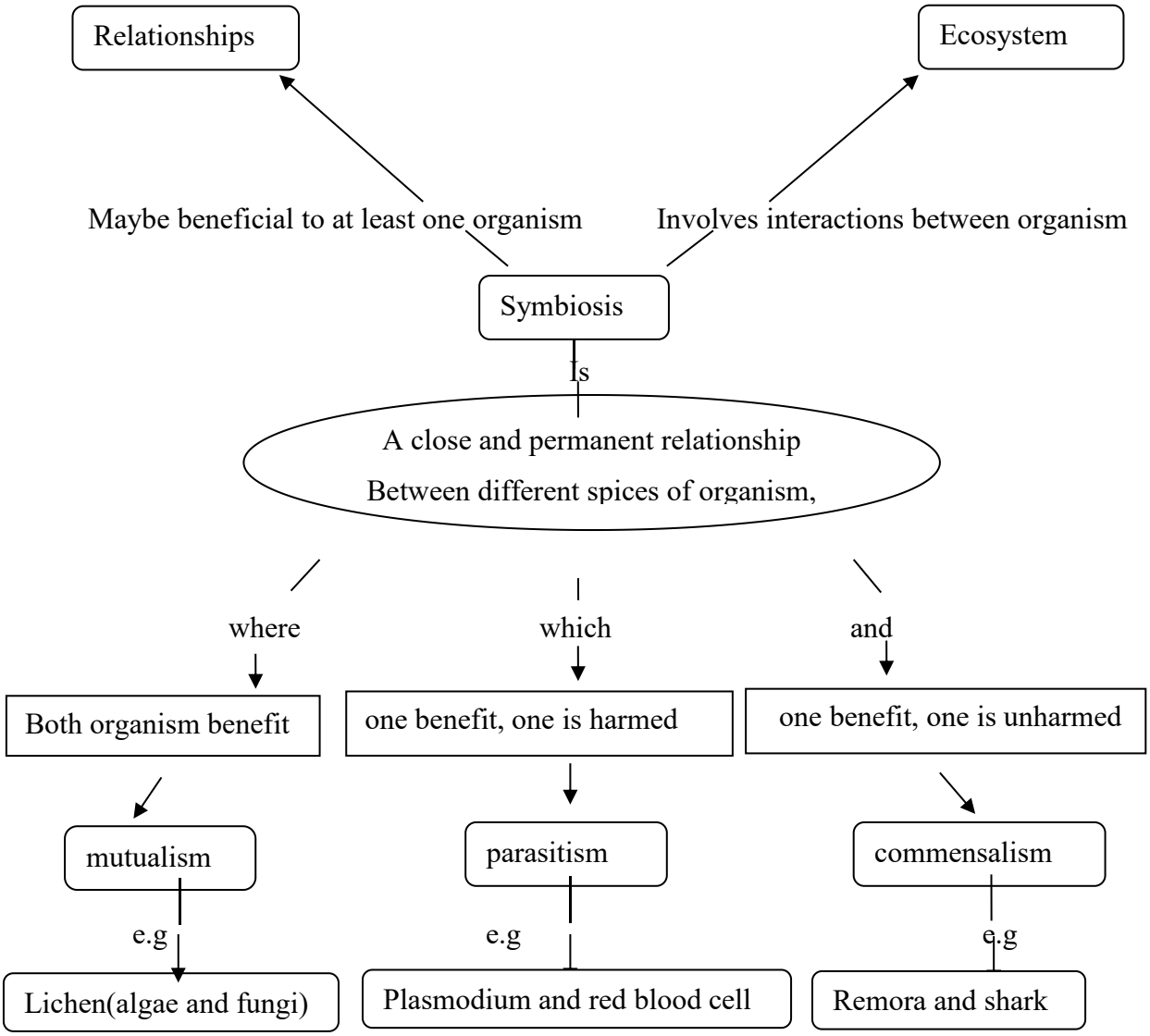
- What is Ecology?
- Define environment

Presentation: Based on the students' responses the teacher presents the lesson in the following steps:

Step I The teacher (present students with sets of cards)explain to the students, that species of any biotic community live in the state of symbiosis with three possible effects that each member of a pair can have on the population growth of the other. Positive (beneficial); negative (harmful); neutral (no significant benefit or harm)

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts sprouting from a central theme)

SPIDER CONCEPT MAP FOR SYMBIOTIC RELATIONSHIP



Step III (a) list the types of associations as: neutralism; inter-specific competition; mutualism; saprophytism; predation; parasitism; commensalism.

(b) Explain the various types of associations with specific examples such as mutualism; is a symbiotic association where both population benefit and at least one of the population is so dependent upon the other for some critical resource. Example algae and fungus (lichen)

Saprophytes; are those organism that derive their food from the dead decaying organism by secreting enzymes on the dead matter and absorbing the nutrient by diffusion. Example, mucor and yeast.

Predation; is an association in which a free organism (predator) kills another free living and eat it as food (prey). Example, cat and rat.

Parasitism; is an intimate association between two living organism of different spices in which one organism obtains food and shelter the other is harm and does not receive any benefit. Example, plasmodium and red blood cells.

Commensalism; is a relationship in which one of the partner (commensal) benefit while the other (host) is neither benefitted nor harmed. Example remora and shark.

Step IV (a) differences between parasitism and saprophytism such as parasitism feed on Living organism while saprophytes feed on dead organism.

Strengthening the cognitive organization by assuring the learners to make summaries by relating the concepts learnt in the learning task to concepts in spider concept map. This is done by encouraging the students to synthesize their experiences creatively by developing spider concept maps

Student's Activity (students draw lines between related terms with propositions and examples)

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Use spider concept map to explain associations between species.
- List two types of association and give two examples of each
- Mention two differences between parasitism and saprophytism.

Summary and Conclusion: The teacher along with the students highlighted main points of the lesson.

LESSON PLAN FOR EXPERIMENTAL GROUP 1 (SPIDER) WEEK 2 (lesson 2)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – Tolerance to environmental factors

Class – SS II

Average Ages – 16 years

Instructional Materials –Flash cards showing different concepts on tolerance

Previous Knowledge – Students have been taught the Basic ecological concepts in SS 1 class.

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define the term tolerance
- List environmental factors that affect living organism survival
- Explain tolerance range using spider concept map
- Mention minimum and maximum tolerance ranges for plants and animals
- Explain how geographical range affects the distribution of plants and animals.

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is a habitat?
- Define environment

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: presenting students with sets of cuts cards, the teacher instructs the students to sort and also arrange cards with related terms fairly kept close with space between them, placing the central theme in the centre of the map with sub-theme surrounding the center of the map.

Step II: (a) The teacher (present the students with sets of cards): Define tolerance as the ability of living organism to withstand or tolerate little unfavorable changes in the environment which affect their survival.

(b) Living organisms can only live in a particular habitat if they can tolerate the ranges of the abiotic factors that operate in it. Because of changes in the environmental factors some these conditions are sometimes unfavorable. Too little or too much of certain environmental factors such as:

i. sunlight

ii. Heat

iii. Cold

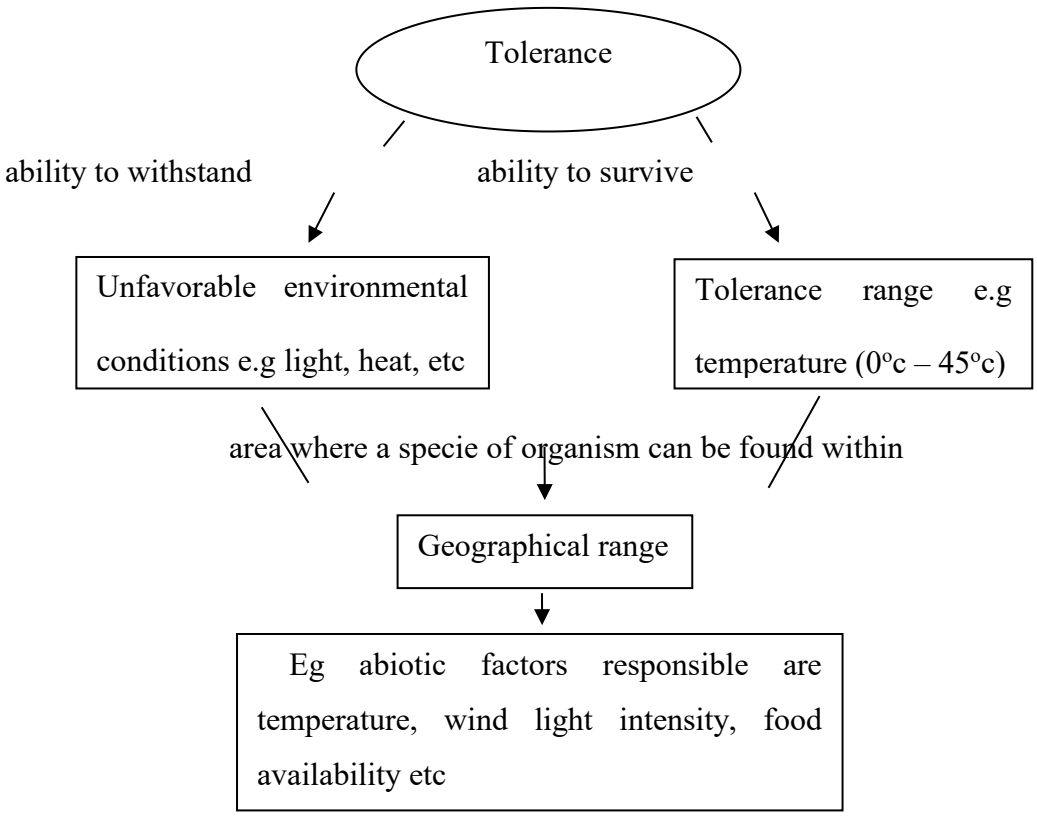
iv. Acidity

v. alkalinity

(c) Tolerance range is the range between the minimum and maximum limits to which organisms can tolerate certain changes in their environment so as to survive

(d) Organism can only live within certain minimum and maximum limits for each abiotic factor. Death occurs beyond this range, example for most animals, the minimum temperature limit is $0^{o}c$ while the maximum limit is $45^{0}c$ their tolerance range is $0 – 45^{0}c$. Some plants can withstand long period of drought, many cannot.

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts sprouting from a central theme)



Step III: (a) geographic range refers to the areas where a species of organism can only be found within the minimum and maximum limits of it s tolerance.

(b) different abiotic factors like

i. rainfall

ii. temperature

iii. light intensity

iv. availability of food

v. relative humidity

vi. day length

vii. wind

These factors are often responsible for the geographical boundaries of species of organism. For example geographical range for tropical rainforest is within the equator as a result of high temperatures and high rainfall, whereas tropical rainforest cannot be found at the northern and southern poles because of low rainfall and low temperature.

Step IV: (a) differences between tolerance range and geographic range

Student's Activity (students draw lines between related terms with propositions and examples)

Step V: Strengthening the cognitive organization by assuring the learners to make summaries by relating the concepts learnt in the learning task to concepts in spider concept map.

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define tolerance
- List five environmental factors that affect living organism survival
- Use spider concept map to explain tolerance range
- Mention minimum and maximum tolerance ranges for plants and animals

Summary and Conclusion: The teacher along with the students highlighted the main points of the lesson

LESSON PLAN FOR EXPERIMENTAL GROUP 1 (SPIDER) LESSON 3 (WEEK 3)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – food chain in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards showing different concepts on food chain.

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define food chain
- List the various types of food chain
- Differentiate between the various types of food chains
- Construct a food chain using spider concept map

Introduction – The teacher introduces the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step: I Presenting students with sets of cards: the teacher define food chain as the transfer of energy from one organism to another in a series of trophic levels of eating and being eaten:

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts sprouting from a central theme)

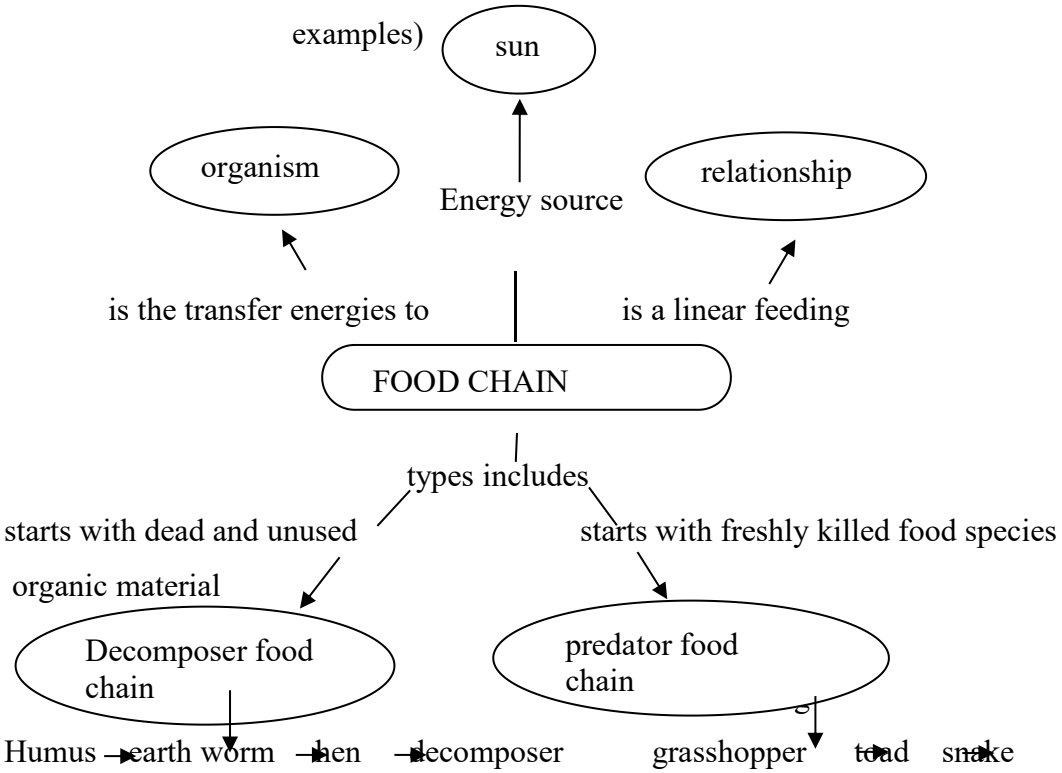
(a) list the types of food chains predator (grazing food chain); detritus (decomposer) food chain

(b) Explain the various types of food chain with specific examples such as predator (grazing) food chain; this is made up of predator spices and their prey or food species which are usually alive or freshly killed when they are eaten.

Step III: The sun is usually the source of energy and green plants use it to make food for the ecosystem. Example in aquatic habitat the following can be observed Diatom→ Paramecium ⟶Tilapia ⟶Crocodile ⟶Decomposer.

Detritus (decomposer) food chain; in this food chain the starting material is dead and unused organic material. The feeding spices attack only dead organism or nonliving fragments of the organism it is also called decomposer food chain. Example Humus ⟶ earth worm→ domestic fowl ⟶man →decomposer.

Step IV Student's Activity (students draw lines between related terms with propositions and examples)



(a) differences between predator food chain and detritus food chain

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Using spider concept map explain food chain
- List two types of chains and give two examples of each
- Mention two differences between these types.

Summary and Conclusion: The teacher with the students highlighted main points of the lesson.

LESSON PLAN FOR EXPERIMENTAL GROUP 1 (SPIDER) LESSON 4 (WEEK 4)

Date –

School -

Subject – Biology

Time – 40 minutes

Subtopic – food web in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards showing different concepts on food web.

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define food web
- describe the various examples of food web
- Differentiate between the various types of food web
- Construct a food web using spider concept map

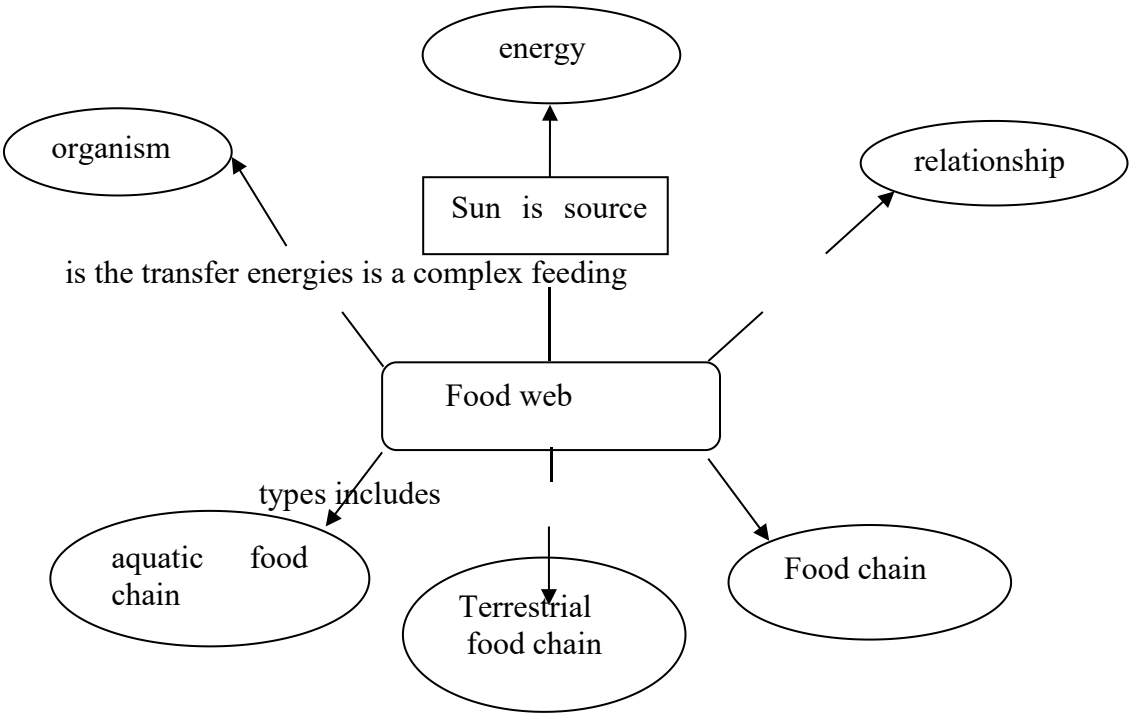
Introduction – The teacher introduces the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: Presenting students with sets of cut cards: the teacher define food web as a complex inter connection of food chains in an ecosystem(a) list the types of food webs as predator (grazing food chain); detritus (decomposer) food chain

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts sprouting from a central theme)



Step II: (b) explain the various types of food webs with specific examples such as

predator (grazing) food web; this is made up of predator spices and their prey or food species which are usually alive or freshly killed when they are eaten. The sun is usually the source of energy and green plants use it to make food for the ecosystem. Example in aquatic habitat the following can be observed Diatom, Paramecium, Tilapia and Crocodile.

Detritus (decomposer) food web; in this food web the starting material is dead and unused organic material. The feeding spices attack only dead organism or nonliving fragments of the organism it is also called decomposer food web. Example of organism include Humus, earth worm, domestic fowl, man and decomposers.

Student's Activity (students draw lines between related terms with propositions and examples)

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Using spider concept map explain food web
- List two types of web and give two examples of each

Summary and Conclusion: The teacher with the students highlighted main points of the lesson.

LESSON PLAN FOR EXPERIMENTAL GROUP 1 (SPIDER) LESSON 5 (WEEK 5)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – trophic level in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials –Flash cards showing different concepts on trophic level.

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- define trophic level
- describe the nature of energy transfer or flow in the ecosystem using hierarchical concept map
- explain that chemical energy and nutrients are transferred among producers; consumers and decomposers
- describe the three types of pyramids

Introduction – The teacher will introduce the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: Presenting the students with sets of cuts cards: the teacher explain the following.

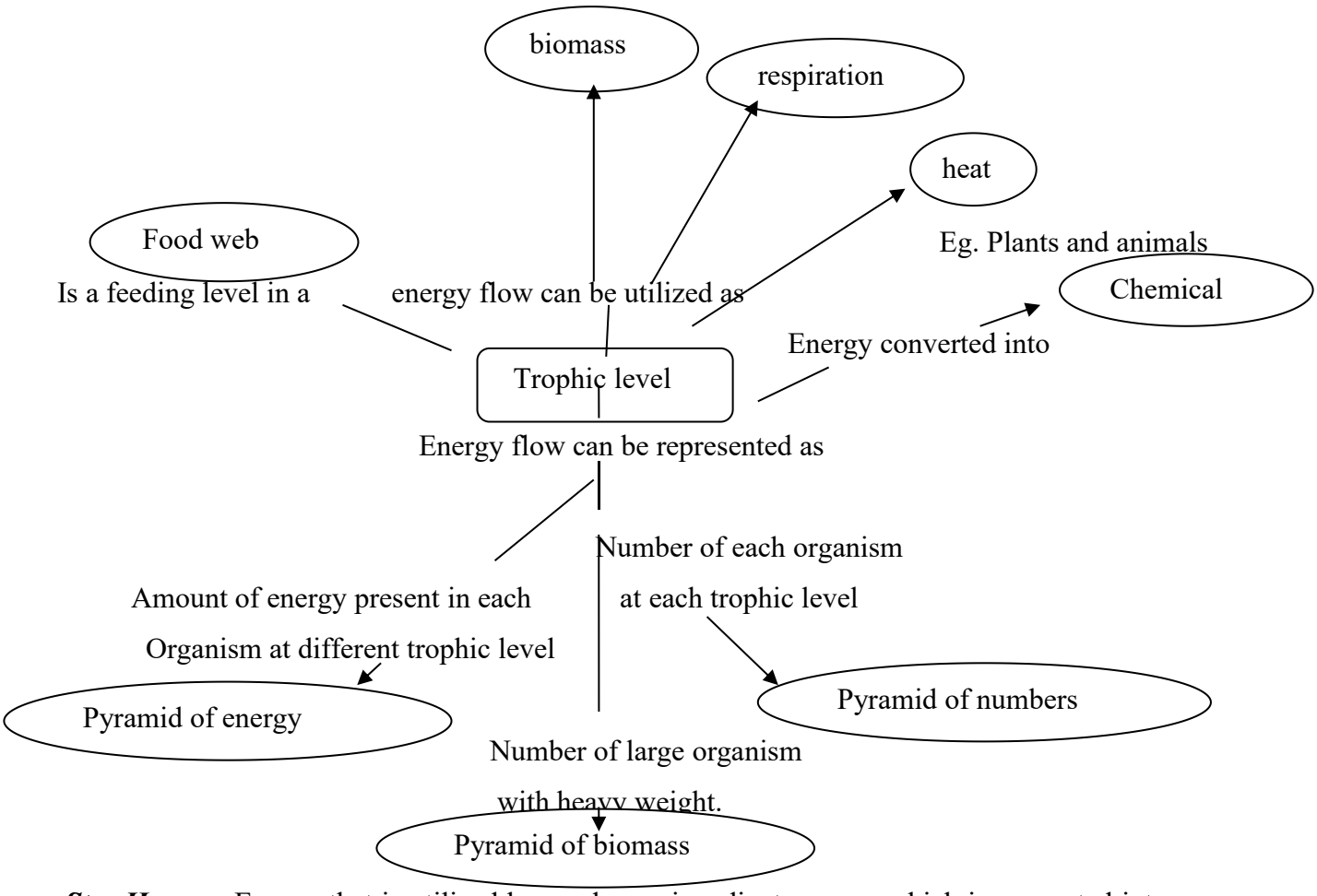
In a food chain each successive level is known as a trophic level, energy flow from one trophic level to another is utilized in the following manner;

(a) Production of material is called biomass or is the weight of producer, consumers and decomposer that exist in an ecosystem.

(b) A part of energy is lost due to respiration

(c) The rest of the energy is lost as heat which is release during various activities

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts sprouting from a central theme)



Step II: Energy that is utilized by producers is radiant energy, which is converted into chemical energy by green plants which is required by all living organism. The chemical energy is concentrated in food which is synthesized by the producer. In general in the transformation of energy through the ecosystem the energy in magnitude of 10 is lost from one trophic level to another.

Step III: The flow of energy through a community can be represented by a pyramid of energy. In an ecological pyramid the first level forms the base and successive trophic level as the upper tiers. Each successive level can support fewer organism than the previous, this is due to inefficiency of energy transfer from one trophic level to another. The pyramid energy is progressively reduced from plants to herbivores to carnivores. And also there is a reduction of biomass along the food chain.

Student's Activity (students draw lines between related terms with propositions and examples)

Step IV: Types of pyramids are; pyramid of numbers; pyramid of biomass; pyramid of Energy

Pyramid of number; in this pyramid the number of individual at each trophic level is arranged in a graphic system.

Pyramid of biomass; this pyramid emphasis the importance of large organism that have heavy weight. The organisms at the higher level are usually larger and heavier in size than the top

Pyramid of energy; this indicate the amount of energy flow at each level and the role which the organism play in the transfer of energy.

Student's Activity (students synthesize their experiences creatively by developing spider concept maps)

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define trophic level
- List two types of pyramid
- Using spider concept maps describe the transfer of energy from one trophic level to another.

Summary and Conclusion: the teachers with the students highlight main points of the lesson.

APPENDIX B
LESSON PLAN FOR EXPERIMENTAL GROUP 2 (HIERARCHICAL) LESSON 1 (WEEK 1)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – Types of association

Class – SS II

Average Ages – 18 years

Instructional Materials –Flash cards showing different concepts on association

Previous Knowledge – Students have been taught the Basic ecological concepts in SS 1 class.

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- identify the different types of association existing between different species
- Identify beneficial; harmful and neutral forms of association among organisms.
- Explain the differences between the various types of associations using hierarchical concept map
- Deduce the mode of life in a given organism from observed characteristic

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is Ecology?
- Define environment

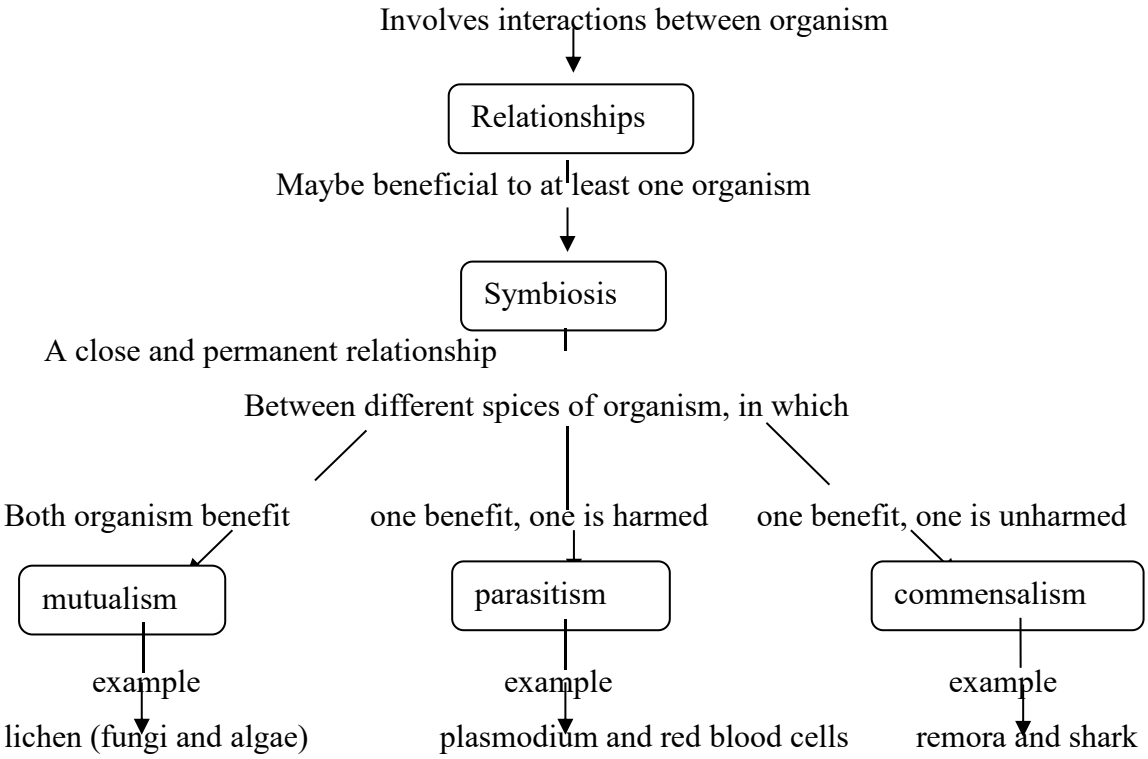
Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I:. The teacher presenting set of cuts card to the students, explains that species of any biotic community live in the state of symbiosis with three possible effects that each member of a pair can have on the population growth of the other. Positive (beneficial); negative (harmful); neutral (no significant benefit or harm)

Step II: (a) list the types of associations as: neutralism; inter-specific competition; mutualism; saprophytism; predation; parasitism; commensalism.

(b) Explain the various types of associations with specific examples such as mutualism; is a symbiotic association where both population benefit and at least one of the population is so dependent upon the other for some critical resource. Example algae and fungus (lichen) Saprophytism; are those organism that derive their food from the dead decaying organism by secreting enzymes on the dead matter and absorbing the nutrient by diffusion. Example, mucor and yeast.

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts in descending order of importance)



Step III: (a) differences between parasitism and saprophytism: such as parasite feeds on Living organism while saprophytes feed on dead organism.

Step IV Student's Activity (students draw lines between related terms with propositions and examples)

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Explain association using hierarchical concept map
- List two types of association and give two examples of each

Summary and Conclusion: The teacher with the students highlighted the main points of the lesson.

LESSON PLAN FOR EXPERIMENTAL GROUP 1 (HIERARCHICAL) WEEK 2 (LESSON 2)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – Tolerance to environmental factors

Class – SS II

Average Ages – 16 years

Instructional Materials –Flash cards showing different concepts on tolerance

Previous Knowledge – Students have been taught the Basic ecological concepts in SS 1 class.

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define the term tolerance
- List environmental factors that affect living organism survival
- Explain tolerance range using hierarchical concept map
- Mention minimum and maximum tolerance ranges for plants and animals
- Explain how geographical range affects the distribution of plants and animals using hierarchical concept map.

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is a habitat?
- Define environment

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I the teacher present set of cuts cards to the students and define tolerance as: the ability of living organism to withstand or tolerate little unfavorable changes in the environment which affect their survival.

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts in descending order of importance)

(b) Living organisms can only live in a particular habitat if they can tolerate the ranges of the abiotic factors that operate in it. Because of changes in the environmental factors some these conditions are sometimes unfavorable. Too little or too much of certain environmental factors such as:

i. sunlight

ii. Heat

iii. Cold

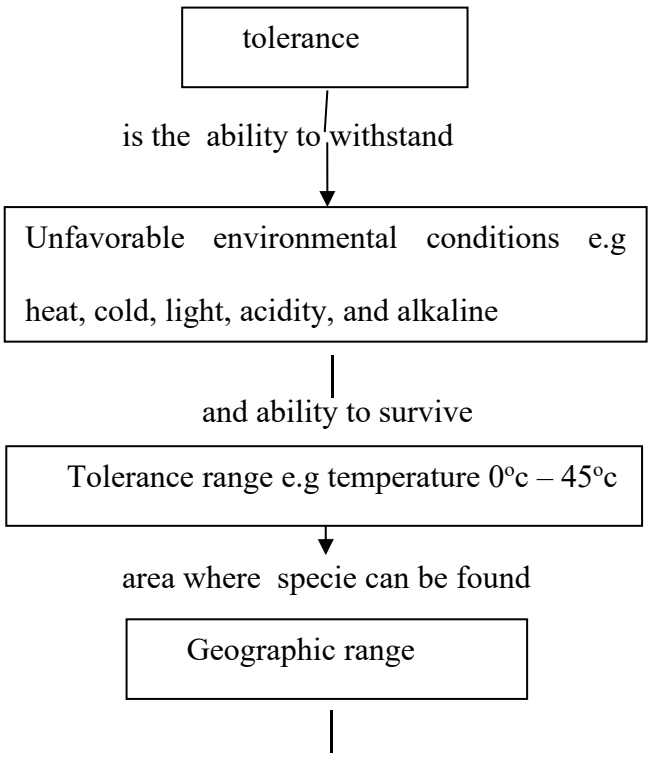
iv. Acidity

v. alkalinity

(b) Tolerance range is the range between the minimum and maximum limits to which organisms can tolerate certain changes in their environment so as to survive

(c) Organism can only live within certain minimum and maximum limits for each abiotic factor. Death occurs beyond this range, example for most animals, the minimum temperature limit is $0^{o}c$ while the maximum limit is $45^{0}c$ their tolerance range is 0 – $45^{o}c$. Some plants can withstand long period of drought, many cannot.

Student's Activity (students draw lines between related terms with propositions and examples)



Step III: (a) geographic range refers to the areas where a species of organism can only be found within the minimum and maximum limits of it s tolerance.

(b) different abiotic factors like

i. rainfall

ii. temperature

iii. light intensity

iv. availability of food

v. relative humidity

vi. day length

vii. wind

These factors are often responsible for the geographical boundaries of species of organism. For example geographical range for tropical rainforest is within the equator as a result of high temperatures and high rainfall, whereas tropical rainforest cannot be found at the northern and southern poles because of low rainfall and low temperature.

Step IV: (a) differences between tolerance range and geographic range

Step V:Student's Activity (students synthesize their experiences creatively by developing hierarchical concept maps)

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define tolerance
- List five environmental factors that affect living organism survival
- Explain tolerance range using hierarchical concept map
- Mention minimum and maximum tolerance ranges for plants and animals
- List five factors that are responsible for the geographical boundaries of species of organism.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

LESSON PLAN FOR EXPERIMENTAL GROUP (2) (HIERACHICAL) LESSON 3 (WEEK 3)

Date –

School -

Subject – Biology

Time – 40 minutes

Subtopic – food chain in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials –Flash cards showing different concepts on food chain.

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

Define food chain

- Construct a food chain using hierarchical concept map
- List the various types of food chain
- Differentiate between the various types of food chains
- Construct a food chain using different organisms

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

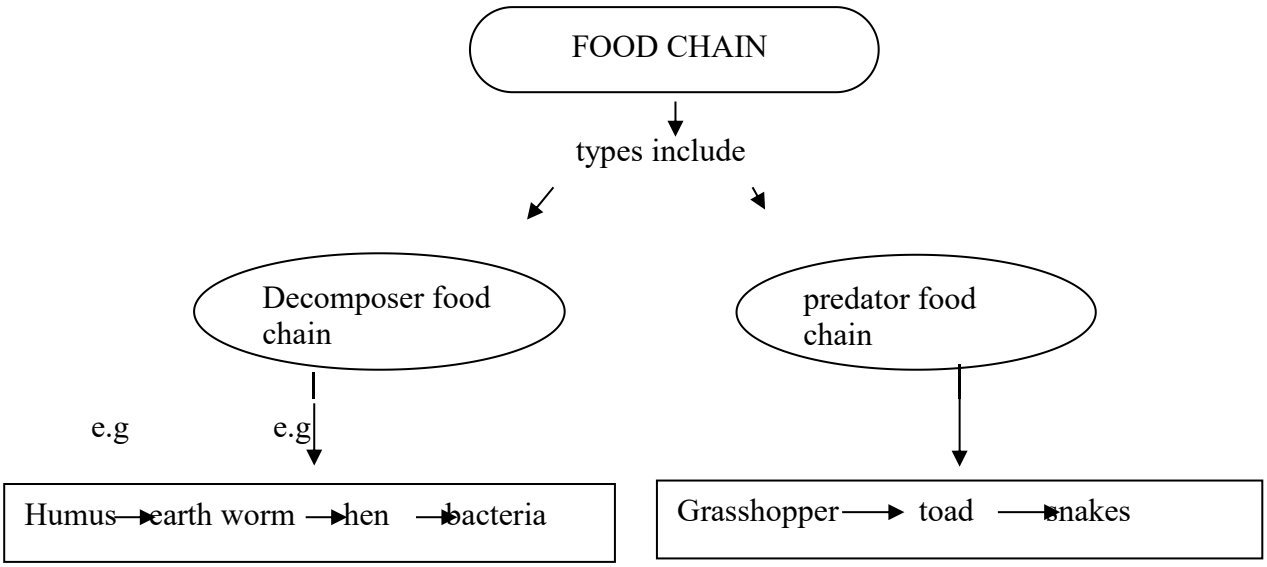
- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: Making links to hierarchical concept mapping strategy by presenting the learning task and logically ordering and linking learning materials to the concept map.

Step II The teacher present the students with sets of cards

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts in descending order of importance)



Step III: Define food chain as the transfer of energy from one organism to another in a series of trophic levels of eating and being eating.

Step IV: (a) list the types of food chains as predator (grazing food chain); detritus (decomposer) food chain

(b) explain the various types of food chain with specific examples such as predator (grazing) food chain; this is made up of predator spices and their prey or food species which are usually alive or freshly killed when they are eaten. The sun is usually the source of energy and green plants use it to make food for the ecosystem. Example in aquatic habitat the following can be observed Diatom → Paramecium → Tilapia → Crocodile → Decomposer.

Detritus (decomposer) food chain; in this food chain the starting material is dead and unused organic material. The feeding species attack only dead organism or nonliving fragments of the organism it is also called decomposer food chain. Example Humus → earth worm → domestic fowl → man → decomposer

Step V:(a) differences between predator food chain and detritus food chain

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Construct food chain using hierarchical concept map
- List two types of chains and give two examples of each

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson

LESSON PLAN FOR EXPERIMENTAL GROUP 2 (HIERARCHICAL) LESSON 4 (WEEK 4)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – food web in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials– Flash cards showing different concepts on food web.

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define food web
- describe the various examples of food web
- Differentiate between the various types of food web
- Construct a food web using different organisms

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I presenting spider concept mapping strategy logically, ordering and linking learning materials to the concept map. The teacher present the students with sets of cards

Step II: Define food web as a complex inter connection of food chains in an ecosystem

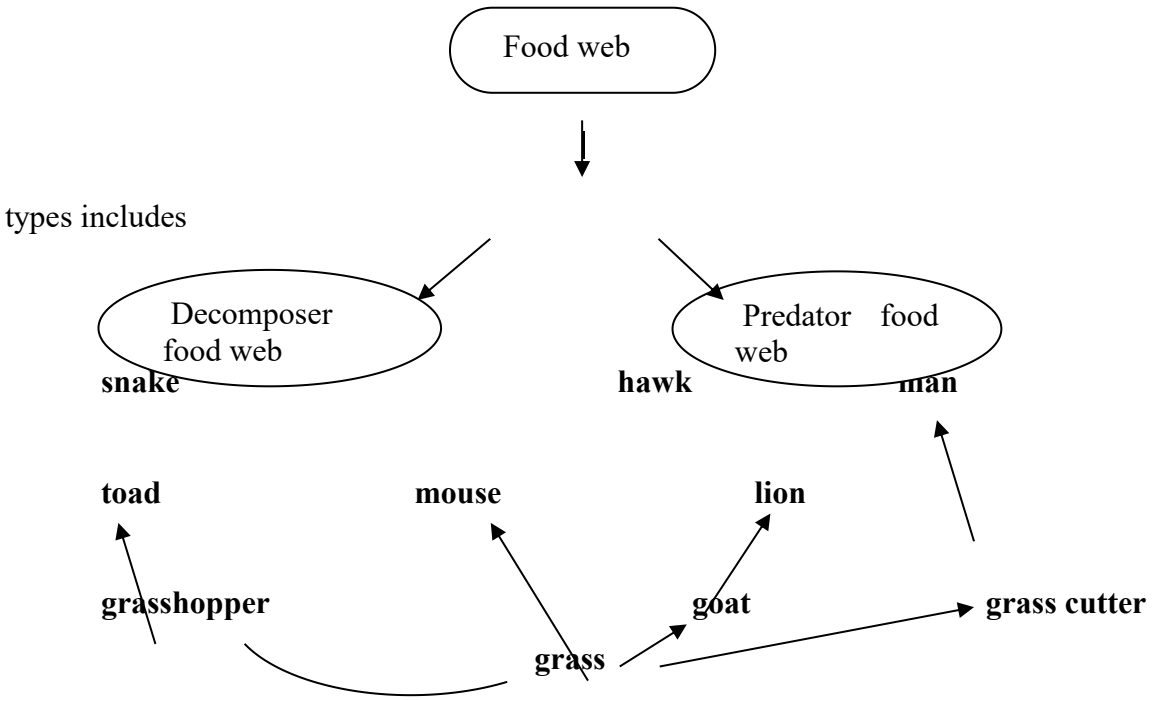
(a) list the types of food chains as predator (grazing food chain); detritus (decomposer) food chain

(b) explain the various types of food chain with specific examples such as predator (grazing) food chain; this is made up of predator spices and their prey

or food species which are usually alive or freshly killed when they are eaten. The sun is usually the source of energy and green plants use it to make food for the ecosystem. Example in aquatic habitat the following organisms can be observed Diatom, Paramecium, Tilapia, Crocodile, and Decomposer.

Detritus (decomposer) food web; in this food web the starting material is dead and unused organic material. The feeding species attack only dead organism or nonliving fragments of the organism it is also called decomposer food web. Example of organism include Humus, earth worm, domestic fowl, man decomposer

Student's Activity(students sort and arrange cuts cards with terms kept fairly close together with key concepts in descending order of importance)



Step III: (a) differences between predator food chain and detritus food chain

Student's Activity (students draw lines between related terms with propositions and examples)

Step IV: (a) differences between predator food chain and detritus food chain

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define food web using an hierarchical concept map
- List two types of webs and give two examples of each

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

LESSON PLAN FOR EXPERIMENTAL GROUP 2 (HIERARCHICAL) LESSON 5 (WEEK 5)

Date –

School -

Subject – Biology

Time – 40minutes

Topic – trophic level in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials –Flash cards showing different concepts on trophic level

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define trophic level
- describe the nature of energy transfer or flow in the ecosystem
- recognize that chemical energy and nutrients are transferred among producers; consumers and decomposers
- describe the three types of pyramids

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps: presenting the learn task logically and linking learning materials to hierarchical concept map.

Step I: The teacher presents set of cuts cards to the students and explains that in a food chain each successive level is known as a trophic level. Energy flow from one trophic level to another is utilized in the following manner;

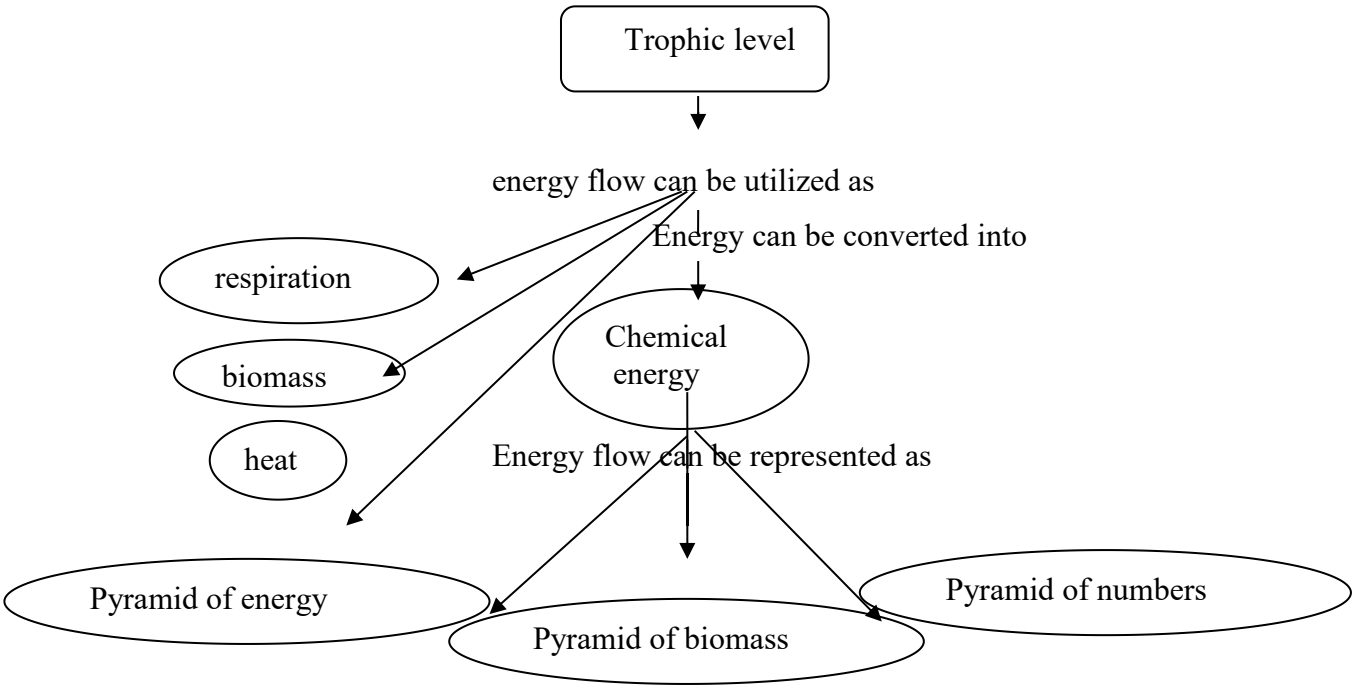
(d) Production of material is called biomass or is the weight of producer, consumers and decomposer that exist in an ecosystem.

(e) A part of energy is lost due to respiration

(f) The rest of the energy is lost as heat which is release during various activities

Step II: Energy that is utilized by producers is radiant energy, which is converted into chemical energy by green plants which is required by all living organism. The chemical energy is concentrated in food which is synthesized by the producer. In general in the transformation of energy through the ecosystem the energy in magnitude of 10 is lost from one trophic level to another.

Student's Activity (students sort and arrange cuts cards with terms kept fairly close together with key concepts in descending order of importance)



Step III: The flow of energy through a community can be represented by a pyramid of energy. In an ecological pyramid the first level forms the base and successive trophic level as the upper tiers. Each successive level can support fewer organism than the previous, this due to inefficiency of energy transfer from one trophic level to another. The pyramid s original energy is progressively reduced from plants to herbivores to carnivores. And also there is a reduction of biomass along the food chain.

Step IV: Types of pyramids are; pyramid of numbers; pyramid of biomass; pyramid of Energy Pyramid of number; in this pyramid the number of individual at each trophic level is arranged in a graphic system. It gives a quick idea of the relative abundance of the organism that constitutes each trophic level. Pyramid of biomass; this pyramid emphasis the importance of large organism that have heavy weight. The organisms at the higher level are usually larger and heavier in size than the top. Pyramid of energy; this indicate the amount of energy flow at each level and the role which the organism play in the transfer of energy. It gives an overall picture of the functional nature of the communities and throws light on the rate at which food materials passes through the food chain.

Step V : Student's Activity (students synthesize their experiences creatively by developing hierarchical concept maps)

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define trophic level
- List two types of pyramid
- Describe the transfer of energy from one trophic level to another.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

APPENDIX C
LESSON PLAN FOR CONTROL GROUP LESSON 1 (WEEK 1)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic –Types of association existing among different species

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards.

Previous Knowledge – Students have been taught the Basic ecological concepts in SS 1 class.

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Identify the different types of association existing between different species
- Identify beneficial; harmful and neutral forms of association among organisms.
- Differentiate between the various types of associations
- Deduce the mode of life of a given organism from observed characteristics

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is Ecology?
- Define environment.

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: the teacher explain to the students that species of any biotic community live in the state of symbiosis with three possible effects that each member of a pair can have on the population growth of the other. Positive (beneficial); negative (harmful); neutral (no significant benefit or harm)

Step II: (a) list the types of associations as: neutralism; inter-specific competition; mutualism; saprophytism; predation; parasitism; commensalism.

(b) explain the various types of associations with specific examples such as mutualism; is a symbiotic association where both population benefit and at

least one of the population is so dependent upon the other for some critical resource. Example algae and fungus (lichen)

Saprophytism; are those organism that derive their food from the dead decaying organism by secreting enzymes on the dead matter and absorbing the nutrient by diffusion. Example, mucor and yeast.

Predation; is an association in which a free organism (predator) kills another free living and eat it as food (prey). Example, cat and rat.

Parasitism; is an intimate association between two living organism of different spices in which one organism obtains food and shelter the other is harm and does not receive any benefit. Example, plasmodium and red blood cells.

Commensalism; is a relationship in which one of the partner (commensal) benefit while the other (host) is neither benefitted nor harmed. Example remora and shark.

Step III: (a) differences between parasitism and saprophytism such as parasitism feed on Living organism while saprophytes feed on dead organism.

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- What are association
- List two types of association and give two examples of each
- Mention two differences between parasitism and saprophytism.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

LESSON PLAN FOR CONTROL GROUP WEEK 2 (lesson 2)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – Tolerance to environmental factors

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards

Previous Knowledge – Students have been taught the Basic ecological concepts in SS 1 class.

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define the term tolerance
- List environmental factors that affect living organism survival
- Explain tolerance range
- Mention minimum and maximum tolerance ranges for plants and animals
- Explain how geographical range affects the distribution of plants and animals.

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is a habitat?
- Define environment

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: (a) Define tolerance as: the ability of living organism to withstand or tolerate little unfavorable changes in the environment which affect their survival.

(b) Living organisms can only live in a particular habitat if they can tolerate the ranges of the abiotic factors that operate in it. Because of changes in the environmental factors some these conditions are sometimes unfavorable. Too little or too much of certain environmental factors such as:

i. sunlight

ii. Heat

iii. Cold

iv. Acidity

v. alkalinity

(b) Tolerance range is the range between the minimum and maximum limits to which organisms can tolerate certain changes in their environment so as to survive

(c) Organism can only live within certain minimumand maximum limits for each abiotic factor. Death occurs beyond this range, example for most animals, the minimum temperature limit is $0^{o}c$ while the maximum limit is $45^{0}c$ their tolerance range is 0 – $45^{o}c$. Some plants can withstand long period of drought, many cannot.

Step II: (a) geographic range refers to the areas where a species of organism can only be found within the minimum and maximum limits of it s tolerance.

(b) different abiotic factors like

i. rainfall

ii. temperature

iii. light intensity

iv. availability of food

v. relative humidity

These factors are often responsible for the geographical boundaries of species of organism. For example geographical range for tropical rainforest is within the equator as a result of high temperatures and high rainfall, whereas tropical rainforest cannot be found at the northern and southern poles because of low rainfall and low temperature.

Step III: (a) differences between tolerance range and geographic range

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define tolerance
- List five environmental factors that affect living organism survival
- Explain tolerance range
- Mention minimum and maximum tolerance ranges for plants and animals

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson

LESSON PLAN FOR CONTROL GROUP LESSON 3 (WEEK 3)

Date –

School -

Subject – Biology

Time – 40 minutes

Topic – food chain in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define food chain
- List the various types of food chain
- Differentiate between the various types of food chains
- Construct a food chain using different organisms

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: Define food chain as the transfer of energy from one organism to another in a series of trophic levels of eating and being eating

Step II: (a) list the types of food chains as predator (grazing food chain); detritus (decomposer) food chain

(b) Explain the various types of food chain with specific examples such as predator (grazing) food chain; this is made up of predator spices and their prey or food species which are usually alive or freshly killed when they are eaten. The sun is usually the source of energy and green plants use it to make food for the ecosystem. Example in aquatic habitat the following can be observed Diatom Paramecium Tilapia Crocodile Decomposer.

→ → → →

Detritus (decomposer) food chain; in this food chain the starting material is dead and unused organic material. The feeding spices attack only dead organism or nonliving fragments of the organism it is also called decomposer food chain. Example Humus → earth worm → domestic fowl → man → decomposer

Step III: (a) differences between predator food chain and detritus food chain

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define food chain
- List two types of chains and give two examples of each
- Mention two differences between these types.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

(b) List factor common to aquatic habitat as; salinity; dissolved oxygen; turbidity and currents.

(c) Factors common to terrestrial habitat as; relative humidity; edaphic and topographic factors (d) Give example of measuring instruments for each factor as thermometer; photometer; secchi disc; hygrometer

Step III: Identify how these factors influence the distribution of plants and animals. Example temperature variations have effects on the distribution of organism; their mode of life and their rate of physiological activities example cold blooded animals such as lizards remain inactive at low temperature

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- What are ecological factors?
- List two major categories of ecological factors and give two examples of each.
- Give one example of measuring instruments for each factor.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

LESSON PLAN FOR CONTROL GROUP LESSON 4 (WEEK 4)

Date –

School -

Subject – Biology

Time – 40 minutes

Subtopic – food web in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials – Flash cards

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- Define food web
- describe the various examples of food web
- Differentiate between the various types of food web
- Construct a food web using different organisms

Introduction – The teacher introduced the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: Define food web as a complex inter connection of food chains in an ecosystem

Step II: (a) list the types of food chains as predator (grazing food chain); detritus (decomposer) food chain

(b) explain the various types of food chain with specific examples such as predator (grazing) food chain; this is made up of predator spices and their prey or food species which are usually alive or freshly killed when they are eaten. The sun is usually the source of energy and green plants use it to make food for the ecosystem. Example in aquatic habitat the following oganisms can be observed Diatom, Paramecium, Tilapia, Crocodile, and Decomposer. Detritus (decomposer) food web; in this food web the starting material is dead and unused organic material. The feeding spices attack only dead organism or

nonliving fragments of the organism it is also called decomposer food web which includes the following organisms Humus, earth worm, domestic fowl, man, decomposer

Step III: (a) differences between predator food web and detritus food web

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define food web
- List two types of webs and give two examples of each
- Mention two differences between these types.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

LESSON PLAN FOR CONTROL GROUP LESSON 5 (WEEK 5)

Date –

Subject – Biology

Time – 40 minutes

Topic – trophic level in the ecosystem

Class – SS II

Average Ages – 16 years

Instructional Materials –Flash cards.

Previous Knowledge – Students are familiar with the concepts of association in the ecosystem

Behavioral Objective(s) – By the end of the lesson, the students were able to:

- define trophic level
- describe the nature of energy transfer or flow in the ecosystem
- explain that chemical energy and nutrients are transferred among producers; consumers and decomposers
- describe the three types of pyramids

Introduction – The teacher will introduce the lesson by asking the students some question on basic ecological terms such as:

- What is autotrophy
- Define heterotrophic mode of feeding

Presentation: Based on the student's responses the teacher presents the lesson in the following steps:

Step I: In a food chain each successive level is known as a trophic level. Energy flow from one trophic level to another is utilized in the following manner;

(a) Production of material is called biomass or is the weight of producer, consumers and decomposer that exist in an ecosystem.

(b) A part of energy is lost due to respiration

(c) The rest of the energy is lost as heat which is release during various activities

Step II: Energy that is utilized by producers is radiant energy, which is converted into chemical energy by green plants which is required by all living organism. The

chemical energy is concentrated in food which is synthesized by the producer. In general in the transformation of energy through the ecosystem the energy in magnitude of 10 is lost from one trophic level to another.

Step III: The flow of energy through a community can be represented by a pyramid of energy. In an ecological pyramid the first level forms the base and successive trophic level as the upper tiers. Each successive level can support fewer organism than the previous, this due to inefficiency of energy transfer from one trophic level to another. The pyramid s original energy is progressively reduced from plants to herbivores to carnivores. And also there is a reduction of biomass along the food chain.

Step IV: Types of pyramids are; pyramid of numbers; pyramid of biomass; pyramid of Energy

Pyramid of number; in this pyramid the number of individual at each trophic level is arranged in a graphic system. It gives a quick idea of the relative abundance of the organism that constitutes each trophic level.

Pyramid of biomass; this pyramid emphasis the importance of large organism that have heavy weight. The organisms at the higher level are usually larger and heavier in size than the top

Pyramid of energy; this indicate the amount of energy flow at each level and the role which the organism play in the transfer of energy. It gives an overall picture of the functional nature of the communities and throws light on the rate at which food materials passes through the food chain.

Evaluation: The teacher evaluates the lesson by asking the followings questions:

- Define trophic level
- List two types of pyramid
- Describe the transfer of energy from one trophic level to another.

Summary and Conclusion: The teacher along with the students will highlight main points of the lesson.

APPENDIX D
ECOLOGY CONCEPT PERFORMANCE TEST

SECTION A; Bio-data of respondents

Location of school; _____

Class; _____

Gender; _____

Age; _____

SECTION B; Test

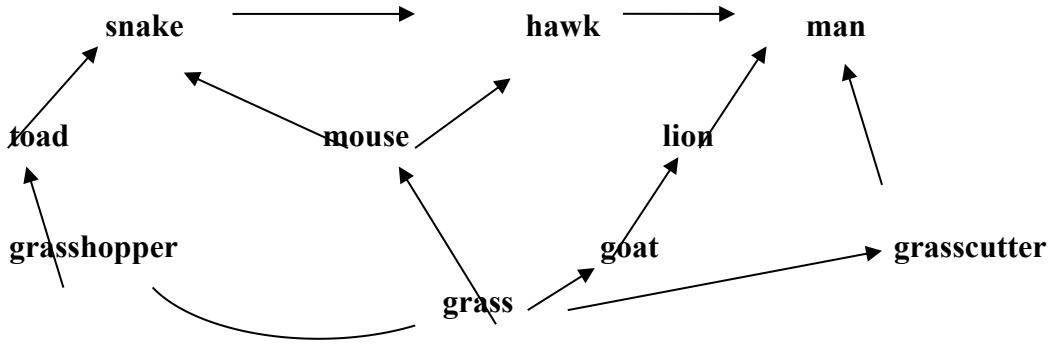
Instruction; choose and shade on the answer sheet the appropriate option that best answers the questions below

Time allowed: 1 hour

1. Which of the following is not an abiotic factor for tolerance?
   A. Wind
   B. Temperature
   C. alkalinity
   D. Competition.
2. Which of the following defines symbiosis?
   A. Parasites feed on dead organism
   B. Both organisms benefit mutually by living together.
   C. Saprophytes feed on living organism.
   D. Organisms serve as host to parasite.
3. The continuity of an ecosystem depends on constant flow of energy and circulation of matter. However, the amount of energy passed on from decomposers to producer should be?

A. Great
B. Small
C. Irreversible
D. Zero

Study the diagram below and use it to answer questions **4** and **5**



4. The best title for the above diagram is

A. Terrestrial food web

B. Terrestrial food chain

C. Aquatic food web

D. Aquatic food chain

5. How many food chain are there in the diagram

   A. Three

   B. Four

   C. Five

   D. Six

6. Which of the following the minimum and maximum temperature tolerance range

   A. $0^{O} - 25^{O}C$

   B. $1^{O} - 45^{O}C$

   C. $1^{O} - 25^{O}C$

   D. $0^{O} - 45^{O}C$

7. Which of the following sequence best illustrates a food chain in an aquatic habitat?

A. algae ⟶ fungi ⟶ toad ⟶ snake

B. Diatom ⟶ tadpole ⟶ fish ⟶ kingfisher

C. Grass ⟶ grasshopper ⟶ toad ⟶ whale

D. Phytoplankton ⟶ fish ⟶ snake ⟶ kingfisher

8. The ability of an organism to withstand little unfavorable changes in its habitat is refers to as?

A. competition

B. dispersal

C. tolerance

D. patience

9. An importance of food web is that living organisms

A. Use web to collect food

B. Can live on their own

C. Have to form a web

D. Depend on one another for their existence.

10. Which of these organism is most likely to have the least number, if found within the same habitat?

A. Grasshopper

B. Hawk

C. Lizard.

D. snake

11. The following factors are responsible for geographical boundaries of species of organism **except**?

A. Day length

B. Relative humidity

C. Light intensity

D. Enzymes

12. The range between minimum and maximum limit of tolerance is refer to as

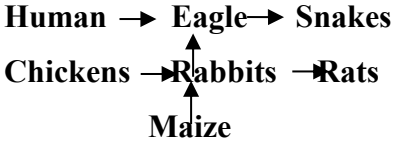
A. Biotic range

B. Tolerance range

C. Geographic range

D. Topographic range

13. Which of the following are consumers in these food chains?



A. Maize and rabbits

B. Chicken, rats, and maize

C. Eagle, maize and snakes

D. Human, eagle and snakes.

14. Which of the following is a producer in the above food chains

A. Rat

B. Eagle.

C. Maize.

D. Chicken.

15. The association existing between man and tapeworm is?

A. Holozoic

B. Parasitic

C. predatory

D. saprophytic

16. The following are factors that affect the distribution of organisms in an aquatic habitat EXCEPT?

A. Availability of nutrients.

B. Depth of water.

C. Humidity.

D. Turbidity.

17. The correct sequence of energy transfer among living organisms in an ecosystem is?

A. Consumer – decomposer - producer.

B. Consumer – producer - decomposer

C. Producer – consumer - decomposer

D. Producer – decomposer – consumer.

18. An association between two organisms where both members benefit is known as?

A. commensalism

B. mutualism

C. parasitism

D. saprophytsim

19. Which of the following is the correct sequence of a food chain?

A. grass → grasshopper → toad → snake → hawk

B. grasshopper → grass → hawk → snake →toad

C. grass →hawk →snake →toad →grasshopper

D. grasshopper →grass →hawk →toad →snake

20. In the food chain below, the organism with the least available energy is?

Grass →grasshopper →fowl →hawk →man

A. Fowl

B. Grass.

C. Grasshopper.

D. Man.

21. The flow of energy through a community can be represented by a?

A. Pyramid of energy
B. pyramid of Nature
C. pyramid of numbers
D. pyramid of biomass

22. Which of this best defines a feeding relationship involving complex inter-connections of food chains?

A. symbiosis
B. tropic level
C. food chain
D. food web

23. The following are ecological pyramids except

A. Pyramid of numbers
B. Pyramid of numbers
C. Pyramid of energy
D. Pyramid of nature

24. Which of these best defines an association in which the host is harmed?

A. commensalism
B. mutualism
C. parasitism
D. saprophytism

25. The activities of an organism which affect the survival of another organism in a habitat can be described as?

A. Biotic factor
B. Climatic factor
C. Abiotic factor
D. physiological

APPENDIX E
Ecology Concept Performance Test (ECPT) Marking Scheme

1. D	**6. A**	**11. B**	**16. C**	**21. A**
2. D	**7. B**	**12. B**	**17. B**	**22. D**
3. A	**8. C**	**13. D**	**18. B**	**23. D**
4. A	**9. D**	**14. C**	**19. A**	**24. C**
5. C	**10. D**	**15. B**	**20. D**	**25. A**

APPENDIX F

Facilities Index and Discrimination Results

Answer Key, Facility (F1) and Discrimination (D) Indices for Ecology concept Performance Test (ECPT**)**

	Right answers	**Right scores**	**RU**	**RL**	**Facility Index** **F1** $=\frac{R}{T}X\frac{100}{1}$	**Item Discriminations** $\frac{RU-RL}{1/2N}$
1	D	17	11	3	37.7	.356
2	D	23	12	4	511	.356
3	A	18	12	3	40.0	.40
4	A	18	13	2	42.0	.488
5	C	20	14	3	44.44	.488
6	A	21	15	3	46.6	.533
7	B	29	14	5	64.4	.40
8	C	26	11	4	57.7	.31
9	D	31	15	7	68.8	.356
10	D	28	14	4	62.2	.44
11	B	27	16	5	60.0	.48
12	B	24	14	5	53.3	.40
13	D	24	14	2	53.3	.53
14	C	30	19	9	66.6	.44
15	B	25	12	3	55.5	.48
16	C	32	15	83	71.11	.40
17	B	29	18	6	64.44	.31
18	B	26	14	4	57.7	.53
19	A	33	20	6	73.3	.44
20	D	30	15	4	66.6	.53
21	A	23	10	2	51.5	.48
22	D	28	17	5	51.1	.356
23	D	26	13	5	62.2	.44
24	C	21	14	4	57.7	.40
25	A	21	14	5	46.6	.40

APPENDIX G

ANSWER SHEET FOR ECOLOGY CONCEPTS PERFORMANCE TEST

SECTION A: BIODATA

Name of School _____

Class _____

Gender _____

SECTION B:

Please shade the correct answer appropriately

• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
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• =A= =B= =C= =D=	• =A= =B= =C= =D=
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• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=
• =A= =B= =C= =D=	• =A= =B= =C= =D=