UNIVERSITY OF EDUCATION, WINNEBA

USING CONCEPT MAPPING TO ENHANCE STUDENTS' UNDERSTANDING ON ECOLOGICAL CONCEPTS AT MIM SENIOR HIGH SCHOOL

COSMOS ANNING

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A Dissertation in the Department of Science Education, Faculty of Science, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfilment of the requirements for award of the Master of Education (Science) degree.

OCTOBER, 2016

DECLARATION

Student's Declaration

I, **Cosmos Anning** hereby declare that this dissertation, with the exception of quotations and references contained in published and unpublished works that have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

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COSMOS ANNING **DATE:**

Supervisor's Declaration

I hereby declare that the preparation of this dissertation was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

Mrs. RUBY HANSON (Ph. D) **DATE:**

(Supervisor)

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DEDICATION

This dissertation is dedicated to the MOST HIGH GOD, My wife and children.

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ABBREVIATIONS

ANOVA	Analysis of Variance
Cmap	Concepts map
IHMC	Institute for Human and Machine Cognition
MANOVA	Multivariate Analysis of Variance
SHS	Senior High School
JHS	Junior High School
BAT	Biology Achievement Test
EAT	Ecology Achievement Test
SSS	Senior Secondary School
SPSS	Statistics Package for Social Science
U.S	United States
WAEC	West African Examination Council

ABSTRACT

The purpose of this study was to raise awareness of the potential of concept mapping as an aid to enhance students' understanding of conception about ecology through action research. Mim Senior High School was the experimental school while Ahafoman Technical Senior High School was the control school in this study. A pre-test and post-intervention test as well as retention test non-equivalent quasi-experimental design was used for the study. The sample size was 105 students. The experimental group consisted of 55 students while the control group consisted of 50 students. The students in the experimental group were instructed with concept mapping while the control group were instructed with the traditional method of teaching. Both groups were taught the same content which was on basic concepts in ecology. Three instruments were used for the data collection in this study. These were an achievement test, a questionnaire on students' perception towards concept mapping (QCM) and a structured interview. Descriptive statistics, paired and unpaired t-test were used to analyse the data for answering the research questions. Results showed that treatment factor (concept mapping method) produced significant difference in the performance of the experimental group as the mean score of students taught with concept mapping was significantly higher than those who were not exposed to the method. Results also showed evidence of retention of learnt concepts among the experimental group. It has been recommended that concept mapping method should be encouraged in many biology classes at the SHS. Much attention should be given to students concerning analysis and other high order cognitive level questions.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter comprises the background of the study, statement of the problem, purpose and objectives, research questions, significance of the study, limitation, delimitation and general layout of the study.

1.1 Background of the Study

Science and technology play an important role in the modern world. Science is believed to serve as the foundation of technological development and a key factor in economic growth (Letao & Bradley, 2015). The process of science is a way of building knowledge about the universe, and formulating new ideas that promote the existence human being on the earth. These ideas are inherently tentative, but as they cycle through the process of science again and again and are tested and retested in different ways, we become increasingly confident in them (Appaw, 2011). Mclutosh (1985), believed that as ecology developed as a science its concepts of population, community, environment, ecosystem and its effects on human being must be studied. Human actions have profound, reciprocal, and commonly destructive effects on the earth on which humanity depends. Worster (1993) also stressed the importance of the concepts of ecosystem to human existence. Ecological studies use quantitative samples of populations and community to assess the numbers and kinds of organisms in a habitat and to measure the physical environment. Ecological knowledge has played a very important role in the society. It has been used to solve problems of diseases and poor yields in agriculture by the production of disease resistant and high yielding plants and animals and overpopulation through the development of hormone based contraceptives. It has also enabled us gain knowledge about the protection and management of the environment (Maundu, Sambili, & Muthwii, 2005).

The importance of the science is not limited to the development of the individual alone but the advancement of the social, economic and political goals of countries all over the world. Knowledge in science education transforms the economy and social-cultural status of a nation (Anammuah-Mensah, 1989). The rise of Japan into the status of an economic giant today (Evans, 1991) as well as the emergence of Singapore, Hong Kong, Korea, Taiwan and Malaysia recently into economic giants have all been attributed to the heavy investments these countries made in the science education of their citizens (Ranis, 1990). Ecology is among the topics in biology, which is considered as difficult to teach and to learn because it consists of unfamiliar concepts that involve complex relations (Okebukola, 1990). The conceptual nature of ecology makes it particularly difficult for students in senior high schools. Meanwhile the present instructional strategies of traditional method used in the classroom have not sufficiently eased difficulties that students encounter in the learning process. Naturally, some people find it easy to understand concepts in ecology, whereas others find it difficult. However, the fact remains that ecology demands careful thoughtfulness, a creative mind, and conscious thinking from learners, which has been difficult for some students (Letao & Bradley, 2015). For the past decade, candidates have not been performing well in biology. For instance, in 2002, out of 8922 candidates who sat for the West African

Examination Council (WAEC) examination in biology nationwide, only 3,476 (39%) passed with grades A to D. In 2003, 3,772 (39.4%) out of 9581 candidates passed with grades A to D. In 2004 out of 10,546 candidates, 5,051(47.9%) passed with grades A to D. While in 2005, 5803 (40.7%) passed with grades A to D out of 14176 candidates (Anthony–Krueger, 2007). The chief examiner"s report released by the West African Examination Council (WAEC, 2003, 2004, 2005 & 2006) indicated that students" general performance was not good in biology. Students showed poor performance in providing answers for questions based on genetics and evolution, ecology, internal respiration, co-ordination in mammals, biological classification, protein synthesis, secondary growth, and transport system (WAEC, 2003, 2004, 2005 and 2006). Over five years of the Researcher"s teaching experience in the Mim Senior High School (2010-2015), has observed that most students perceive ecology to be difficult area to learn. This has resulted into rote learning of ecological concepts and reflected in poor performance in tests involving these concepts. During the classroom interaction of the Researcher in the first year with the biology students of Mim Senior High School he noticed some of the difficulties of the students that have affect their performance. Possible sources of students' difficulties in learning can be attributed mainly to the high school biology curriculum, teaching and learning strategies, textbooks, and insufficient laboratory conditions and equipment. In addition, students' motivation and interest must be also taken into consideration. Ongowo (2013), believed that teachers are pivotal to students" perceptions of learning as they could, inhibit or facilitate the processes of learning. The study stated that some of the teacher qualities that lead to effective relationships are positive affection, warm attitude, tact of teaching, teacher immediacy, teacher power, teacher assertiveness, responsiveness, and low differential treatment. In sub-Saharan Africa, the dominant method of teaching science in general and biology in particular is the lecture method because of lack of equipped laboratories (Ajewole, 2006). This approach also tends to make the study of biology uninteresting and boring. Students normally see their colleague students who do well in the subject as those who have ability to memorise what is taught in class; hence, a search for innovative ways and best instructional methods that will help students to improve upon their understanding is always laudable (Adiyiah, 2011).

Considering the importance of ecology to man"s understanding of himself and his environment, there is a need to inquire into ways of ensuring that students" attain meaningful learning of ecological concepts rather than learning by rote. Concept mapping is one of the activity-based instructional strategies that help students to learn meaningfully, thus assisting them to overcome the problem of misconceptions (Novak, 2010). In most Ghanaian less endowed schools where the name laboratory only exists in books the use of concept mapping is the alternative instructional approach to make a teacher"s lesson a reality. Concept mapping is one of the constructivists" methods recommended for teaching science at all levels of education in order to improve upon teaching and learning (Rye & Rubba, 2002). The visual nature of concept maps allow the learner to figure out the links among key ideas and makes it easier for them to see information in different ways and from different viewpoints. Concept mapping therefore, structures the learning process more effectively which result in higher-quality learning (Kiran, 2012). Concept maps have been found to enhance the understanding of most biology topics; hence, many studies have been, and are still being conducted in the use of concept maps to enhance students‟ conceptual understanding. The extent to which concept mapping could enhance the understanding of basic concept in ecology is consequently worth investigating. Thus, this study will particularly use the concept of mapping to help students of Mim Senior High School who have performed abysmally in biology for the past five years to improve upon their ecological concepts, which is an aspect of biology.

1.2 Statement of the Problem

One of challenges confronting biology students in Mim Senior High School of Asunafo North Municipal are that for several years candidates have not been performing well in biology (WAEC, 2003, 2004, 2005 and 2006). Through the Researchers‟ classroom interactions with some students during lessons, it became apparent that most students had constrains with their understanding of biological concepts. These concepts seemed abstract to them. According to Webb and Bolt (1990), conceptual difficulties relating to energy flow through an ecosystem are not limited to students in the elementary and middle school grades, but also, students in high school and colleges also demonstrate difficulties in understanding ecology concepts. Majority of first year students studied could not predict the probable effect on one organism in a food chain when a second organism was removed. They are unable to predict successfully the effect on an entire food web if one population was eliminated. Though these students were aged between 15 to 18 years, and were expected to reason in abstract or manipulate ideas in their minds because they were in the formal operational stage, it was not so (McLead, 2005). They behaved as students in the concrete operational stage, because they mostly wanted to see or handle concrete materials before they could understand concepts. Most teachers in the senior high schools are still using the traditional techniques of teaching (Wood, 2007). The traditional technique of teaching is mainly taught in abstract and besides it has most of terminologies that may be difficult to pronounce. This seems to cause students to inadequately understand the lessons they are taught hence, might cause them to memorise facts only for examinations and thereafter promptly forgetting what they have learnt. This may be due to the fact that, knowledge does not become internalised and is not transferred between topics and across subjects. Meaningful learning may not be taking place as expected. Anamuah–Mensah, Otuka and Ngama-Wara, (1995) emphasised the need to introduce more innovative and effective instructional techniques of teaching science in Ghanaian schools. One teaching approach that is widely used in the Western countries is concept mapping. Concept maps have been proven to be effective method of teaching for retention and comprehension of concepts. It appears however, that concept mapping as a method of instruction is not widely used in senior high schools in Ghana. Hence, our senior high school students may not be benefiting from concept mapping effectiveness. This study therefore, was designed to explore the effectiveness of concept mapping in enhancing the students‟ understanding on ecological concepts.

1.3 Purpose of the study

The overall aim of the study was to enable the researcher explore alternative instructional approach in the teaching science to enhance the students" understanding on ecological concepts. This study also focused on finding out whether the concept mapping technique could positively affect students" retention. Finally, it was aimed at finding the perception of students towards concept mapping.

1.4 Research Objectives

The objectives of the study were to:

1. Find the significant difference in achievement between Mim SHS students taught through concept map technique and Ahafoman Technical Senior High School taught with the traditional technique method.
2. Find the significant difference in the retention of learnt ecological concepts between the Mim SHS students taught with concept map techniques and Ahafoman Technical Senior High School students taught with traditional method.
3. Find out the experimental group (Mim SHS) perception towards concept mapping.

1.5 Research Questions

In order to ascertain how biology lessons are organised in the selected Senior High Schools, the following questions were addressed in the study:

1. What difference in achievement would students of Mim SHS and Ahafoman Technical Senior High School students demonstrate through the use of different teaching methods?

2. What differences in performance would be observed among students taught with different methods, in a retention test?

3. What are the Experimental group (Mim SHS) perceptions towards concept mapping?

1.6 Significance of the Study

The importance of the research cannot be underestimated. The findings, recommendations and suggestions could be an important source of information to the teachers in the selected schools and other teachers who teach biology. The study could unveil the teaching and learning techniques that could ensure maximum student participation in the teaching and learning of biology. The concept mapping technique would help students to summarise, organise, memorise and logically present their work with no ambiguity. This could hopefully help students study how to learn meaningfully, thereby enhancing their understanding, not only in basic ecological concepts but in biology and other subjects as well. This study could also serve as a source of information for further research work on the topic by teachers in the Asunafo North Municipal area. Additionally, the findings could augment the pool of data needed by other educational researchers in their bid to design interventions to solve educational problems in the sciences in general and biology in particular.

The result of this study could serve as a basis for the organisation of workshop, seminars and in-service training to train biology teachers on how to use concept mapping to supplement strategies they have been using in classroom to bring about improvement in students" achievements. Finally, the results and findings will serve as a basis for future research work in a related area or field of study

1.7 Limitation of the Study

The nature of the research involved investigation into pedagogical issues for appropriate instructional tool. The research involved observation, discussions and interaction with learners in order to get reliable data. The basic limitation was that only Mim Senior High School and Ahafoman Technical Senor High School were selected out of the several senior high schools in Ghana for the study since the study was time bound.

1.8 Delimitation of the Study

First year students who offer elective biology in the selected schools participated in the study. The study was restricted to the topic ecology and its sub-topics such as ecosystem, symbiosis, biomass, energy exchange and components of ecosystem.

1.9 General Layout of the Study

Chapter one dealt with the introduction of the study. It discussed the background of the study, statement of the problem, purpose of the study, research questions, significance of the study, delimitation, and limitation, organisation of the rest of the study.

Chapter two is a review of literature relevant to the study. The review focused on this chapter discusses the available literature related to this study.

Chapter three described the methodology used in the study. This chapter would discuss the research design, population, sample and sampling techniques, instruments, data collection procedures and data analysis.

Chapter four presents and describes the results in reference to the purpose of the study and findings of other researchers as reviewed in chapter two.

Chapter five presents the overview of the research problem and methodology, summary of the key findings, draws conclusions and offers recommendations as well as suggestions.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter discusses the available literature related to this study. The discussions include the following; origin of concept maps, concepts of ecology, types of concept maps, features of concept maps and how standard concept maps are constructed. The chapter also looks into how concept maps are scored, other method of scoring concept maps, uses of concept maps, and benefits of concept maps. The chapter further discusses how concept maps aid students‟ retention, traditional method of teaching, conceptual framework of the study and summary of related literature review.

2.1 The Origin of Concept Maps

Concept map is used as teaching techniques, which gives graphical illustration of the link among terms. Concept map gives a unique graphical perspective of how students organise, connect and synthesis data. Instructional strategy is very important in the teaching and learning of science. It serves as a path that directs students‟ understanding of concepts and so is an integral part of classroom experiences. Various methods are opened to teachers to use to teach, from kindergarten to tertiary levels in order to enhance students‟ understanding of scientific concepts. Coll, France, and Taylor (2005), pointed out that the use of analogies and mental models can enhance students understanding of complex and abstract scientific conceptions.

Cardemone (1975) made the first use of concept maps. He found that the preparation of a "master" concept map for the topic of 'ratio and proportion' helped him to plan instruction on this topic. Two years later, Bogden (1977) also found that concept maps prepared by him in a genetics course were found to be valuable in learning the course by a small minority of students. The concept maps used by Cardemone (1975) and Bogden (1977) did not have words on the linking lines between concepts. In the years to follow, the fate of concept mapping existed in a dilemma until 1984, when Novak and Gowin (1984) gave the concept maps their present shape and carried out extensive experiments with concept mapping in the school teaching and learning process. Since then the science of concept mapping has grown at an exponential pace. Concept mapping has been reported to provide a very effective strategy to help students learn meaningfully by making explicit the links between scientific concepts (Fisher, Wandersee, & Moody, 2000). It has also been reported that concept maps improve students‟ problem solving capabilities and aid collaborative learning (Omotayo , 2013). Concept maps are tools for organising and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts or propositions, (indicated by a connecting line and a linking word) between two concepts. Linking words on the line specify the relationship between the two concepts (Novak & Canas, 2008).

Indumati (2012) studied the effectiveness of concept mapping in teaching an environmental education subject. The study concluded, that concept mapping is a far more sensitive and accurate evaluating tool than the 'objective' tests used in their study. Novak and Wandersee (1990) identified in their study that concept maps are designed to find out what the learners already know about a subject. The conclusion of the study was that concept maps can offer rich and detailed insight into the extent of meaningful learning resulting from classroom instruction. Other results also suggested that concept mapping is valid and a potentially useful technique for documenting and exploring conceptual change in biology. Okebukola (1990) examined the potency of concept mapping technique to attain meaningful learning of concepts in genetics and ecology. A higher mean score obtained in favor of experimental group who used concept maps suggest that students achieved meaningful learning in ecology. She concluded that concept mapping techniques promote meaningful learning of genetics and ecology. Besides the learners, her study has direct implications for biology educators. Lambiotte and Dansereau (1992) selected few concepts from college biology textbook and taught students using concept map. It was revealed that concept mapping enhances meaningful learning as compared to the lecture method that is mostly used in teaching secondary school biology topics. In other words, a concept map provides a visual roadmap showing the pathways that we may take to construct meanings of concepts and proposition in a simpler way (Kinchin, 2000). Concept maps are a way to develop logical thinking and study skills, by revealing connections and helping students to see how individual ideas form a larger whole. "Concept mapping is a learning technique which employs graphical representations to assist the learners organise information about science concepts in a meaningful manner to facilitate learning" (Omotayo , 2013).

2.2 Concepts of Ecology

Ecology is the scientific study of the interactions between organisms and their environment (McPherson & DeStefano, 2003). Oxford dictionary defines population as group of individuals belonging to the same species and living in the same geographic area at a given time. Individual species depends on natural resources available in the geographical area. Population ecology basically, examines the factors affecting population density and distribution (Ricklefs & Miller, 2000). Population density on its part is the number of individuals in a given area or volume whiles population distribution is how individuals in that area are scattered. Community ecology however, emphasis on how two or more populations of different species inhabiting a particular geographic area interact, thus competition and predation, one way to represent these relations is through a food web. Ecological concepts are general understandings or facts about ecosystems and its management and these provide a foundation for developing ecological principles.

2.3 Types of Concept Maps

According to Canas, Hill, Carf and Suri, (2013) numerous types of mapping systems have been developed that enable the graphical depiction of ideas and concepts, some of these are concept maps, knowledge maps, mind maps, cognitive maps, and semantic networks. Concept maps differ from these other superficially similar types of representations in a variety of ways. Essentially, concept maps are defined by:

1. their theoretical basis in Ausubel"s (1968) assimilation learning theory and constructivist epistemology

2.their semi-hierarchical organisation.

3. the use of unconstrained and meaningful linking phrases, and

4. the way concepts are defined.

2.4 Features of Concept Maps

A key feature of concept maps is that they are constructed to represent text structure patterns which serve to help students" mental constructs or schemata of how texts are organised. Novak and Canas (2008) identified three characteristic features of concept maps as indicated below:

1. Concept maps are represented in a hierarchical structure with the most inclusive, and general concept at the top of the map, while the more specific, less general concepts are 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.
2. There is the inclusion of cross- links. These are relationships of links between concepts in different segments or domains of the concept maps. Cross- links help us to see how a concept in one domain of knowledge represented on the map relates to a concept in another domain shown on the map.
3. The final feature is specific examples of events or objects that help clarify the meaning of a given concept. Normally these are not included in the ovals or boxes, since they are specific events or objects and do not represent concepts.

2.5 Method of Constructing Concept Maps

Concept maps can be constructed by using a variety of methods. The method that is employed depends on the purpose of map construction. Concept maps can be constructed either by hand or with the assistance of software that supports specific tasks or general diagramming. Individuals or groups, either with or without facilitation, can construct concept maps (Canas, Hill, Carff, & Suri, 2013). The Concept mapping method defined by Novak and Gowin (1984) involves a series of steps.

1. Define the topic or focus question.

2. Once the key topic has been defined, the next step is to identify and list the most important or "general" concepts that are associated with that topic.

3. Next, those concepts are ordered top to bottom in the mapping field, going from the most general and inclusive to the most specific, an action that fosters the explicit representation of subsumption relationships (i.e., a hierarchical arrangement or morphology).

4. Once the key concepts have been identified and ordered, links are added to form a preliminary concept map.

5. Linking phrases are added to describe the relationships among concepts.

6. Once the preliminary concept map has been built, a next step is to look for crosslinks, which link together concepts that are in different areas or sub-domains on the map. Cross-links help to elaborate how concepts are interrelated.

7. Finally, the map is reviewed and any necessary changes to structure or content are made.

Ruiz-Primo, Li, Schultz and Shavelson (2001a) suggested that the degree of control or directedness in map construction differs in different mapping tasks. They further suggested that graph construction tasks that are low in directedness may provide clearer insights into differences among students" knowledge structures. Concept maps can be constructed with or without the use of a facilitator, either within a group or within an individual setting. In either case, the facilitator may simply play the role of transcriptionist, or may actively promote elaboration or clarification of ideas in the concept map, and improvement of map structure. Concept mapping software has been designed to provide different types of facilitation for map construction, including online scoring and assessment of maps, or suggestions about improvements that may be made to the concept map (Canas, Hill, Carff, & Suri, 2013).

2.6 Concept Mapping Scoring System

Ruiz-Primo, Shavelson, Li, & Schultz, (2001b) proposed various scoring schemes for assessing and scoring concept maps. Closeness index is that type of the weighted scheme of scoring system that takes into account a number of students and teachers instructional needs. Teachers need to determine the importance of each proposition based on their professional knowledge, by giving propositions weights, which range from 0 to 1. A concept map, which uses weighted propositions, is termed a "weighted concept map." The higher a proposition ranks is importance, the higher weight is assigned to it. The quantitative analysis is a similarity value found in the comparison of concept maps drawn by students and an expert concept map drawn by a teacher. To address this problem, this study proposes the use of a new style of concept map scoring technique called the weighted concept maps which are closeness index and similarity index developed by Goldsmith, Johnson, and Acton (1991).

2.7 Other Method of Scoring Concept Maps

Novak and Gowin (1984), proposed the traditional method of concept map scoring. Their method was based on the components and structure of the concept map. Novak and Gowin"s system assigns points for valid propositions and other points for the remaining stages, which are indicated below:

1. levels of hierarchy (5 points for each level),
2. number of branching (1 point for each branch),
3. cross links (10 point for each valid cross-link), and

4. Specific examples (1 point for each example).
5. The number of hierarchical levels addresses the degree of subsumption,
6. The number of branching indicates progressive differentiation, and the number of cross-links indicates the degree of integration of knowledge.

Some other scoring techniques have been developed as extensions or variations of Novak and Gowin"s system. For example, Kinchin (2000) and Klein, Chung, Osmundson, Herl, and O"Neil (2001) explored different systems of scoring the same components of map but weighed them differently. Some researchers are pursuing the possibility of providing automated assessment of the structural components of concept maps (Vanides, Yin, Tomita, & Ruiz- Primo, 2005). Ruiz-Primo, Schultz, Li, and Shavelson (2001a), describe methods that compare a student"s map to that of an expert"s. A computerised technique could be used to simplify the comparison of maps, and researchers have explored this possibility. Clariana, Koul, and Salehi (2006), confirmed that computer-based approach that could be used to score concept maps. They used the computer-based approach to compare a student"s map to that of an expert"s. These automated scoring systems are typically based on propositional matching within limited sets of concepts and linking phrases. Holistic or structural comparisons are more difficult to automate, as they often require human judgment. Some researchers have experimented with the combination of methods based on components, and methods in comparison to a criterion map. One example of this approach is to use traditional component-based scoring combined with some comparison to a criterion map, by assigning more weight to propositions that were considered critical by experts.

2.8 Uses of Concept Maps

Concept mapping has been proven to assist learners in many ways such us to enhance learners learning skills, researchers to create new knowledge, and for evaluators to assess learning. Concept maps have been used for many instructional purposes, in many subjects, and with many levels of students (Stoddart, Abrams, Gasper, & Canaday, 2000). Concept maps are used to stimulate the generation of ideas, and are believed to aid creativity. Concept map can be used in the following area of education; curriculum development, strategy for learning, teaching and collaborating, explanations of various concepts (Gururao, 2013)

2.9 How Concept Maps Aid in Students' Retention

The use of concept mapping to teach science in general has the potential to increase students‟ cognition at the same time imparting positively on the affective and psychomotor domains because it enhances retention (Arokoyu & Obunwo, 2014). In a related development when Oluikpe and Chibuzo (2014) tested the effect of concept mapping on students‟ retention in English grammar, it came to light that concept mapping was more efficacious than the lecture method in the improvement of students' retention. Hassan and Fatemeh (2012) also used concept mapping to assess students' retention in English grammar and found out that it had significant effect on students' retention. Though the above study was conducted using English grammar it was however, consistent with the study by Ezeudu (2013) who investigated the effect of concept map on students‟ retention in organic chemistry. His result showed that the use of concept maps had a significant effect on students‟ achievement and retention in organic chemistry.

Ajaja (2009) examined the use of concept mapping as a study skill on students" achievement in biology. The result indicated that there was no significant difference in immediate post- achievement test scores between students who used concept mapping as a study skill and those who use it to review and summarise what was learnt. However, in relation to retention a significant difference was found between students who used concept mapping as a study skill and those who used it as a summary tool. He observed that the use of concept mapping technique helped learners to retain knowledge for a longer period. Moreover, it allows students to visualise a certain knowledge structure in a graphic form that helps them to take in all the data from an image simultaneously and recall the information easier and faster. Concept mapping was thus, investigated as a tool for enhancing students understanding of basic ecological concepts.

2.1.0 Benefits of Concept Maps

Scientific concepts are perceived by students as difficult to understand due to unfavorable strategy used by instructors. Students consequently resort to rote learning to pass their examination. Schmid and Telaro (1990) sought to test the effectiveness of concept mapping on high school biology achievement and to assess this by student academic ability level. The study was conducted in Montreal, Canada and involved students at levels 4 and 5 of the Canadian system. The subject matter was a unit of a biology course on the nervous system. The experimental design combined treatment and control crossed with three levels of academic ability (high, medium, and low). The results indicate that the helpfulness of concept mapping increased as groups went from high to medium to low ability. The authors speculate that concept mapping helps low ability students to a greater degree because it requires them to take an organised and deliberative approach to learning, which higher ability students are likely do anyway. The usefulness of concept map on students learning ability was also revealed when Omotayo (2013) used concept mapping in child science education and obtained a significant difference in the performance of pupils who were taught by using concept mapping and those that were not.

Cheem and Mirza (2013) set out to determine the effect of concept mapping on students‟ academic achievement. The study aimed to analyse the effect of concept mapping, on the academic performance of 7th grade students in the subject of general science. The treatment lasted for five months. The experimental group was trained to develop concept maps for three weeks. Subsequently students developed concept maps of general science content individually, shared their ideas in groups, and were compared with scientifically accepted concept maps by the teacher for possible correction and improvement. Data on gain achievement scores were analysed through a 2-way ANOVA. Results showed that male and female students taught through concept mapping performed better than the students taught through traditional teaching method. The study recommended that concept mapping should be used in elementary classes for teaching general science and also incorporates it in the textbooks of science subjects at the school level. Concept map tool can be used in any discipline (basics, social or applied sciences) and at any level of education (from nursery education to tertiary education). In this way, it could be applied as a technique to study or as a learning tool promoting reflection, analysis, and creativity among students. Concept maps are usually depicted by circles or boxes, forming the nods of the new work by labeled links (Buzzetto-More, 2007). Juall and Moyet (2007) maintain that concept map is an educational technique that uses diagrams to demonstrate the relation of one concept or situation, by linking a central concept to another one, to help the learner understand the central concept better.

Teachers on the other hand could benefit immensely from the use of concept mapping strategy. Concept mapping provides science educators with a more comprehensive understanding of what students need to learn and helps eliminate sequencing errors in the development of lesson plans (Martin, 1994). With the current emphasis on teaching for understanding and the importance of conceptual knowledge, teachers need techniques that help children see patterns and connections (rather than memorise facts) and form mental structures that would help them handle new knowledge and relate it to past knowledge (Erickson, 2002). To meet rising expectations and increase instructional capacity, teachers must strengthen their content and pedagogical knowledge as well as increase their proficiency in using them with their students. It is the teacher‟s responsibility of assessing students' existing knowledge, providing quality content, which is structured.

2.1.1 Traditional Method of Teaching

This method of teaching is referred to conventional or expository method of teaching. It was derived from lecture method of teaching. It is mostly described as teacher-centred or teacher dominated method. Students are passive listeners in the teaching and learning process while teachers occasionally demonstrate processes for students to observe, engage students in brief discussion and questioning, and often use illustration from diagrams, and charts. Wood (2007) observed that biology teachers in the secondary schools introduce lessons followed by explanations and demonstrations. He pointed that teachers allow few questions from students of which he or she answers them. After each explanation, the teacher dictated copious notes for students to write.

Tamakloe, Amedahe, and Atta (2005), stated that the traditional method is not suitable for students who are low on the academic ladder as these students find it difficult to listen and take notes at the same time. It does not take into consideration individual differences. Meanwhile, Charlton (2006) thinks that traditional method is probably the best teaching method in many circumstances and for many students especially for communicating conceptual knowledge at where significant knowledge gap exists between teacher and students. It is effective because it exploits the spontaneous human aptitude for spoken (rather than written) communications.

The practice of science needs to manipulate tool meant for activities such drawing, observation and interactions to undertake practical skills requisite for foundation of science for higher in science education. As already stated, the traditional method does not promote students‟ participation in classroom activities. Wood (2007) indicated that biology teachers resort to the traditional method because of the workload. He reported that the enrolment in most science classes is about 50 to 70 students, making it difficult for teachers to resort to the use of more competitive methods. He suggested that biology teachers can enrich traditional methods of teaching by using more teaching and learning materials, slides and overhead projectors. In the absence of the above mentioned, concept maps would seem to be suitable tool for teaching and learning.

2.1.2 Conceptual Framework for the Research

Concept mapping is grounded in a sound cognitive learning theory. According to Novak and Cañas (2006) new knowledge can be learned most effectively by relating it to previously existing knowledge. This knowledge structure held by a learner is also referred to as the individual‟s cognitive structure. One of the most fundamental goals in the use of concept maps is to foster meaningful learning. Concept map is as an evaluation tool, thus encouraging students to use meaningful-mode learning patterns (Mintzes, Wandersee, & Novak, 2000). Concept maps are also effective in identifying both valid and invalid ideas held by students. Rote learning which occurs as a result of absence of activity in teaching and learning contributes very little to our knowledge structures, and therefore cannot underlie creative thinking or novel problem solving. Concept mapping is an excellent studying-exercise for the promotion of critical thinking and identification of new problem-solving methods (Novak, 2010). Concept maps may be seen as an instructional tool of assimilation theory that reviews basic elements of the theory such as subsumption, integrative reconciliation and progressive differentiation. The idea of a concept is defined as a perceived regularity in events or objects, or a record of events or objects, designated by a label, symbols and so on (Cañas, Valerio, Lalinde-Pulido, Arguedas, & Carvalho, 2003).

Students are supposed to be exposed to many and varied activities such as collecting, sorting and cataloguing; observing, note-taking and sketching; interviewing, polling, and surveying. In particular, biology students have to learn to use hand lenses, microscopes, thermometers, cameras, and other common instruments. They should be engaged in dissection session as well as have the abilities to measure, count, graph, and compute. They have to observe the social behavior of humans and other animals. None of these activities is more important than measurement, in that figuring out what to measure, what instruments to use, how to check the accuracy of measurements, and how to configure and make sense out of the results are at the heart of much of science concept development and understanding. Facilitation of understanding takes many forms. Thus, successful teachers are those who spice up their teaching methodology with different ways to present and facilitate understanding among students in their classroom. Concept maps have been used as advanced organisers to improve learners‟ organisation of facts and subsequent achievement. It also provides teachers with a meaningful and practical structured approach, and the development of deep meaningful teaching which moves towards critical thinking rather than surface approaches. Teachers and students are often able to identify misconceptions within the context of a concept mapping with the links and nodes relationships (Adiyiah, 2011). Concept maps strategy put students at the center of teaching and learning process with teachers as facilitators guiding learners through an exploratory journey of meaning making in the class.

2.1.3 Summary of Review of Related Literature

Reviewed literature has shown that concept maps are graphical tools for organising and representing knowledge. Concept maps can be used at all levels of education. Concept maps enable an individual to present concepts hierarchically from the most inclusive and most general at the top, to the more specific and less inclusive. It is a good technique for teaching ecology and other biology topics. Finally, the literature reviewed revealed that the traditional method discourages active involvement of students in teaching and learning and compel the students use rote learning approach in passing their examination.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter covers the research design, population, sample and sampling procedure, instrument, data collection procedure, description of interventions and data analysis.

3.1 Design of the Study

A pre-intervention test, post-intervention test and retention test non-equivalent design was used for the study since the subjects were not to be assigned randomly to the experimental and control groups (Cohen, Manion, & Morrison, 2000). In a typical school situation, classes cannot be disrupted or reorganised for the Researcher to conduct a study; it is therefore, appropriate to use groups that are already organised or intact. Even though this design suits this study, it has some weaknesses. The major weakness lies in its inferiority to randomised experiments in terms of internal validity (Trochim, 2000). Hence, some extraneous factors such as age, ability, maturation and previous learning experiences were not controlled in this study. The schools which participated in the study were 11km apart. Both qualitative and quantitative data were used for the study. Scores of students" achievement tests for pre-intervention test, post-intervention test as well as retention test constituted the quantitative data while the interview and questionnaire on students" perceptions towards concept mapping constituted the qualitative data.

The achievement tests that were Pre-intervention test, Post-intervention test and retention test were administered to both the control and experimental groups. The retention test was administered two weeks after the intervention. The experimental group received treatment using the concept mapping method while the control group received treatment using the traditional method. Both groups however, covered the same content in basic concepts in ecology. In this study, the achievement of the students was the dependent variable while the teaching approaches (concept mapping and the traditional method) were the independent.

3.2 Population

The target population for the study was all SHS students offering elective biology in the Asunafo North Municipal. There are two public SHSs in the municipality. It is estimated that about 350 students offer elective biology in the Asunafo North Municipal. However, the accessible population was SHS 1 elective biology students whose population was 105. This number consists of 58 males and 47females.

3.3 Sample and Sampling Procedure

For the purpose of this study, the Researcher selected all SHS 1 biology students in Mim Senior High School as the experimental group, through a purposive sampling technique. This school was purposively chosen due to its closeness to the Researcher. Besides the closeness, the school was selected because of readiness of the school to accommodate the study and partly because the number of the students offering biology was reasonable enough for the study. The Researcher administered the pre-intervention test, post-intervention test and retention test to all selected SHS 1 students and questionnaire to the Mim SHS (experimental group). The questionnaire was given to the experimental group. Twenty-five students were also randomly selected from the experimental group for the interview. The SHS 1 biology students in Ahafoman Senior High Technical School were purposely selected as the control group. The experimental group was made up of 55 students with 30 males and 25 females, while the students in the control group were 50 in number with 28 males and 22 females. Therefore, the sample size for the study was 105 SHS 1 elective biology students. The two schools selected were 11 km apart so; to avoid between group interactions.

3.4 Instruments

Three instruments were used for the data collection in this study. These were Achievement test, questionnaire on students" perception towards concept mapping (QCM) and a structured interview.

3.5 The Achievement Tests

The achievement tests were categorised into Ecology Achievement Test (EAT) in appendix B, and EAT2 (Appendix C) and Biology Achievement Test (BAT) in appendix A. BAT consisted of twenty (20) multiple- choice items with four options to choose the correct answer. Students were given 45 minutes to work on the BAT**,** which was pre-intervention test. The pre-intervention test was used to ascertain the students" initial academic achievement and to determine the homogeneity or the heterogeneity of the control and experimental groups. The pre-intervention test questions were developed from the junior high school (JHS) integrated science syllabus and textbooks. The post-intervention test was administered after the intervention had been given. The achievement of the post-intervention tests between the experimental and the control groups were compared. Class exercise on ecosystem was administered to only the experimental group to ascertain how they answered 28 ecosystems fill in map questions and how they constructed their concept maps, this exercise lasted for one hour. EAT was given to both experimental and control group and comprised of 20 multiple-choice items and two theory type questions with their sub- questions lasted for one and half hours. The total marks for EAT was 60 marks. EAT2 is a retention test developed from the topic under investigation. EAT2 consist of 20 objectives test and two essay type questions. For the EAT2 objective questions, each correct answer or response was assigned one mark while a wrong response was assigned a zero mark. The total mark for the EAT2 was 80. Thus, the objective questions were scored over 20 marks and the essay 60 marks.

The test items were developed based on the SHS biology syllabus and textbooks, and some modified past questions of the West African Examinations Council (WAEC) biology test items. To ensure content and face validity of the instrument, the test items were subjected to expert judgment by a biology teacher with five years of experience for corrections and suggestions to improve upon the instruments. Scoring rubrics were developed for BAT, EAT and EAT2 to facilitate the scoring. For the multiple-choice questions, each correct answer or response was assigned one mark while a wrong response was assigned a zero mark. The total marks for the EAT had a maximum score of 20 marks and class exercise had a maximum score of 28. For the class exercise, four areas were looked at; the hierarchies, the concepts, the propositions and cross-links. In order to ensure internal consistencies of the achievement tests, the assistance of examiners were sought, one for BAT pre-intervention test, one for EAT post-intervention test and another for EAT2 retention test. The examiners for the EAT had between 4-11 years of teaching experience as biology tutors and served as assistant examiners for the West African Examination Council. The Researcher discussed the scheme with the examiners and agreed on the marks to be awarded. Some photocopies of the students" script were marked and the scores compared among the examiners so that the differences in scoring could be discussed for agreement to be reached before the live scripts were scored. The marking of scripts lasted for eight days. The second examiner who is a biology tutor was trained to mark the concept map class exercise. The scoring rubric was adapted from Novak and Gowin, (1984). Five marks were allocated for each correct hierarchy and zero for an incorrect hierarchy, one mark was allocated for each correct concept and zero for an incorrect concept; one mark was also allocated for each correct proposition and zero mark for an incorrect proposition.

3.6 Questionnaire on Perception of Students towards Concept Mapping (QCM)

The student‟s questionnaire items were (Appendix D) chosen to gather the data on the perceptions experimental group towards the efficacy of concept mapping. Since the concept mapping was a new method that the students had been exposed to, it was important to find out from them their perceptions towards this new method. The items consisted of two (2) main parts (A and B). Part (A) contained four (4) items that elicited information on the demographic or background of the participants. The variables in part **A** covered respondents‟ age. These data are in tandem with the purpose of this research since the respondents‟, age might have significant influence on how the experimental group perceive the effectiveness of concept mapping as a method of improving their understanding in scientific instruction.

The second part B consisted of six (6) items that elicited information on respondents‟ perception of the effectiveness of concept mapping in the teaching and learning of science. In addition, there was an open - ended item in the questionnaire that was used to get information on participants‟ views about concept mapping integration in science instruction.

3.7 Scoring the Questionnaire Items

A Likert scale with five options (Strongly Agree (SA= 5), Agree (A = 4), Neutral (N =3), Disagree (D = 2), and Strongly Disagree (SD = 1) was used to score the questionnaire items. The items on the questionnaire were positively and negatively stated in order to reduce participant-satisfying responses for instance, "the use of concept map demystifies learning and do away with abstract reasoning. "A Likert scale was used because is easier to construct, interpret and provide the opportunity to compute frequencies and percentages of scores. This in turn, allows for a more sophisticated statistical analysis such as Analysis of Variance (ANOVA), t-test and regression analysis (Fraenkel & Wallen, 2000).

Variable scores were obtained by averaging the numeric values of the responses for the related items on the variable as stated above. A mean score near 5 was considered a very high level of support, between 3 and 4 a high level of support, and a score between 1 and 2 was regarded as the low level of support. The percentages of the participants" response to the likert- scale items were also used to indicate the extent to which participants agreed or disagreed with the statement.

3.8 Validity and Reliability

The content validity of the instruments was determined by subjecting them to expert judgment (Rye & Rubba, 2002). Pre-intervention test and the post-intervention test as well as retention tests were subjected to inspection by experts including the supervisor of this project, who is a senior lecturer and doubles as head of department in chemistry at the University of Education, Winneba, and two SHS teachers who have vast experience in the teaching of biology, for their judgments on the content and the level of language. To ensure validity of the interview, the transcribed responses were read back to the students who were interviewed to ascertain from them whether the responses were exactly what they said. The reliabilities (internal consistencies) of the three tests were determined and the reliability co-efficient (Cronbach‟s alpha) were calculated using SPSS Version 16.0. The interrater reliability of the BAT pre-intervention test was 0.82 and 0.83 for the post-intervention test (EAT), and the retention test (EAT2) had interrater reliabilities 0.83 respectively

3.9 Pilot Testing

A pilot test was conducted in Hwidiem Senior High School in the Asutifi South District, in the Brong Ahafo Region, in order to check for the suitability of the instrument for data collection. The students of the school in Hwidiem took a pre-intervention test before a treatment was administered, wrote a post-intervention test two weeks after pre-intervention test and finally wrote retention test the next one week. The students who were exposed to concept mapping approach were given questionnaires to respond to on their perceptions towards concept mapping after they had taken the retention test. The interrater reliability of the pre-intervention test, post-intervention test as well as retention test were 0.82, 0.83 and 0.83 respectively. Cronbach alpha coefficient of reliability for pilot QCM was 0.78.

3.1.0 Data Collection Procedure

A letter of introduction from the Researcher was sent only to the headmistress of Ahafoman Senior Technical School before the beginning of the study but since Mim SHS is where the Researcher teaches the headmaster there did not require a letter but verbal briefing. The Researcher met the headmistress of Ahafoman Senior Technical School who introduced the Researcher to the head of science department, after explaining the reason of his study to him. The Researcher was then introduced to the teacher who taught SHS 1 biology by the head of the science department. This was followed by interactions with the SHS 1 biology teacher to know from him the method he often used for teaching the students in his class. It was revealed that the traditional method of teaching was most familiar to both teacher and the students.

The traditional method of teaching is characterised by the teacher introducing the lesson and explain it expository. Students also had to write copious notes given by the teacher in either dictation or copying it from the white board. After going through the notebooks of the students it was realised that they all had the same notes, indicating that they copied their notes from their teacher. The Researcher took time to observe the teacher while he taught, but this was done with his consent. This action helped to pre-inform the researcher the kind of method that was to be used in teaching the control group. The Researcher also took time to familiarise with the students as well. The relationship established between the teacher and the students created a perfect atmosphere throughout the period of data collection. During the familiarisation session, the experimental group was introduced to concept mapping.

The topic on the photosynthesis was used to teach students the various phases of concept mapping. The topic on photosynthesis was not the topic to be treated in the main study. This topic was chosen because it was treated in the integrated science and so served as revision for them. The emphasis was on linkages between concepts (propositions) and the hierarchical arrangement of concepts on the concept map. Also cardboards were cut into circles and rectangles on which topics and sub-topics on photosynthesis were written on. Students were to arrange the circles and the rectangles to form concept maps. The Researcher gave students various exercises to make them conversant with concept mapping (Appendix G).

The control group was also taught the same topic using traditional method. Students were briefed on how they could benefit from lessons taught using the traditional method. They were told to pay attention to the voice variation of the teacher and certain phrases like, „the most important‟ „the two main stages are‟. At the end of the three days of familiarisation, a pre-intervention test on the students‟ knowledge in basic biological concepts test (BAT) was administered to both the control and experimental groups. The test comprised items on the topic biological classification, tissue, cell, transport system and photosynthesis. The pre-intervention test was to ascertain the homogeneity of the experimental and control groups, and also to know the level of knowledge each group had on basic biological concepts before the intervention was given. Students were encouraged to do independent work during the exercise. The class teacher helped in the sitting arrangement and the supervision of students. After the pre-intervention test, the intervention followed. Students in both the control and the experimental groups were taught for two weeks. The Researcher, being a qualified biology teacher taught both groups. Researcher bias, which is often associated with this type of design, was strongly considered. The intervention covered 80 minutes for each day. The experimental group had biology on Wednesday and Friday 7:10am to 8:40am, while the control group had biology on Tuesday 9:30 to 10:50 and on Thursday 12:10 to 1:30. The flexibility of the timetable made it possible for the Researcher to commute between both schools.

The Researcher went to the control group school first followed by the experimental group the following day. The Researcher alternated between both schools two times in a week. The first week was for familiarisation, the other two weeks was for teaching the topic and the third week was for administration of the post-intervention tests, however, the retention test was administered on the fourth week and the last week was used for the questionnaires and the interview. Both the control and the experimental groups were taught the same content, had the same instructional objectives, same lesson duration and class assignment.

3.1.2 Description of Interventions

The intervention started with the control group who was taught ecosystem using the traditional method. This approach which some authorities often refer to as „the chalk and talk" approach, employed chalkboard illustrative sketches when necessary, and verbal description. The teaching and learning activities were mainly teacher-centred. Students occasionally asked questions, which were answered by the Researcher who was the teacher for the lesson. The Researcher explained associated concepts to students followed by writing main ideas on the board for them to copy. Each lesson concluded by Researcher summarising main ideas in the lesson. After each lesson was taught, students were given assignment. The experimental group were taught the same content and in the same sequence as the control group. However, they were taught using the concept map approach. This approach was grounded on the constructivist"s view of learning where students take active role in learning process to ensure meaningful learning. Before the start of the lesson, students were put into groups which comprised five members each. Based on the consensus each group selected their own leaders and secretaries, this engaged the groups in collaborative learning. The lesson, which involved the use of concept maps, took place in four phases. These were:

Phase I: Presentation of abstraction**:** The students were presented with a definition or a generalisation. Since a generalisation arises from common characteristics of various concepts, the students were asked to identify various concepts and sub-concepts.
Finally, they were asked to provide new and unique examples to judge their understanding of these concepts.
Phases II: Propositional phase: The researcher guided the learners to arrange the concepts hierarchically in a deductive manner, with the broader concepts placed at the top followed by less inclusive concepts. Lines link the various concepts and these lines are supplemented by words or phrases that indicate meaningful relationship among various concepts. Thus, the whole concept map is viewed as a network of concepts.
Phase III: Application: here, the students applied their knowledge by citing new examples and reflecting on the present examples.
Phase IV: Closure: Closure is a point at which the students came to the formal conclusions of the lessons. Students summarised major ideas involved in the process.

During the first and second sessions, ecosystem and symbiosis that are sub-topics in ecology were treated. The students" previous knowledge on concept maps were reviewed before the lesson continued. The lesson ended with a concept mapping exercise. Students were put into their groups and given a focus question with a list of concepts and sheets of papers to construct concept maps. Groups submitted their maps for scoring after the exercise (Appendix F). On the third and fourth days, energy exchange and biomass were treated. Students were made to construct concept map individually or sometimes in groups on those days. After the intervention to the experimental group, both the experimental and the control groups were given the same ecology achievements test, the post-intervention test the following week. The experimental group did EAT2A on Wednesday and on Thursday the control group did EAT2B. The experimental group was given the questionnaires to respond to. They were given 20 minutes to answer the items but most of them finished before the allotted time. After the administration of the questionnaire, 25 of the students comprising ten females and fifteen males in the experimental group were randomly selected for the interview. The questionnaire and the interview were to find out students" perceptions towards concept mapping. The national service personal in science department in the school assisted in the administration and the supervision of the test. After the test, the scripts were collected for scoring.

3.1.3 Data Analysis

The data received were entered separately into Microsoft excel for data output. The scores from the pre-intervention test, post-intervention test as well as retention test were subjected to descriptive and inferential statistics. A t – test (Paired and Unpaired), which allow for the testing of the statistical significance at 0.05 alpha levels were used for the analysis of data. When the P- values from the results of these statistical tools are greater than 0.05, then there is no significant difference, but if the P- values are less than 0.05, then there is significant difference. Unpaired t - test was used to compare the pre-intervention test scores in achievement for the experimental and control groups to ascertain the entry behaviour of the students.

In addition, unpaired t-test was used to compare the post-intervention test as well as retention-tests scores between the experimental and control groups in order to test research questions1and 2 respectively. Thematic content analysis was used to analyse students‟ responses to the questionnaire and the structured interview to answer the third research question. By this, the major area of the questionnaires and the interview were put into themes to determine the perception of students about the concept maps approach to teaching and learning.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

In this chapter, the results from the study were presented, analysed and discussed in relation to the three stated research questions.

Findings Related to the Research Questions.

4.1 Research Question One

Find the significant difference in achievement between **Mim SHS** students taught through concept map technique and **Ahafoman Technical Senior High School** taught with the traditional technique method?

The question sought to test whether there was any statistical significance difference in achievement between students of Mim Senior High School taught with the concept map technique and Ahafoman Senior High/ Tech School taught with the traditional method. The pre-intervention test was conducted before the intervention to ascertain the amount of knowledge the students had on basic biological concepts. The pre-intervention test was also to determine the homogeneity or the heterogeneity of the control and experimental groups. The pre-intervention test was analysed using t – test (Paired and Unpaired), the outcome is presented in the Table 1.

Table 1: t-test on Pre –intervention test means scores of experimental and control group

Group	N	Mean	P< 0.05
Experimental	55	15.13	0.72
Control	50	14.78	

When the level significant (P-value) is less than 0.05 it means there is a significant difference between the tests, but when the P-value is greater than 0.05 then there is no significant difference between the tests. Results from table 1, indicates that the P value was 0.72, this shows that there was no statistically significant difference between performance of students in the experimental group and control group. The mean ranks (experimental group was 15.13 and control group was 14.78) showed that both the experimental and the control groups performed almost at the same level. Hence, the two groups do not differ significantly with respect to initial academic achievement.

The post-intervention means scores of the experimental and control groups obtained after the intervention were also compared. A t-test analysis was used in comparison process and the output is captured in table 2 below.

Table 2: The mean and 'P' value of post-test scores of experimental and control group

Group	N	Mean Score	P-Value
Experimental	55	36.20	0.002
Control	50	28.50	

The Table 2 indicates that the 'P' value (0.002) is significant at 0.05 level of significance. The result indicates that there is significant difference between post-test mean scores of the group of students taught by using concept mapping (experimental group) and the group of students taught without using concept mapping (control group).

The outcome of students taught through the concept mapping approach in this study is consistent with Okebukola (1990) of the Lagos State University, Nigeria who examined the potency of concept mapping technique to help students to attain meaningful learning in genetics and ecology. She concluded that concept mapping techniques promote meaningful learning of genetics and ecology. The outcome of this study in Asunafo North Municipal is also in line with that of Lambiotte and Dansereau (1992) who selected few concepts from college biology textbook and taught students using concept maps. They found that concept mapping enhanced meaningful learning as compared to the lecture method that is mostly used in the teaching secondary school biology topics. From the analysis above, it can be said that concept map is effective instructional tool to enhance students understanding in basic concepts in ecology at SHS level.

4.2 Research Question Two

What differences in performance would be observed among students taught with different methods, in a retention test? The retention means scores of the two classes obtained after two weeks of treatment were compared. These were experimental and the control groups. A t- test analysis was used in comparison process the output of the analysis is presented in the Table 3.

Table 3: The mean and 'P' value of retention-test scores of experimental and control group

Group	N	Mean Score	P-value
Experimental	**55**	**32.10**	2.5×10^{-21}
Control	**50**	**29.50**	

The P- value of 2.5×10^{-21} in the table 3 above shows that there is a significant difference in the retention mean scores of both experimental and control groups. A higher mean score of 32.10 of the experimental group against 29.50 of the control group implied that the concept mapping strategy seems to prompt ability to recall learning tasks better even after two weeks of intervention. The findings of this study showed that using concept mapping strategy in teaching and learning helps students better in their understanding of basic concepts in ecology over traditional methods and students showed evidence of retention of the learnt concepts even after two weeks. This study confirmed a studies by Ezeudu (2013), Arokoyu and Obunwo (2014), Oluikpe and Chibuzo (2014), and Hassan and Fatemah (2012). The possible reason behind it may be that, traditional method of teaching usually dominated by teacher-cantered, direct instruction and often rely heavily on textbooks for the content of the course. Information and instruction are separated in two parts that make up a whole concept. The teachers seek to transfer their thoughts and meanings to the passive students. There is little room for student-initiated questions, independent thought or interaction between students. However, concept maps are most useful when the key objective is to be developed a comprehensive understanding of all concepts involved in a subject area. It bridges the new knowledge with existing previous knowledge and meaningful relationship can be developed which is helpful in understanding and remembering the concepts, processes, principles etc. Therefore, it can be concluded that the use of concept mapping help students to recall ecological concepts more effectively than the traditional method of teaching.

4.3 Research Question Three.

What are the perceptions of students towards concept mapping?. Responses from the questionnaire on students‟ perceptions towards concept mapping were analysed to find out their opinion about the use of concept maps. A 5-point Likert scale with

„strongly agree", „agree", „undecided", „disagree" and „strongly disagree" with scores of 1, 2, 3, 4, and 5 were assigned, respectively to negative worded items. Also scores of 5,4,3,2, and 1 were assigned, respectively to positive worded items. Mostly students strongly agreed and agreement were considered to be positive perceptions, undecided was considered to be neutral while disagree and strongly disagree were considered negative perceptions.

Responses of students" perceptions towards concept mapping were analysed thematically and the results are presented as Table 4.

Table 4: Responses of Students' Perceptions towards concept mapping (%)

Item	SA	A	N	SD	D
1. Concept map demystifies learning and do away with abstract reasoning.	**29(52.73)**	**16(29.12)**	**2(3.64)**	**2(3.64)**	**6(10.94)**
2 The use of concept mapping can aid Students' retention of material learnt.	**28(50.96)**	**13(23.40)**	**3(5.46)**	**3(5.46)**	**8(7.50)**
3. Concept maps enhance students' ability with their learning tasks.	**30(54.60)**	**21(38.18)**	**1(1.82)**	**1(1.82)**	**2(3.64)**
4. The use of concept mapping instruction is an effective means of helping students to understand relationships among concepts.	**30(54.60)**	**20 (36.40)**	**2(3.64)**	**1(1.82)**	**2(3.64)**
5. I concept map promote extrinsic and intrinsic motivation when use as teaching and learning instructional tool.	**27(49.14)**	**11(20.20)**	**3(5.46)**	**3(5.46)**	**1(1.82)**
6. Concept maps would make me provide unambiguous responses in a given assignment.	**35(63.63)**	**12 (21.82)**	**3(5.46)**	**1(1.82)**	**0(0)**

Table 4 indicates the ratings of the experimental groups‟ perceptions on efficacy of concept mapping instructional strategy in teaching and learning. The responses of students have been illustrated with chart and graphs. Majority of the participants (52.72%) strongly agreed with item 1, which indicates that, concept map demystifies teaching, learning and do away with abstract reasoning and it is represented on the graph below.

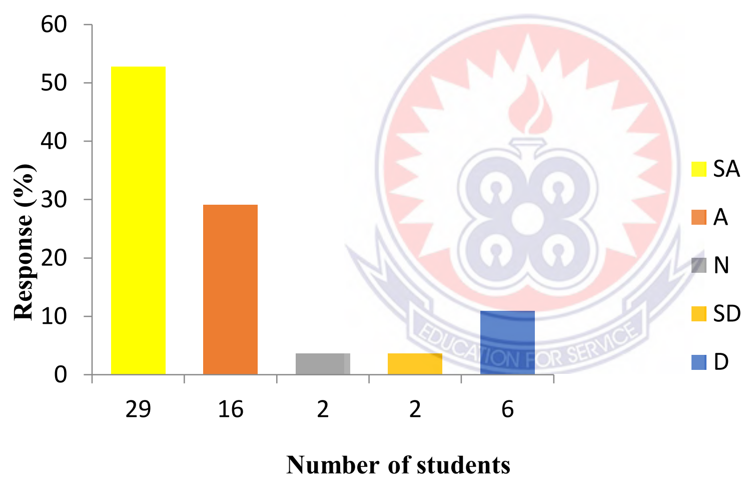

Figure 1*: concept map demystifies teaching, learning and do away with abstract reasoning.*

As seen from Figure 1, students who strongly agreed that concept map demystifies teaching, learning and do away with abstract reasoning had the highest peak. For item 2, 50.96% out of the 55 participants strongly agreed that, the use of concept mapping could aid students‟ retention of material learnt. One of the participants who asserted that confirmed that „concept mapping can help individual students to recall easily and do away with „chew and poor" which hinders critical thinking and these responses are shown in Figure 2.

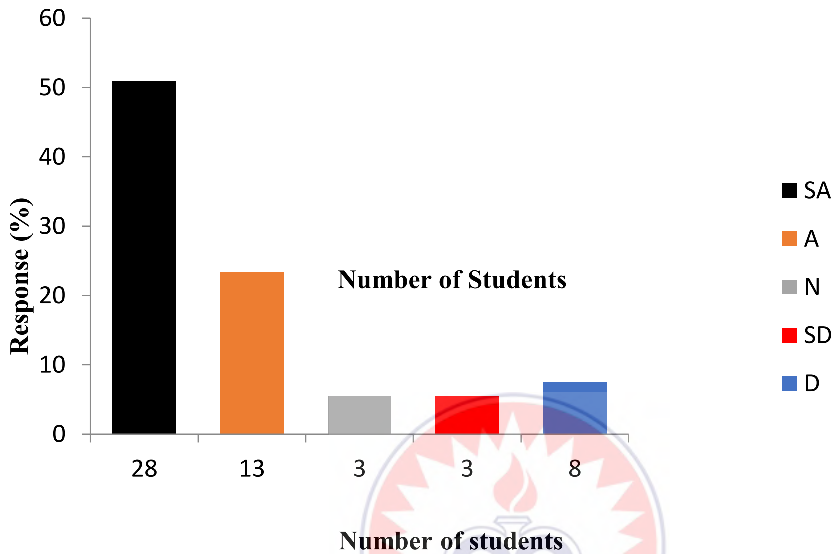

Figure 2*: concept maps can aid students' retention of material learnt.*

From Fig. 2, 28 students strongly agreed with the statement concept maps can aid students" retention of material learnt. This means that students can recall learnt scientific concepts better with concept mapping.

The third item, 30 students representing 54.60% strongly agreed to the assertion that concept maps enhance their ability with learning task. This is captured in Figure 3.

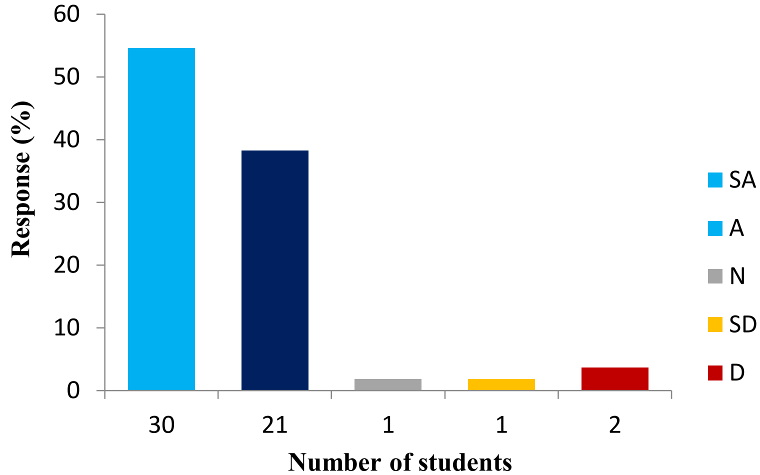

Figure 3*: Concept maps can enhance students learning abilities.*

As seen from Figure 3, majority of the students strongly agreed that concept maps enhance their ability with their learning task this had the longest peak of 54.60%.

Additionally, in item 4, 54.55% (n = 30) of the participants strongly agreed that the use of concept mapping is an effective means of helping students to understand relationships among concepts. One of the participants indicated: The enforcement and integration of concept mapping in science will go a long way to affect the subject positively even though there may be some lapses. It will help us to have an in-depth understanding of most concepts in the teaching and learning of biology, and the responses are presented in Figure 4.

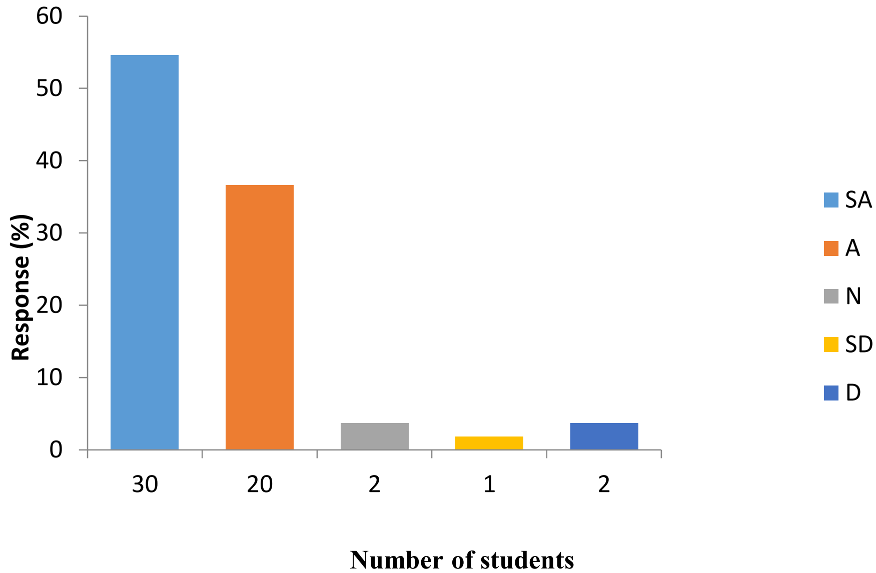

Figure 4: ***The use of concept map instruction is an effective means of helping students understand relationships among concepts.***

As shown in Figure 4, in the view of the experimental groups the use of concept maps instruction is an effective means of helping students to understand relationships among concepts and is clearly seen as the highest peak with 58.18%. Among the 55 experimental groups who were exposed to concept mapping strategy, only 1.82% strongly disagreed to the statement. This means that most of the students perceived concept maps as effective learning strategy. For item 5, 67.5% (n = 27) of the participants strongly agreed with the statement which indicates that, most of the participants believed they were extrinsically and intrinsically motivated when concept mapping was used as instructional tool for the teaching and learning of basic concepts in ecology, this is indicated in Figure 5.

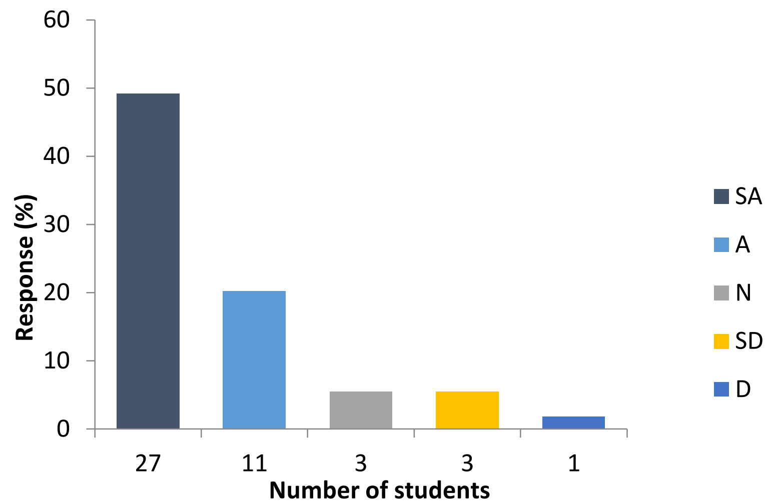

Figure 5: ***Concept maps promote extrinsic and intrinsic motivation when use as teaching and learning instructional tool.***

It can be observed from Figure 5, that majority of the students strongly agreed to the statement and is represented by the highest peak (49.14%). However, there were few number of students who strongly disagreed with the statement and is seen as shortest peak among the peaks. Judging from the students" responses, one will not be wrong to say that greater percentage of students had opinion that concept maps motivate them to learn. For item 6, 63.63% out of 55 participants strongly agreed, which indicates that most of the participants believed concept mapping tools help them to provide unambiguous responses in given assignment. Figure 6, presents the perception of the students on the research question "concept map makes me provide unambiguous answers in given assignment"

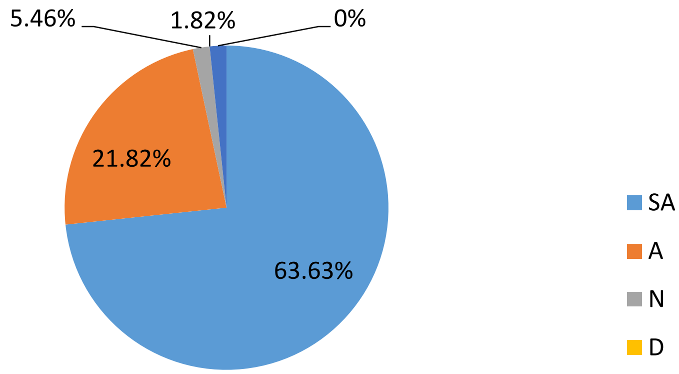

Figure 6. ***Figure 6: Concept maps would make me provide unambiguous responses in a given assignment***

As seen in the Figure 6, majority of the students strongly agreed with the proposition that concept maps would make them provide unambiguous responses in a given assignment. This occupied the largest sector on the chart. From the above analysis, it can be said that, the use of concepts mapping is effective in enhancing SHS level students‟ understanding of basic concepts in ecology. These findings are supported by the results Appaw (2011), Adiyiah (2011) and Bogden (1977). It can be concluded that, majority of experimental group had opinion that concept mapping enhanced their understanding of basic concepts in ecology.

4.4 Interest in Concept Mapping

An interview was conducted to corroborate the responses from the questionnaire. Many of the students who were interviewed said that teaching and learning with concept mapping was interesting. When a student was asked whether he found concept mapping to be an interesting learning technique, he responded affirmatively and stated that concept mapping made him get deeper understanding about the topic we treated. Others also responded "It was very good; I enjoyed it because it was new; it was easy for presenting knowledge and answers but it was time consuming". It was noticed that the students developed interest in concept mapping because it enhanced their understanding of the basic concepts in ecology. Student B commented, "It is interesting because it‟s a new way of learning". Student C said "it makes one creative, makes one know what he/she doesn‟t know. The method was good, arrows and propositions made everything like a note". Student E said "I am happy constructing concept maps". Student A commented, "It was a good and nice thing to use it made remember what learnt for long period. After using it, one finds out that he or she gains a wide collection of information and knowledge of the topic of study."

4.5 Summary of the significant ideas from the findings

A summary of significant ideas obtained from the major findings during the discussion of the research question of this study are:

1. There was a significant difference between the performance of Mim SHS students who were taught with concept map technique (experimental group) and Ahafoman Senior / Tech School who were taught with the traditional method (control group).
2. There was a significant difference in the retention means scores between Mim SHS students who were taught with concept map technique (experimental group) and Ahafoman Senior / Tech School who were taught with the traditional method (control group).
3. Most students had positive perception towards concept mapping.

4.6 Summary

The findings of this study tend to suggest that concept mapping, when efficiently used as a teaching strategy and study skill, could enhance performance in post-achievement test scores and retention of basic ecological concepts as compared to the traditional method of teaching. This is because concept mapping brings about meaningful conceptual understanding of the topic among students of different background.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This is the final chapter of the dissertation where major findings of the research are presented. Recommendations and suggestions for future research have also been made.

5.1 Summary

A quasi-experimental design involving two intact classes from two different schools were used. The two schools were purposively selected from the Asunafo North Municipal. By purposive sampling Mim SHS was assigned the experimental group and Ahafoman Senior High Technical School the control group. SHS 1 science students were selected for the study because the topics under consideration were in the SHS 1 elective biology syllabus. The experimental group was taught using concept mapping while the control group was taught using the traditional method. Three achievement tests BAT, EAT, and EAT1were used to assess students. The BAT was pre-intervention test. The pre-intervention test was used to identify the entry behaviour of students in the two groups. The EAT1 is post-intervention test comprised a fill in concept maps test items which was administered to only experimental group. EAT is also post-intervention test which comprised of objectives test was administered to the both the experimental and control group. EAT2 was administered to both groups after two weeks of the intervention, this was to ascertain how the students are able to recalled what was learnt.

5.2 Summary of Key Findings

Comparison between the post-intervention test and retention test of each group showed that each group achieved significantly higher marks in the post-intervention test and retention test. Analysis of the post-intervention test and retention test scores, using independent sample t-test, indicated there were statistically significant differences between the mean scores of the experimental and the control groups after the intervention. The experimental group outscored those in the control group. This implies that the use of concept mapping approach was successful and enhanced students" understanding in basic concepts in ecology than the traditional method. Students indicated that they had interest in concept mapping. In addition, students indicted that concept mapping helped them to summarise, organise, memorised, retain and logically present their work. It helped them to actively participate in teaching and learning process.

5.3 Conclusion

There were statistical differences between the experimental and the control groups in favour of the experimental group. The results of the study in chapter four showed that students exposed to concept map understood basic concepts in ecology more effectively at the SHS level than the traditional method and improved upon their achievement in biology as whole.

In addition, biology students have positive perception towards concept mapping. Students are able to summarise, organise and logically present their work in unambiguous style using concept mapping. Concept mapping helps students to contribute and socialise in biology class. However, in this study constructing concept map was found to be time consuming for biology students. Findings from this study show that concept mapping can be effective tool in enhancing students understanding in ecology and assist students to learn meaningfully and achieve significantly in their examination.

5.4 Recommendations

1. Concept mapping is worth adopting as a teaching method by biology teachers at the SHS level in the Asunafo North Municipal because it has the potential of enhancing students" conceptual understanding in biology.

2. The concept mapping method should be encouraged in many biology classes since it gives students opportunity to identify links between concepts, summarise and organise their works and thoughts logically and sequentially.

3. In view of the immense versatility of concept mapping, it should be incorporated into teacher education programmes in order to equip biology student teachers with alternative instructional strategies that could make them effective teachers.

   It was also found in the study that students generally have positive perceptions about the instructional usefulness of concept mapping in the teaching and learning process. Therefore, it is recommended that the Curriculum Research Development Division (CRDD) of the Ghana Education Service must revisit the biology curriculum and integrate concept mapping instructional tool in the teaching and learning processes for biology.

5.5 Suggestions for Further Research

1. The study may be replicated in other parts of Ghana.
2. The period for the intervention may be extended to cover a one term to incorporate the teaching of other topic with concept maps.

3. Future research can be carried out with four different groups at the same level. One group may be taught with concept mapping strategy, another group with collaborative concept mapping, and a third group with interactive computer animation accompanied by concept mapping, and the last group traditional method.
4. There should be in-service training courses for teachers to keep abreast with current trend of teaching and learning processes so that they would develop the necessary pedagogical content knowledge required for concept mapping integration.

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APPENDICES

APPENDIX A

BIOLOGY ACHIEVEMENT TEST (BAT)

Instruction

Answer all the question.

Each question is followed by three options letter **A to D**. Find the **correct** options for each question and shade in **pencil** on your answer sheet, the answer space which bears the same letter as the option you have chosen.

1. A group of similar cells that have a shared function is known as

   A. A system

   B. cytoplasm

   C. tissue

   D. An organism.

2. The function of the cell membrane is …………………

   A. To give the shape and support

   B. To control activities in the cell

   C. To control reproduction in the cell

   D. To control what enter and leaves the cell.

3. Which one of the following is not contained in an animal cell?

   A. A nucleus

   B. A. cell membrane

   C. cell wall

D. cytoplasm

4. The process by which cells make copies of themselves is known as ……………………

A. Cell division

B. cell wall

C. cell membrane

D. cell body

5. Which one of the following is NOT an example of animal tissue?

A. Bone

B. vitamins

C. skin

D. muscles

6. Which one of the following parts of a microscope is used to hold the slide in position?

A. The focus adjustment

B. The stage

C. The objective lens

D. The eyepiece.

7. Which one of the following statement is correct?

A. Cells from tissue, and system form organ

B. Tissue form organ, and organs form system

C. cells form system and system form organ

D. cells form organs and organ form tissue

8. The loss of water vapor from the surface of a plant is known as……………………

A. Respiration

B. transpiration

C. photosynthesis

D. phototropism

9. Which two of the following is transport tissue in plants?

A. Leaves and roots

B. leaves and phloem

C. xylem and root

D. xylem and phloem

10. What is taxonomy?

A. The scientific study of how living things are classified

B. The name of Aristotle‟s classification

C. The process used by geologist to classify rocks

D. The process of observing an organism behavior.

11. Why do scientist groups living organisms?

A. So they can find them in the wild more easily

B. So that the organisms are easily study

C. So they can make sense of the variety of rocks on earth

D. So product from living thing can easily found in groceries.

12. What is binomial nomenclature?

A. Classifying organisms into seven levels

B. The naming system developed by Aristotle

C. Grouping animals based on how they move

D. A naming system in which each organism is given a two-part name.

13. An organism‟s scientific name consist of …………………………….

A. It‟s class name and its family name

B. it‟s kingdom name and its name

C. its genus name and its species name

D. it‟s phylum name and its species name

14. Which is the broadest classification level?

A. family

B. kingdom

B. phylum

D. species

15. Which classification level is broader than the phylum?

A. Order

B. class

C. family

D. kingdom

16. Which of the following characteristic do all plants share?

A. Being unicellular

B. Producing flowers

C. Being a prokaryote

D. Being an autotroph.

17. What is the only kingdom that contains only autotrophs in them?

A. Plants

B. Protists

C. Eubacteria

D. Fungi

18. Which of the following is a characteristic of living things?

A. Having a heartbeat

B. Being made of cells

C. Breathing

D. Having complex system of organ.

19. What are called building blocks of life?

A. Organs

B. systems

C. cells

D. tissue

20. Which kingdom does mushroom belong to?

A. Protest

B. Plan

C. Fungi

D. Animal

APPENDICE B

ECOLOGY ACHIEVEMENT TEST (EAT)

Instruction

Answer all the question.

Each question is followed by three options letter A to C. Find the **correct** options for each question and shade in **pencil** on your answer sheet, the answer space which bears the same letter as the option you have chosen.

1. A group of species is termed as ……………………….

A) Population

B) Organisms

C) Carnivores

2. A relationship that is beneficial to at least one organism is referred to as ……………………….

A) Symbiosis

B) Parasitism

C) Commensalism

3. Which of the following organisms is an example of decomposer?

A) Flea

B) Worm

C) Tiger

4. An organism that eats both plants and animals is referred to as …………………….

A) Omnivores

B) Carnivores

C) Herbivores

5. Decomposers breakdown detritus, which is living organic…………..

A) True

B) False

6. The following are examples of herbivorous organisms, except ……………………..

A) Cow

B) Sheep

C) Hawk

7. Which of the following is an example of commensalism?

A) Flea in human hair

B) Birds nest in a tree

C) Tick on sheep

8. An ecosystem possess …………………

A) Only living components

B) Only non-living components

C) Both living and non-living components.

9. A relationship in which both organisms benefit is referred to as …………………………

A) Parasitism

B) Mutualism

C) Commensalism

10. ……………… are autotrophic organisms with the ability to carry out photosynthesis and make food for themselves.

A) Producers

B) Consumers

C) Herbivores

11. The relationship exists between flea in a child‟s hair is …………………

A) Parasitism

B) Commensalism

C) Mutualism

12. Biomass of an ecosystem consists of ………………………

A) Living components of the ecosystem

B) Non –living components of the ecosystem

C) The energy in the ecosystem

13. An example of aquatic habitat includes ……………………

A) Desert

B) Marine

C) Forest

14. An organism that feeds on dead animals is termed ………………………

A) Scavenger

B) Decomposers

C) Carnivores

15. A community is ……………………………

A) Organisms and the physical environment in which they live

B) A hierarchy that includes population and the physical environment in which they live

C) A group of individuals of the same species that occurs at the same geographical area and interacts with each other.

16. Mixture of different species and biotic factors make a ………………………..

A) Community

B) Habitat

C) Environment

17. A relationship between organisms, where one organism benefits as the other is hurt is known as…………………

A) Parasitism

B) Commensalism

C) Decomposers

18. Which of the following is an example of major land biome ……………………

A) Terrestrial

B) Aquatic

C) Freshwater

19. A mixture of different population and species forms ……………………

A) Community

B) Habitat

C) Environment

20. An organism that feeds only on meat is …………………………..

A) Carnivore

B) Herbivore

C) Omnivore

Theory

1 a. Explain habitat?

1 b. State three types of habitat and give two examples each.

1c. What is parasitism?

1d. State three structural adaptations of parasitic organisms.

2a. Explain the following terms:

i. Food chain ii. Food web iii. Producers iv. Consumer

2b. Describe pyramid of energy and state two importance of ecological pyramid.

2c. Explain the following biological association:

i. Mutualism

ii. Commensalism

iii. Competition

iv. Symbiosis

APPENDICE B1

A CONCEPT MAP EXERCISE ON ECOSYSTEM

Time allowed: 1 hour

Instructions:

Fill in the blank space indicated on the map with the numbers. From the list below, select the answer that best fit the statement.

Map answer list

a) Population

b) Habitat

c) Hawk

d) Cow

e) One species of an organism

f) Eat dead animal remains

g) Desert

h) Marine

i) Worm

k) Omnivores

l) Herbivores

m) Carnivores

n) Fresh water habitat

o) Eat only meat

p) Eat only plant matter

q) Scavenger

r) Vulture

s) Catfish

t) Bacteria

u) Mixture of different species

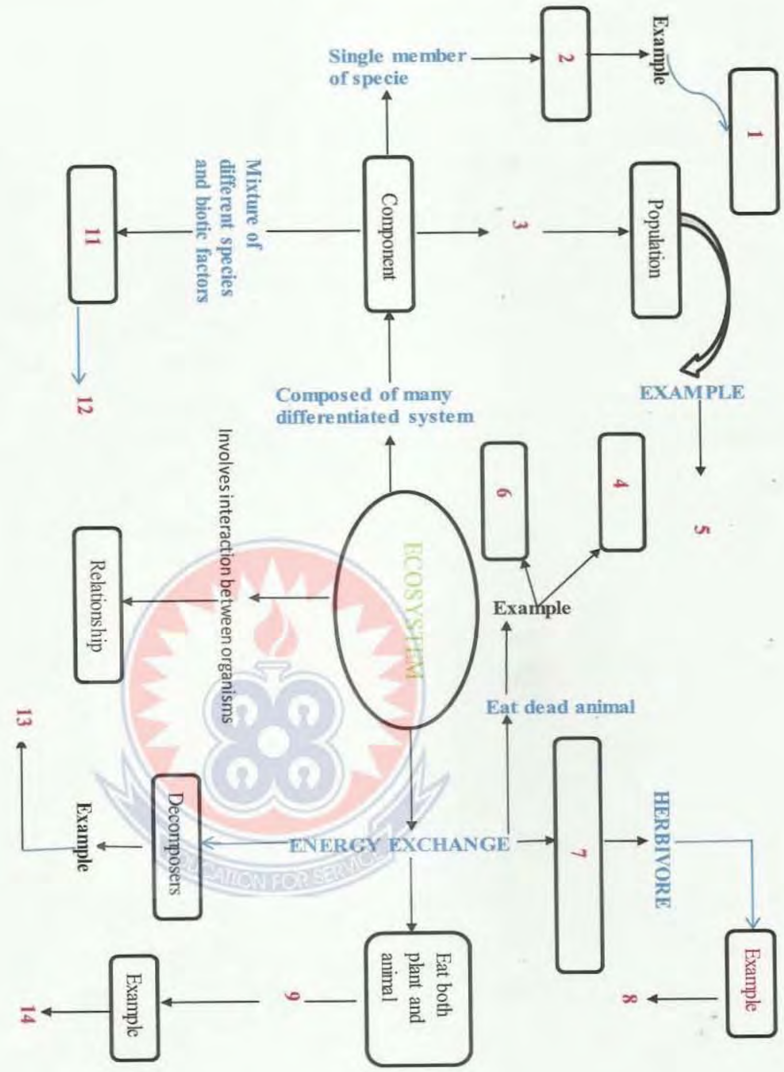

Figure : Concept map question on ecosystem

APPENDICE C

Example of teacher constructed concept map on ecosystem.

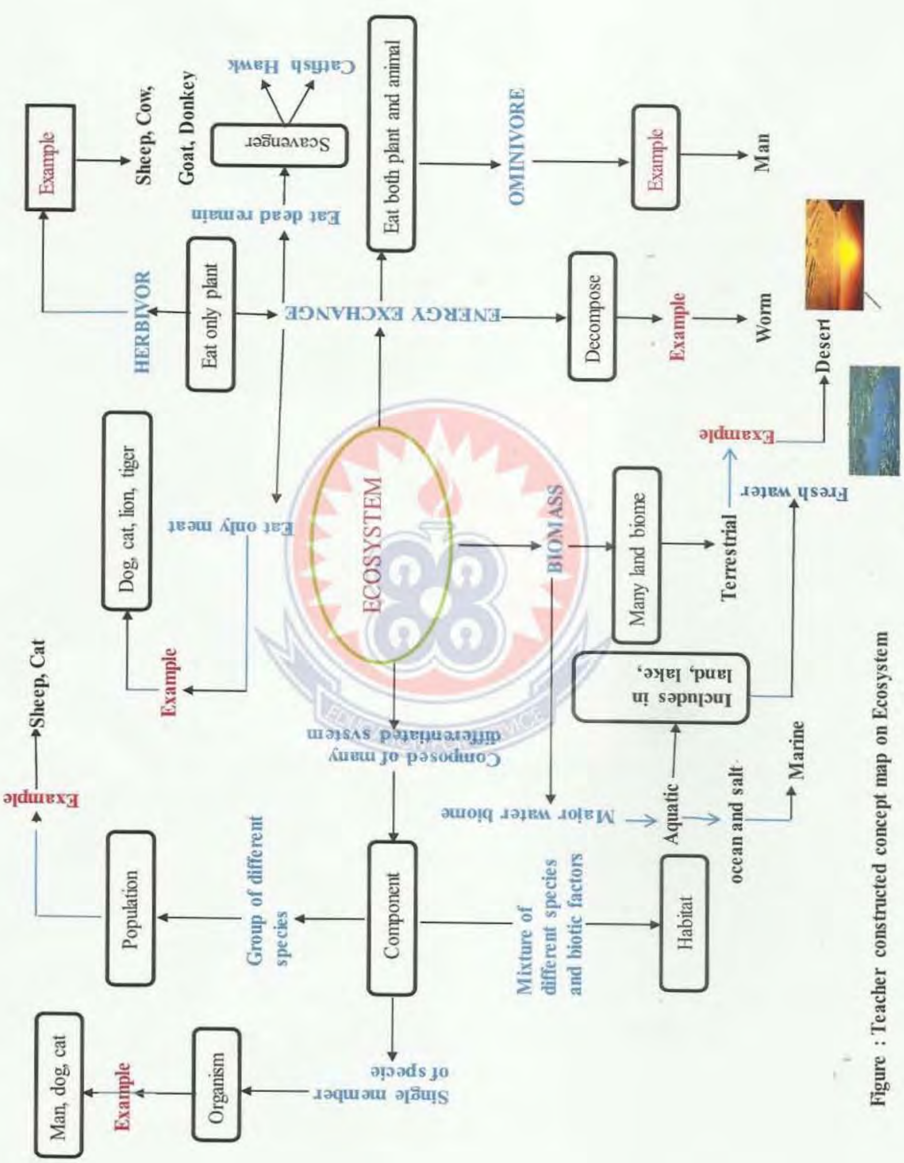

Figure : Teacher constructed concept map on Ecosystem

APPENDICE C

ECOLOGY ACHIEVEMENT TEST (EAT2)

Instruction

Answer all the question.

Each question is followed by three options letter A to C. Find the **correct** options for each question and shade in **pencil** on your answer sheet, the answer space which bears the same letter as the option you have chosen.

1. A relationship in which both organisms benefit is referred to as …………………………

   A) Parasitism

   B) Mutualism

   C) Commensalism

2. Biomass of an ecosystem consists of ………………………

   A) Living components of the ecosystem

   B) Non –living components of the ecosystem

   C) The energy in the ecosystem

3. Which of the following descriptions about the organization of an ecosystem is correct?

   A) Species make up populations, which make up communities

   B) Populations make up species, which make up communities

   C) Species make up communities, which make up populations

4. An organism that feeds only on meat is …………………………...

A) Omnivore

B) Herbivore

C) Carnivore

5. The lowest level of environmental complexity that includes living and nonliving factors is the……………….

A) Biome.

B) Ecosystem

C) Community

6. Plants are ………………………...

A) Carnivores

B) Omnivores.

C) Primary producers

7. An organism that eats both plants and animals is referred to as …………………….

A) Omnivores

B) Carnivores

C) Herbivores

8. Which of the following is an example of commensalism?

A) Flea in human hair

B) Birds nest in a tree

C) Tick on sheep

9. An organism that feeds on dead animals is termed ………………………

A) Scavenger

B) Decomposers

C) Carnivores

10. Mixture of different species and biotic factors make a ………………………...

A) Environment

B) Habitat

C) Community

11.A symbiotic relationship in which both species benefit is ……………………

A) Commensalism

B) Mutualism

C) Parasitism

12. The movement of organisms into a range is called ………………

A) Immigration

B) Emigration

C) Carrying capacity.

13. ……………… are autotrophic organisms with the ability to carry out photosynthesis and make food for themselves.

A) Producers

B) Consumers

C) Herbivores

14. An ecosystem possess …………………

A) Only living components

B) Only non-living components

C) Both living and non-living components

15. Which will reduce competition within a species" population?

A) Fewer individuals

B) Higher population density

C) Fewer resources

16. The relationship exists between flea in a child"s hair is …………………

A) Parasitism

B) Commensalism

C) Mutualism

17. The following are examples of herbivorous organism, except ……………………...

A) Cow

B) Sheep

C) Hawk

18. Which of the following organisms is an example of decomposer?

A) Flea

B) Worm

C) Tiger

19. A relationship that is beneficial to at least one organism is referred to as ………………………

A) Commensalism

B) Parasitism

C) Symbiosis

20. Which of the following is a biological aspect of an organism‟s niche?

A) The way it gets food

B) Amount of sunlight

C) Composition of soil

Theory

1a. Define the following ecological terms:

i. Community

ii. Ecosystem

iii. Ecology

iv. Habitat

v. Species

b. Name the two types of ecosystem.

2a. State and explain the two major components of ecosystem.

b. Classify the following organisms into producer, secondary consumers, tertiary consumers and quaternary consumers.

Grasses, Snake, hawks, grasshopper and lizards

c. Use the organisms listed above to construct food chain.

APPENDIX D

STUDENTS QUESTIONNAIRE

Teaching with concept mapping strategy.

Introduction

A research is being conducted to find out students" perception towards effectiveness of concept mapping strategy in the teaching and learning of basic concepts in ecology. I have the honour to involve you in this research. Kindly read the questions carefully and tick/write in the appropriate box or make a response against each question. Copying your friend"s opinion will make this work worthless. Confidentiality of your responses is assured. Thanks for your co-operation.

Please read the following statements and kindly provide the information required.

A. Background information

Please tick [✓] in the appropriate space provided below and supply answers where required.

1. Age ………………years
2. At what level were you taught the use of concept mapping? Please, tick [✓] only one level.

Nursery Level	
Kindergarten Level	
Junior High School level	
Senior High School level	
Other, please specify	

B. The effectiveness of Concept mapping on teaching and learning

Instructions: Please rate how strongly you agree, neutral or disagree with of the following statements by placing a check ✓ appropriate box.

1. The use of Concept mapping instruction demystifies learning and does away with abstract reasoning.

Strongly agree [ ] Agree [ ] Neutral [ ] Strongly disagree [ ] Disagree [ ]

2. The use of concept mapping would aid students‟ retention of material learnt.

Strongly agree [ ] Agree [ ] Neutral [ ] Strongly disagree [ ] Disagree [ ]

3. Concept maps enhance students‟ ability with their learning tasks.

Strongly agree [ ] Agree [ ] Neutral [ ] Strongly disagree [ ] Disagree [ ]

4. The use of concept mapping instruction is an effective means of helping students to understand relationships among concepts.

Strongly agree ( ) Agree ( ) Neutral ( ) Strongly disagree ( ) Disagree ( )

5. I concept map promote extrinsic and intrinsic motivation when use as teaching and learning instructional tool**.**

Strongly agree ( ) Agree ( ) Neutral ( ) Strongly disagree ( ) Disagree ( )

6. Concept maps would make me feel more involved and offer more contributions in a given project.

(7) Please, give your general view(s) about the how effective the use concept mapping integration in the teaching and learning of science as a practice to enhance students‟‟ understanding in biology in the space below:

....

....

....

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Thank you very much for your assistance and time.

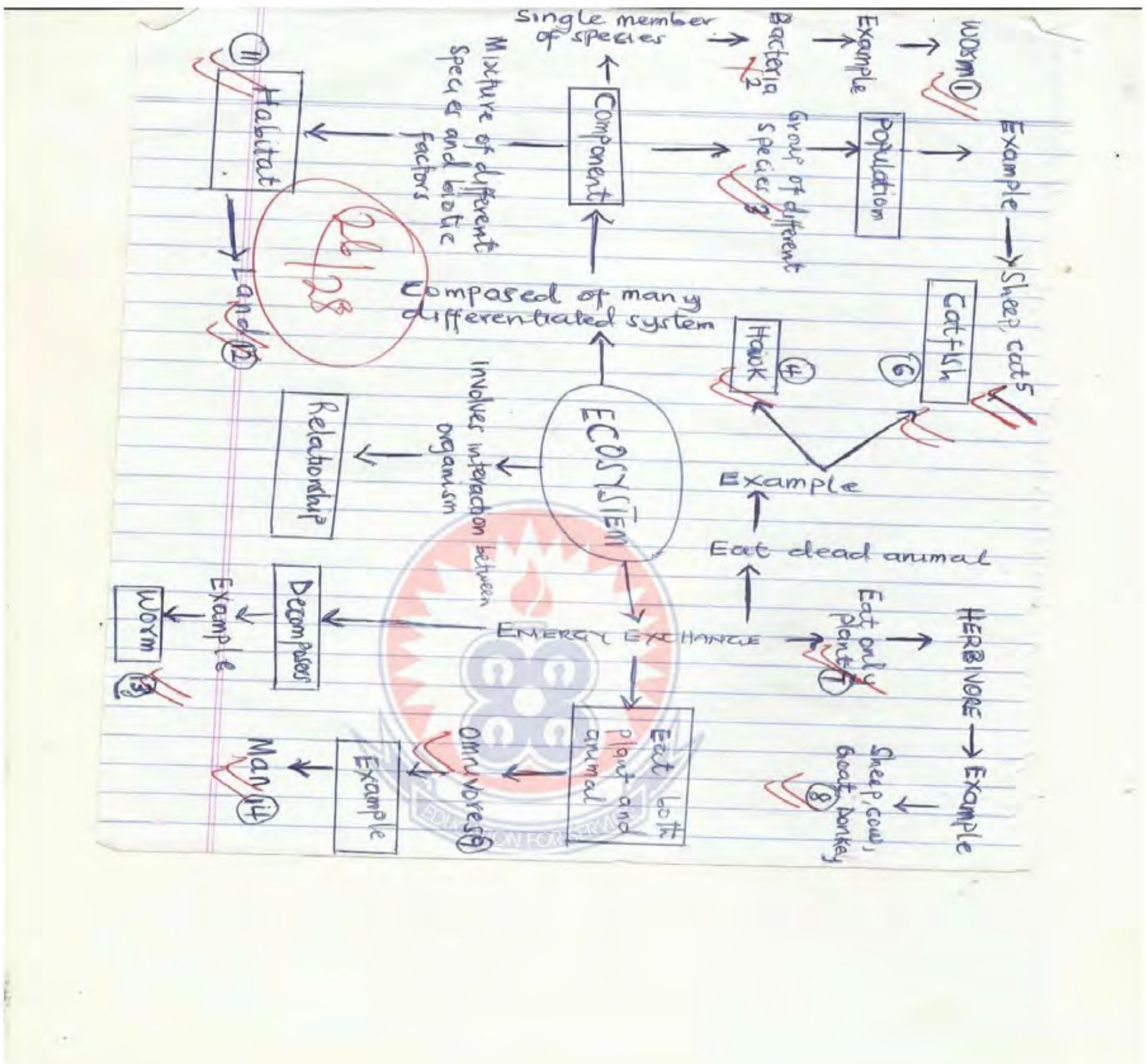
APPENDIX E

STRUCTURED INTERVIEW ON CONCEPT MAPPING

1. Did the use of concept mapping make you participate actively in teaching and learning process?
2. How did you find concept mapping as a teaching method?
3. How did your understanding of basic concepts in ecology enhanced after being exposed to concept mapping?
4. What did you like or dislike about concept mapping?
5. What is your opinion on construction of concept map?
6. Did you find concept mapping interesting?

APPENDICE F

Concept map on ecosystem constructed by student



APPENDICE G

Concept map on photosynthesis constructed by student