USMANU DANFODIYO UNIVERSITY, SOKOTO

POSTGRADUATE SCHOOL

EFFECTS OF GUIDED DISCOVERY APPROACH ON STUDENTS' ACADEMIC PERFORMANCE IN ECOLOGY IN SENIOR SECONDARY SCHOOLS IN SOKOTO STATE, NIGERIA.

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DEDICATION

This research work is dedicated to my parents, my husband and my lovely daughters, Khairat and Neemat Abdulkadir. May Allah reward them abundantly.

CERTIFICATION

This dissertation by SALIHU, Zainab (09211404001) has been certified as meeting the requirements for the award of the Degree of Master of Science Education in the Department of Education and Extension Services, Usmanu Danfodiyo University, Sokoto and is approved for its contribution to knowledge.

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ABSTRACT

The study investigated the effects of guided discovery approach on students' academic performance in ecology among Senior Secondary I students in Sokoto metropolis. The population of the study comprised of 13,045 students offering Biology in the 43 secondary schools within Sokoto metropolis. The researcher used stratified random sampling to select the sample 521 students and used purposive sampling technique to select intact classes from each sampled school. The instruments used for collection of data are Ecology Performance Test, lesson plans and teaching modules. Three hypotheses were tested using t-test technique at alpha level of 0.05. The results obtained from the analysis shows that students in experimental group (i.e. students taught using guided discovery) performed better than those in control group (i.e. students taught using traditional method). This is an indication that students taught with guided discovery method performed significantly better than those taught with traditional method. It was also found that male students taught ecology with guided discovery performed better than their female counterparts. Students in private schools taught ecology with guided discovery also performed better than their counterparts in public schools. It was recommended that there is need for an in service training of biology teachers to be exposed to the use of guided discovery in teaching ecology and other biological concepts.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Education, especially in science has always been seen as the most appropriate and fastest vehicle for the planned transformation of any society (Jegede *et al.*, 1996). Thus, in Nigeria, the contemporary national aims and objectives of education were geared towards the training of individual through child- centered learning for maximum self and societal development and fulfillment. Accordingly, education should aim at helping a child acquire appropriate skills, abilities, and competence - both mental and physical as equipment for the individual to live and contribute to the development of his society (Federal Govt. of Nigeria, 1981). The science curricula materials advocated the teaching of science via investigative approaches. These approaches include strategies like cooperative learning, constructivism and guided discovery. All these approaches emphasize active learning by the learner. The cognitive factor of students and teachers, the availability of learning resource, and instructional strategies adopted by the teacher have been identified as some of the factors that determine the performance of students in science (Nwosu, 1991; Okebukola, 1996). Science teaching in Nigerian secondary schools is dominated by teacher-centered lecture/expository methods (Ajewole *et al.*, 1990). This method has failed to produce science students that are committed to science and who can reason critically and be able to transfer what is learnt to new but similar situations (Ajewole, 1990).

Research in science education have discovered better methods of teaching science that are not only superior to the traditional method but also have the potential to

promote achievement and retention of what is learned and inculcate positive scientific attitudes in students (Ajewole & Carew, 1993). Various studies on methodology of science teaching such as inquiry, discovery and process approach have shown that students learn more from science lesson by doing rather than mere observation (Betty & Woolnough, 1982). With reference to ecology, many emphases had been placed on it by the experimental science curriculum project at both international and local levels. But despite the various efforts and emphases, science teachers in Nigerian schools still revert to the use of "chalk and talk" or traditional method for teaching rather than the process and inquiry method (Ali, 1986).With the high enrolment in biology subject in Nigeria, the performance of students at secondary school level is depressingly poor (Turton. 1991, Jegede. 1996). The low percentage of passes has been attributed to the use of "chalk and talk" or traditional method of teaching (Aramide, 1985; Kumari & Aliyu, 1986, Ogunsola *et al.,* 1996). This signifies the use of modern method of teaching science.

The use of modern ideas and scientific methods has been introduced into the educational field. Among them are these modern and scientific approaches: analogy technique, concept mapping, and inquiry/discovery methods. These methods are now being advocated for teachers for use in the classroom because they allow direct participation of students in teaching learning process. They do not only simulate learning but also make education and learning permanent. In developing countries like Nigeria, the importance of science as a weapon of change cannot be over emphasized. Our world is changing with startling rapid scientific advancement. Consequently, it is more important today, than ever before, for children to receive the kind of education that will

equip them with the ability to anticipate this change and obtain the technical know-how necessary to adjust to it and solve problems which constant change creates. However, the concern is to improve science education and participation in adition to developing in pupils some skills that can be referred to as guided discovery process. The concept of guided discovery refers to finding out ideas or process which involves learners in finding answer, gathering and processing information in order to find solution and draw conclusions from the information gathered. The learners are not told what to be learnt but the teacher assign problems to them or give them series of leading questions to work on, the learners then go in search of possible solutions using available resources to arrive at conclusions. Guided discovery is an approach to instruction and learning, which helps students personalize the concept under study, creating an understanding that cannot be matched using any other method of instruction. The teacher must guide the students toward discovery. This can be accomplished by providing appropriate materials, a conducive environment and allotting time for students to discover. Guided discovery is simply a method of finding out (Adekoya, 1998).

According to Okoye, (1998) & Nwagbo, (2000), during the early 70s, the rationale for science teaching shifted from the traditional/lecture method to discovery method, which was adopted worldwide. This was because in traditional/lecture method, students tend to memorize facts and concepts, most of which they do not understand. This resulted in their ability to retain and apply concepts. They maintained that there was a great burst of interest as the guided discovery strategy was adopted in the Nigeria curriculum. The strategy is activity oriented and involves practical demonstration, discussion and experimentation. During such instruction, student's .employed the process

of science likes observation, classification, investigation and critical interpretation of findings. Okebukola & Okoye (2001) believed that in ecology, it is possible to adopt guided discovery strategy of teaching in order to enhance students' performance. This is because guided discovery as a teaching technique encourages students to play a more active role in their learning process by answering series of questions or solving problems designed to introduce a general concept. Bruner (1961) is credited for its development into an accepted instructional technique.

Gender issues are currently the focus of discussion and research all over the world, Nigeria inclusive. The question of gender is a matter of grave concern especially among scholars and policy formulators. Intellectuals are worried about the role of women in the political, social, economic, cultural, psychological, religious, scientific and technological development of nations. Ibrahim (2001) confirmed that women have physical and mental capabilities to contribute meaningfully to the stability, progress and prosperity of Nigeria. In the 1970s, attention was focused on girls as a group who were perceived to be disadvantaged in schools as evidenced by attainment level in general and by the low number of girls offering some subjects. In Africa, especially in Nigeria, research has shown that women's participation and achievement in Science and Technology is too low owing to some avoidable reasons (Ibrahim, 2001). According to Okafor (2001), health problems such as high rate of maternal and infant morality, malnutrition and stressful condition which are associated with developing countries like Nigeria correlate positively with low level of women's achievement in Science and Technology.

Schools are established for the purpose of teaching and learning. It is important that the teacher and learners are properly accommodated to facilitate the teaching and learning that go on there. In Nigeria at large and in Sokoto State in particular, secondary schools, irrespective of the ownership are expected to function for the achievement of the National Education Objectives. To this end, students are expected to perform brilliantly in the final examination as this determines the quality of output of secondary schools. This is one of the parameters used to measure the effectiveness of a school system. The better the performance of the system, the more effective is the system assumed to be (Philias and Wanjobi, 2011). In Nigeria, it is the general opinion of people that private schools are better in terms of students' academic performance than public schools. This situation has made many parents to enroll their children in private schools.

Methodology is very vital in any teaching and learning situation. The method adopted by the teacher may promote or hinder learning. It may sharpen mental activities or may discourage initiatives and curiosity, thus making self reliance and survival difficult. There are different types of methods for efficient and effective learning. These methods include laboratory, field trips, guided discovery, etc. The adoption of traditional method by most teachers in order to overcome the bulky Biology syllabus before the SSCE affects students' academic performance. Researchers believe that, in the traditional teaching method, theory is taught as an absolute knowledge, hence students centered activities for developing scientific reasoning skills and processes are lacking. The traditional method of teaching is also known to cause lack of interest and poor academic performance as opined by Njoku (2007).

Ecology is the scientific study of interactions of organisms with one another and with the physical and chemical environment, although it includes the study of environmental problems such as pollution. The science of ecology mainly involves research as the natural world from many view points using many techniques. Modern ecology relies heavily on experiments, both in laboratory and in field settings. These techniques have proved useful in testing ecological theories and in arriving at practical decisions concerning the management of natural resources.

An understanding of ecology is essential for the survival of the human species. Our populations are increasing rapidly all around the world and we are in grave danger of outstripping the earth's ability to supply the resource that we need for our long term survival. Furthermore, social, economic and political factors often influence the short term distribution of resources needed by a specific human population. An understanding of ecology principles can help us understand the global and regional consequences of competition among humans for the scarce natural resources that support us.

1.2 Statement of the Problem

Achievement in the teaching and learning process has to do with attainment of set objectives of instruction (Nbina & Obomanu, 2011). Studies have shown that the teaching of science in Nigeria secondary schools falls short of standard expected of it. Most of the methods used in teaching have been described as inappropriate and uninspiring (Ibe, 2004). Nnaobi (2007) asserted that there is no best method of teaching but that effective scientific teaching should be child-centered and activity-oriented rather than teacher dominated or lecture method which seems to characterize the Nigerian schools. The lecture method of teaching is widely used by Biology teachers to

convey large volume of scientific information to senior secondary school students in a bid to prepare them for Senior School Certificate Examination. There is no doubt that, these observations are not only relevant to the teaching and learning of science in Nigeria, but also pose a serious problem to Nigerians learning ecology. Since guided discovery approach have been recommended for use in teaching ecology in secondary schools, little effort has been extended to verifying its adequacy and effectiveness. Therefore, in order to contribute to the existing teaching and learning problem, this study attempt to investigate the effect of guided discovery on students' academic performance in ecology in senior secondary schools in Sokoto metropolis

1.3 Objectives of the Study

Guided discovery teaching strategy in science is designed to help students acquire basic scientific skills and improve performance. Bruner (1960) claims that guided discovery promote students achievement in science. It therefore becomes necessary to substantiate this claim empirically. Hence, the purpose of this study is to investigate:

1. The effect of guided discovery method on students academic performance in ecology
2. The effect of guided discovery on ecology performance of male and female students
3. The effect of school ownership on students academic performance in ecology

1.4 Research Questions

The following research questions were raised to guide the study

1. Is there any difference in the performance of students taught ecology using guided discovery and those taught using traditional method?
2. Is there any difference in the performance of male and female students taught ecology using guided discovery method?
3. Is there any difference in the performance of public and private school students taught ecology using guided discovery?

1.5 Null Hypotheses (H_0)

H_{01} There is no significant difference in the performance of students taught ecology using guided discovery method and those taught using the traditional method.

H_{02}: There is no significant difference in the performance of male and female students taught ecology using guided discovery method.

H_{03}: There is no significant difference in the performance of public and private school students taught ecology using guided discovery.

1.6 Significance of the Study

The rate with which examination malpractice and leakages occur in our country suggests that something must be wrong in the way our students learn in school. Poor learning leads to continuous failure which leads to frustration as one of the reactions to be expected of students who face learning problem. Teaching in schools is supposed to give pupils lasting 9-understanding of what is meant to approach a problem scientifically. Learners must be given the opportunity to observe and explore so that they develop critical and imaginative thinking. The findings of the study would provide ample

information on better strategies to be employed by biology teachers, curriculum planners and developers in science education in recommending appropriate changes which will promote effective study habits and ensure meaningful learning in ecology.

This research was therefore devoted to finding solution to each of the research questions outlined. The outcome of which the researcher believes will:

1. Enable the learner to develop creative and observational skills.
2. Allow teachers to make adequate planning as it relates to methods or techniques of teaching.
3. Enable slow learners as well as gifted students face challenges and are motivated to perform activities beyond expectation.
4. Enable both the teacher and learners to use variety of resources in enhancing student's performance.
5. Enable the teacher and learners to device and demonstrate concepts and methods that indicate learning on a higher Level of attainment.

1.7 Scope and Delimitation of the Study

The central focus of this research was to investigate the effect of guided discovery method on students' academic performance in ecology in selected secondary schools within Sokoto metropolis. The study was limited to Senior Secondary School One (SS I). The study addresses ecology as a topic in the senior secondary school biology syllabus. In addition, the study was limited to eight (8) secondary schools out of the fourty three (43) secondary schools within the metropolis. The time of the study was not extended beyond six (6) weeks in the sampled schools due to the limited time within which the research has to be completed.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter deals with review of related literature to this study. The review was done in the following areas:

2.2 Theoretical Framework of Guided Discovery

2.2.1 Cognitive Theory

2.2.2 Theory of Instruction

2.2.3 Constructivist Theory

2.3 Conceptual Framework

2.3.1 Processes of Discovery

2.3.2 Concept of Ecology

2.3.3 Concept of Ecology and Learning

2.3.4 Concept of Gender and Academic Performance in Science

2.3.5 Schools Ownership and Academic Performance

2.3.6 Academic Performance in Science

2.3.7 Traditional Teaching Method and Students' Academic Performance

2.3.8 Guided Discovery Method and Students' Academic Performance

2.4 Review of Empirical Studies

2.5 Summary of the Review and Uniqueness of the Study

2.2 Theoretical Framework of Discovery Learning

Dewey (1997), Piaget (1973) and Vygotsky (1978) all developed theories that serve as the foundation of discovery learning (Rice and Wilson, 1999). All of these theories described learning as active, process-based, and collaborative. In Democracy and Education, Dewey (1997) describes learning as action where knowledge and ideas emerge as learners interact with other learners in a community and build their knowledge by applying conclusions from past experiences that had meaning and importance. Dewey believed that children are naturally motivated to actively learn and that education served to make more learning possible (Berding, 2000). Dewey saw children as participants in their learning rather than passive receivers of their knowledge. To illustrate his theory, Dewey established a laboratory school at the University of Chicago where students were encouraged to participate in active, group learning activities such as students' building a play house to learn geometry and measurement principles. Dewey believed that children should be active, participatory learners who collaborated with others to better understand meaningful situations. Understanding comes from discovery and that without understanding production and creativity are lost and the individual is caught in only reception (Piaget, 1973). Piaget theorized that children do not think with the same logic as adult (Papert, 2000). Piaget was the first to show that children were not "empty vessels" to be filled with knowledge, but active builders of knowledge. Piaget saw children as constantly creating and testing their understanding of the world, in other words, active, participatory learners. Piaget did not strive for educational reform like Dewey but his theory about children's understanding has permeated education.

Vygotsky (1978) emphasized the impact of-cultural and social influences on the cognitive development, particularly the interaction of children with other people in cognitive development. Vygotsky introduced the theoretical concept of the zone of proximal development. In this concept, Vygotsky theorized that there is a difference in what a child can accomplish in isolation and what he or she can accomplish with assistance. In other words, a child is capable of solving more complex problems than would be possible at a particular mental age if the child has peers, teachers, and parent to assist in building the needed experiences. A good example of this theory is a kindergarten child who has been taken to a great deal of different cultural experiences that were discussed by a parent. The child will have a larger vocabulary, be able to relate so much more of the new content presented in the classroom, and be more eager to learn (Rice and Wilson, 1999). This child may appear very bright for a five-year-old, but the child is averagely intelligent. The difference is that the child has had an above average amount of experiences in which he base new construction. Vygotsky felt that determining where a student was in his or her development and building the child's experience so that richer discoveries could be made, could enhance instruction in the classroom.

Also, because of Bruner's (1960) connection with the National Science Foundation Curriculum development project's of the 1960s and 1970s, his finding has a powerful influence on approaches to science learning, Bruner believed that students learn best by discovery and that the learner is a problem solver who interacts with the environment testing hypotheses and developing generalizations. Bruner felt that the goal of education should be intellectual development, and that the science curriculum should foster the development of problem solving skills through inquiry and discovery. Bruner

said that learning is a process rather than the accumulated wisdom of science as presented in textbook. To learn science concepts and to solve problems, students should be presented with perplexing (discrepant) situation guided by the intrinsic motivation, the learner in this situation will want to figure the solution out. Thus simple notion provides the framework for creating discovery-learning activities.

2.2.1 Cognitive Theory of Learning

Learning according to this theory is making sense of the world by organizing the internal mental process such as attention, imagery, insight, perception in order to understand stimuli. The basic position of cognitive theory of learning is that learning is not simply the connection of stimuli and response, that explanation is too mechanical and insufficient to explain learning. Cognitive theory point out that in between the stimulus and response, the learner perceives, organizes and interprets the stimuli before he/she responds. This theory therefore emphasizes perception, organization, the seeing of relationship and insight in learning and this can also be achieved through guided discovery. Behaviourism as a theory is insufficient in explaining learning through guided discovery and problem solving method. This conclusion was reached by observing the problem solving of Apes Wolfang Kohler experimented with an Ape called Sultan placed in a cage, outside was banana far away. In between Sultan and the banana were sticks, one short and one long. The sticks were so arranged that Sultan's hand could not reach the short stick, but the long stick can reach the banana. After examining the problem, Sultan got an insight into how to solve his problem without any trial and error attempt. Sultan perceived a relationship between himself, a short stick and the long stick and using the short stick to pull the long and then using the long

stick to pull the banana. From the experiment, cognitive theorists concluded that learning is not by trial and error but holistic and patterned. Perception according to them is important in some kinds of learning, such as in attainment of insight. From various studies of perception, it was concluded that unfamiliar objects are perceived as totalities and their details are noticed later (Bruner, 1961).

Cognitive theory has a lot of implications for classroom learning. The theory emphasizes the role of structure in learning. According to this theory, each subject matter to be learnt is made up of structure of integrated concepts and principles. The facts and concepts only have meaning in relation to the whole. New insight can be achieved only from an understanding of interrelationship of concepts, for example, soil composition in ecology can be understood only when concepts like humus, organic, water and air are internalized. Cognitive theory also emphasizes the importance of discovery in learning. It is a method of learning where the learner finds solution to problem through the guidance of the teacher and experimenting. The teacher presents the problems to the child, provided a guide for the child to experiment and find solution to problems (Rabia, 2007). In cognitive learning theory, the child's mind and body are active in the learning process. The child is an active participant in the learning process. The child discovers the problem and he experiment to find answers to problem, and guided discovery promote learning and retention in children. Another principle that is important from cognitive theory is the principle of feedback, that is, acknowledgement of result. The learner gets satisfied at finding answers to his problems and that tells him that the steps he or she took to solve the problems were adequate.

2.2.2 Theory of Instruction

Bruner (I960) described his theory as one of instruction rather than learning. His theory has four components as follows:

i. **Curiosity and Uncertainty:** Bruner felt that experiences should be designed that will help the learner willing and able to learn. He called this the predisposition toward learning. Bruner believed that the desire to learn and to undertake problem solving could be activated by devising problem activities in which learners would explore alternative solutions. The major condition for the exploration of alternatives was "the presence of some optimal level of uncertainty". This related directly to the student curiosity to resolve uncertainty and ambiguity. According to this idea ,the teacher would design discrepant event activities that would pique the student's curiosity.

ii. **Structure of Knowledge:** The second component of Bruner's theory refers to the structure of knowledge. Bruner expressed it by saying that the curriculum specialist and teacher "must specify the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner". This idea became of the important notion ascribed to Bruner. He explained it this way "any idea or problem or body of knowledge can be presented in a form simple enough so that any particular learner can understand it in a recognizable form", According to Bruner, any domain of knowledge (physics, chemistry, biology, or earth science) or problem or concept within that domain (law of gravitation, atomic structure, ecology, earthquake waves) can be presented in three ways or

modes: by a set of action (enactive presentation), by a set of image or graphic that stand for the concept (iconic representation) and by a set of symbolic or logical statement (symbolic representation).

iii. **Sequencing:** The third principle was the most effective sequences of construction should be specified. According to Bruner, instruction should lead the learner through the content in order to increase the student's ability to "grasp, transform and transfer' what is learned. In general sequencing should move from enactive (hand on concrete), to iconic (visual), to symbolic (descriptions in words).

iv. **Motivation:** The last aspect of Bruner's theory is that the nature and pacing of rewards and punishments should be specified. Bruner suggests that movement from extrinsic rewards, such as teacher's praise, towards intrinsic reward inherent in solving problems or understanding the concepts is desirable. To Bruner, learning depends upon knowledge of result when it can be used for correction. Feedback to the learner is critical to the development of knowledge. The teacher can provide a vital link to the learner in providing feedback at first, as well as helping the learner develop techniques for obtaining feedback on his or her own.

2.2.3 Constructivist Theory

Formalization of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanism by which knowledge is internalized by learners. He suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individual experiences are aligned with their internal

representations of the world, but may also occur as a failure to change a faulty understanding, for example, they may not notice events, may misunderstand input from others, or may decide that an event is a fluke and is therefore unimportant information about the world. In contrast, when individuals' experiences contradict in their internal representative they may change their perceptions of the experience to fit their internal representation.

According to the theory, accommodation is the process of refraining one's mental representation of the external, world to fit new experiences. Accommodation can be understood as the mechanism by which failure leads to learning, when we act on the expectation that the world operates in one way and it violates over expectations, we often fail, but by accommodating thus new experiences and refraining our model of the way the world works, we learn from the experience of failure, or others failure. Constructivism suggests that learners construct knowledge out of their experiences. However, constructivism is often associated with pedagogic approaches that promote active learning by doing. Constructivist theory is a theory of knowledge (epistemology) that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. In the past centuries, constructivist idea was not widely valued to the perception that children's play was seen as aimless and of little importance. Jean Piaget did not agree with these traditional views, however, he saw play as an important and necessary part of the student's cognitive development and provided scientific evidence for his views. Today, constructivist theories are influential throughout much of the non-formal learning section, one good example of constructivist learning in a non-formal setting is the investigation centre at the National History Museum, London.

Here visitors are encouraged to explore a collection of real natural history specimens, to practice some scientific skills and make discoveries for themselves.

During infancy, it is interaction between their experiences and their reflexes or behavior-patterns, Piaget called these systems of knowledge Schemata. Constructivism is not a specific pedagogy, although it is often confused with constructionism, an educational theory developed by Seymour Papert inspired by constructivist and experiential learning idea of Jean Piaget. Piaget's theory of constructivist learning has had wide ranging impact on learning theories and teaching methods in education and is an underlying theme of many education reform movements.

2.3 Conceptual Framework

Many views have been expressed about guided discovery. According to Richards & Schmidt (2002), Guided Discovery is an effective approach that provides an excellent framework for learning by doing. Guided Discovery utilizes an authentic context in which the problems are presented in certain sequence and choices that enables the learner to reach an outcome. Learning occurs as the user goes through various scenarios and the learner is guided to discover principles, and develop critical competencies. Information and reference modules are presented in context when required or requested. Mistakes can occur and the resulting scenario will allow the user to make decisions. Learning still occurs if the user takes a wrong path all the way through. Thus, leaning becomes an experience and not blindly following a set of rules, or learning by rote. With Guided Discovery approach, mistakes are an integral part of the learning process. In Guided Discovery, there is an appropriate level of guidance that allows students to experience virtually all the characteristics of pure discovery and it

happens within realistic time frames. Guided Discovery Strategy is an approach to instruction through which students interact with their environment by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments (Ormrod, 1995). The idea is that students are more likely to remember concepts they discover on their own. Teachers have found that discovery learning is more successful when students have a prerequisite knowledge and undergo some structure experiences (Rabia, 2007). According Bruner (1961), the father of discovery learning, Guided Discovery learning essentially consisted of learner's processing available information so that they could go beyond the evidence to gain new and novel understanding (Herman, 1969). Concluded discovery learning was a very nebulous concept. In contrast to passively watching a demonstration, there is considerable evidence for the salutary effect of active learning.

The Guided Discovery method incorporates many other methods (Eze, 1982). It can start within a demonstration from where the problem arises. Students are asked probing questions, which leads them to think out principles based on their observations. Here the teacher decides what concept to be taught. However, in order to assist the students, the teacher may breakdown the problem into simpler questions to be answered and may even give advice about the steps which the students take to answer these questions. The teacher thus guides the learners using leading questions. The types of activities the learners will be involve in, will vary from topic to topic and with age and ability of the learner. When the learners have had some experience in the Guided Discovery method, the teacher will give less and less guidance in order to let the learners formulate their own questions to solve the problems being investigated. The

amount of guidance given in any situation will depend on the grade level of the learners, the problem and the teacher. Thus, discovery approach suited all levels. Guided Discovery method has use and the use of the strategy has some values. These include:

i. Intellectual potency

ii. Intrinsic rather than extrinsic motives

iii. Learning the heuristics of discovery and

iv. Conservation of memory

By intellectual potency, Bruner (1960) means an individual only learns and develops his mind by using it. In his second point, he believes that because of succeeding at discovery, the learners receives satisfying intellectual thrill, an intrinsic or self- satisfying reward. According to Olarinoye (1982), if teachers want to learn for the fun of it, they have to device instructional systems that offer learners intrinsic satisfaction. In his third point, Bruner emphasizes that the only way a person learns the technique of making discoveries, is to have the opportunity to discover. Through discovery, a learner slowly learns how to organize and carry out investigations. Bruner argues in his fourth point that one of the greatest “pay offs” of guided discovery is that it aids better in memory retention and transfer of learning. Besides greater content achievement and cognitive development resulting from the activity, guided discovery help to develop skills in scientific thinking. Such logical thinking enhance in learner the abilities of identifying problems and questions, categorizing of attributes through observations, comparison of differences, measuring quantities and manipulating material. Guided Discovery learning encompasses an instructional model and strategies

that focus on active, hands-on-learning opportunities for students (Dewey, 1997; Piaget, 1973). Bicknell-Holmes and Hoffman (2000) describes the three main attributes of guided discovery learning as:

i. Exploring and problem solving to create, integrate and generalize knowledge.

ii. Student driven, interest-based activities in which the student determine the sequence and frequency or,

iii. Activities to encourage integration of new knowledge into the learner's existing knowledge.

The first attribute of discovery learning is a very important one. Through exploring and problem solving, students take an active role to create, integrate and generalize knowledge. Instead of engaging in passively accepting information through lecture and drill and practice, students establish broader application for skills through activities that encourage risk-taking, problem solving and an examination of unique experiences (Bicknell-Holmes and Hoffman, 2000). In this attribute, students rather than teacher drive the learning. Expression of this attribute of discovery learning essentially changes the roles of students and teachers and is a radical change difficult for many teachers to accept.

A second attribute of discovery learning is that it encourages students to learn at their own pace (Bicknell-Holmes and Hoffsman, 2000). Through discovery learning, some degree of flexibility in sequencing and frequency with learning activities can be achieved. Learning is not a static progression of lessons and activities. This attribute contributes greatly to students' motivation and ownership of their learning.

A third major attribute of discovery learning is that it is based on principle of using existing knowledge as a basis to build new knowledge (Bicknell-Holmes & Hoffsman, 2000), scenarios with which the students are familiar allow the students to build in their existing knowledge by extending what they already know to invent new ideas. The three attributes above combine to differentiate guided discovery learning from traditional form in the following ways:

i. Learning is active rather than passive (Mosca and Howard, 1997).

ii. Learning is process oriented rather than content oriented.

iii. Failing is important

iv. Feedback is necessary

v. Understanding is deeper (Parpet, 2000).

First, in discovery learning, students are active. Learning is not defined as simply absorbing what is being said or read, but actively seeking new knowledge. Students are engaged in "hands-on" activities that are real problems needing solutions. The students have a purpose for finding answers and learning more (Mosca & Howard, 1997).

Secondly, the focus shifts from the end product, learning content, to the process, how the content is learned. The focus in discovery learning is learning how to analyze and interprets information to understand what is being learned rather than just giving the correct answer from role memorization. Process-oriented learning can be applied to many different topics instead of producing one correct answer to match one question that is typically found in content oriented learning. Discovery learning pushes students to a deeper level of understanding. The emphasis is placed on a mastery and application of overarching skills (Bonwell, 1998).

Thirdly, failure in discovery learning is seen as a positive circumstance (Banwell, 1998). Discovery emphasizes the popular lesson learned from Thomas Edison. Thomas Edison is said to have tried 1,200 designs for light bulbs before finding one that worked (Love, 1996). When someone asked Edison if he fell discouraged by so many failures, he responded that he never felt discouraged because he had learned thousands of designs that do not work. Learning occurs even through failure. Discovery learning does not stress getting the right answer. Cognitive psychologists have shown that failure is central to learning (Schank & Cleary, 1994). The focus is learning and just as much learning can be done through failure as success, in fact if a student does not fail while learning, the student probably has not learned something new (Schank and Cleary, 1994). Fourthly, an essential part of discovery learning is the opportunity for feedback in the learning process (Bonwell, 1998). Student learning is enhanced, deepened and made more permanent by discussion of the topic with other learners (Schank & Cleary, 1994). Without the opportunity for feedback, learning is as is typical in the traditional classroom where silence is expected, students are encouraged to discuss their understanding.

Lastly, incorporating all of these differences, discovery learning provides for deeper learning opportunities. Learners internalize concepts when they go through a natural progress to understand them. Discovery learning is a natural part of human beings (Papert, 1980). People are born with curiosities and needs that drive them to learn. Infants learn to talk by discovery. They listen to others around them talk, mimic sounds, and try putting together the pieces of language they have discovered. Infant develops a deep understanding of language by figuring it out a piece at a time.

Discovery learning allows for deeper understanding by encouraging natural investigation through active, process-oriented methods of teaching (Papert, 1980).

2.3.1 Processes of Discovery

Friedler *et al.* (1990) describe the discovery learning processes as (a) define a problem (b) state hypothesis (c) design an experiment (d) observe, collect, analyze and interpret data (c) apply the result and(f) make predictions on the basis of result of previous experiments. De Jong and Njoo (1992) divided discovery learning into transformative processes, which include analysis, hypothesis generation, testing and evaluation and into regulative processes, which include planning, verifying and monitoring. In this template, Veermans (2002) describe the processes used:

i. Orientation

ii. Hypothesis generation

iii. Hypothesis testing

iv. Calculation as well as

v. Regulative processes

i. **Orientation: -** During the orientation process learners build their first idea of the domain and the learning environment. It might involve reading introductory and/or background information, explaining the domain, identifying the variable in the domain and relating prior knowledge about the domain to the given problem. The activities and the results of the orientation process can be used as input for other processes. Conversely, the activities and results of other processes (especially from the conclusion phase) alter ideas of the domain and right trigger-

re-orientation of the domain.

ii. **Hypothesis Generation:** In the hypothesis generation process learners start formulating hypothesis about the problems and questions of the domain, A hypothesis is a statement about the relation between two or more input and output variables that expresses an idea about the nature of this relation. Hypothesis can be derived from the exploration of the domain or from ideas or other hypothesis about the domain.

iii. **Hypothesis Testing:** The hypothesis that is generated in the hypotheses generation process cannot be guaranteed to be correct, and should ideally be tested by the learner. This is the focus of the hypothesis testing process. The learner has to design and execute experiments that put a hypothesis to the test, gather the data from the experiments, and interpret the results, it is essential that the experiment designed in this process is set up in a way that evidence that is generated by executing the experiments is suitable for testing the hypothesis.

iv. **Conclusion:** During the conclusion process the learner should review the hypothesis in the light of the evidence that was generated in the hypothesis testing process. The learner should decide whether the evidence is in line with predictions derived from the hypothesis, or identify discrepancies between evidence and predictions. This may lead to revision of hypotheses and/or the generation of new ones.

v. **Regulation, Planning, Monitoring and Evaluation:** The regulation processes are processes by which the learner manages the work through the discovery learning processes described above. On a general level the regulation process

keep track on the progress that has been made in the other processes, and shift between the processes. On a specific level they keep track of the progress that has been made within the processes and the steps ahead. Planning involves setting up goals, and defining a way to achieve these goals. It can be a process at the general level, defining shift through the processes at a specific level, defining steps and actions carried out within a plan, and their results in a way that planning and evaluation process can use them.

Evaluation reflects upon both the outcomes of the processes and the steps taken in the processes. Reflection concerns assessing the outcomes of the discovery process, in relation to the goals. As a result of the assessment, the planning might be revised. For instance, the outcome of the conclusion process is that the evidence is not in line with predictions; the learner has to make a decision about what to do, reformulate the hypothesis or reject the hypothesis. Thus decision has consequences for planning the next steps reformulating the hypothesis implies moving back to the hypothesis generation phase, and generating a new hypothesis is based on the old one and the contradicting evidence. Rejection leaves the next step open, and the learner might proceed with any of the other processes. Reflection on the steps taken in the processes concerns assessing the steps in the discovery processes in relation to the goal of the process might lead to revision of planning within the processes, it could, for instance mean reflecting on the hypothesis-testing phase, deciding whether the evidence that was generated during this process is "sufficient;, or that additional evidence should be obtained. The latter could lead to a revision of further hypothesis plans.

2.3.2 Concept of Ecology

The term ecology was coined in 1866 by the German biologist, Ernst Haeckel from the Greek *oikes* meaning "house" or "dwelling", and *logos* meaning "science" or "study". Thus, ecology is the "study of the household of nature". Haeckel intended it to encompass the study of an animal in relation to both the physical environment and other plants and animals with which it interacted. A contemporary definition of ecology is the scientific study of the distribution and abundance of organisms and the interactions that determine distribution and abundance. This definition encompasses not only the plants and animals that Haeckel recognized but microscopic organisms such as bacteria, Achaea and protozoa as well. The interactions that determine organisms' distribution and abundance are processes that include energy flow, growth, reproduction, predation, competition and many others. To fully understand the science of ecology, there are some common terms that must be defined. The term environment describes in an unspecified way, the sum total of physical and biotic conditions that influence an organism. The subset of the planet earth environment into which life penetrates is termed the biosphere. With respect to the planet earth, the biosphere penetrates only a limited distance into the rock beneath the land and the ocean, and a limited distance out away from the planet towards space. All human effort so far has failed to demonstrate that the biospheres extends beyond these limits or that other biospheres exist elsewhere in the universe. We cannot therefore conclude that they do not exist, only that we know nothing of that existence. Ecosystem is perhaps the most widely used term in ecology. It is defined as the system of organisms and physical factors understudy or consideration. Although the boundaries of ecosystem are sometimes quite difficult to define in nature, ecosystem,

however, comprise basic units of that nature. Habit is generally considered by biologists to be the physical conditions that surround a species population, or community. The basic physical units of the biosphere are the lithosphere (the land), hydrosphere (the water) and atmosphere (the air). Apparently, there is no permanent biota of the atmosphere, although insects and birds among others utilize that environment extensively.

Humanity has been studying nature for thousands of years and formally for several centuries under the science of biology, so why do we say that ecology is a relatively new science? Ecology is one of the three main divisions of biology. The other two being morphology (organism structural aspects) and physiology (organism functional aspects). The behavioural science encompass one facet of the interaction of an organism with its physical and biological surroundings, and therefore are part of ecology.

2.3.3 Concept of Ecology and Learning

Stewart and Yarroch (1982) found that ecology is one of the most difficult content area of teachers to teach. The Chief Examiners' reports (2002, 2003, 2004, 2007) on West Africa School Certificate in biology reveals evidence of low achievement and poor understanding of some basic ecology concepts. Research on problems of teaching ecology revealed (I) inadequacy resources for teaching ecology (II) teachers unsatisfactory use of resources, (III) field work and practical work unsatisfactorily carried out, are some of the problems militating against the effective teaching and learning of ecology (Okeke & Ochuba, 1996). The study of Adeniyi (1985) also reveals that the misconceptions which students hold about some ecology concept affect their performance in ecology test. However, high achievement of ecology concept can be achieve through meaningful teaching using activity based instructional strategies like guided discovery,

cooperative learning etc, which will have motivating effect on the students using other methods (Aworanti & Olakanmi, 1997).

2.3.4 Concept of Gender and Academic Performance in Science

Gender is a general construct that distinguishes the roles, behaviour, mental and emotional characteristics between males and females developed by a society. Umoh (2003) defines gender as a psychological term used in describing behaviours and attributes expected of individuals on the basis of being born as either male or female. According to Okeke (2003), the study of gender is not just mere identification of male or female sexes. Scholars have gone further to identify the responsibilities assigned to opposite sexes and to analyze the conditions under which those responsibilities are assign. Furthermore, Okeke (2003) specifically notes that the study of gender means the analyses of the relationship of males and females including the division of labour, acces to resources and other factors which are determined by society as opposed to the environment under which responsibilities are assigned and the relationship emanating from it. Thus, gender equally projects the properties that distinguish and classify organism on the basis of their productive and cultural expectant roles. It relates to the cultural and psychological attributes of men and women through their socio-economic contributions, expectations and limitations. Thus, the concept of gender does not support or suggest the dominance of male over females or vice versa in academics and other human resources development areas but it stresses equality and equity in enhancing effective and efficient recognition, development and utilization of competences and endowed capabilities of both sexes.

Gender is a major factor that influences career choice and subject interest of students. Further explanation of this context shows that Home Economics, Nursing, Secretary-ship and other feminine related careers have been traditionally regarded as aspects of the school curriculum reserved for females (Umoh, 2003). Based on this, males choose male stereotyped occupations and females choose female stereotyped occupations. According to Umoh (2003), more difficult tasks are usually reserved for males while less difficult ones are considered feminine in a natural setting. Example of this is breaking of firewood, which is often seen as manly task while washing of plates could be seen as a female task at home. Thus, at school, males are more likely to take to difficult subject areas and challenging problem-solving situations while females on the other hand prefers simple subjects and often shy away from difficult tasks and problem-solving situations.

Okeh (2003) discovered that male secondary school students performed better than females in science and mathematics. These differences in performance could be attributed to gender stereotyping which encourages male and female students to show interest in subjects relevant and related to the roles expected of them in the society. The National Assessment of Education Progress in 1992 showed that males had higher average scores than females between the ages of 9, 13 and 17. Studies have shown that co-education has negative impact on cognitive performance of students as females performed better without the males and vice versa (Okeh, 2003). Okeh (2003) stated that the association formed between gender as it applies to co-educational institution causes psychological inferiority complex and this hinders effective classroom participation. Furthermore, it is the known fact that attitude developed by young people during their

study of science can be important as the skills they acquire and they knowledge they obtained. This is because attitude regulates behaviour, not only in the classroom but in all other areas of human experience.

2.3.5 Schools Ownership and Academic Performance

Public schools are schools owned and controlled by government by providing or appointing principals to supervise the work of all the staff and students. Government rules and regulations are strictly followed for effective performance. That is, they are indirectly controlled and managed by the government. Private schools are schools owned and controlled by individual or group of individuals or organization who have direct power or authority to fire or sanction any staff who fails to abide by their rules and regulations.

A careful observation of current trends in Nigeria in terms of parents preferred choice of educational institution for their children would reveal an ineffective learning towards privately run educational institutions, as opposed to public institutions. Regardless of whatever level of education one considers, primary, secondary and tertiary, the trend seems to be the same. It seems that there is a persistent and widespread loss of confidence in public schools. As Ajayi (2000) noted, it is still observed that education today has been faced with various challenges ranging from mismanagement of allocated resources to falling academic standards. This calamitous situation has further caused greater concern to most Nigerians in the educational institutions seems to have overlooked the primary purpose of schooling and the high expectations and disciplined effort needed to achieve them. This nagging challenges faced by the education sector leads to an inevitable consequence as observed by Okafor *et al*. (2003), “falling standards

leading to pushing the good excellence to the back burner as public confidence in our educational system is eroded."

Other important reasons for lose of confidence in our education system include poor planning and consistent lack of investment in the educational system. This had led to a near collapse of the individual. Thus critical point, many parents and guardians have come to understand and this is reason they will handle carelessly matters that have to do with the education of their children. Therefore, many parents feel let down, but they cannot give up their dreams of giving their children the best in terms of education. This is where the private schools came in. It is appropriate at this point to make clear of one fact, and that fact, government alone cannot provide all the education needs of its citizen. However, the little government control and direct involvement in the day to day running of schools has not bee without challenges and this explains why education is in the state it is today. Since the early 1990s, private ownership and control of schools is (or has became) very popular. Privately owned schools are now being looked upon to correct the ills and lapses by the long years of government involvement in running of schools. Private schools in Nigeria have really grown in profile in the last 10 – 15 years, such that they have gained acceptance and higher popularity among parents. This means that many parents could afford to send their children to private schools where, for the most part, the educational experience would, in many cases, seem to be more effective.

At the same time, there are some major challenges associated with a move in private schools. First, many private schools have religious orientation. This raise the thorny issue of religion in our national life. Secondly, will some private schools need to be so profit oriented that they will be tempted to cut corners and deprive students of

extra-curricular activities? Third is the fear that funds for public schools would be diverted to the private sector and that our public schools would end up being even worse off than are now. If this is left unchecked, our public schools could eventually end up resembling remedial detention centres. The above, supported a website article, stating that private schools offer more accelerated college focused courses and are more intent on hurrying their students to go to college.

2.3.6 Concept of Academic Performance in Science

Academic performance is the outcome of education. The extent to which student achieved their educational goals. Academic performance refers to what the students have learned or what skills the student has learned and is usually measured through assessment like standardized test (Santrock, 2006).

In the contemporary Nigeria, subsequent to the national endorsement of International Protocols for Education for all (EFA), the Millennium Development Goals (MDGs) and the adoption of a National Economic Empowerment and Development Strategies (NEEDS), a greater emphasis is now being placed on industrial and technological development (NERDC, 2007). Consequently, students are being encouraged to take up science related subjects. Today in global perspectives, scientific methods pervade literally every field of human endeavour and play a fundamental role in economic development of any country including Nigeria. In our match towards scientific and technological advancement and our aspiration to be among the first economic in the world by the year 2020 (Obioma, 2007; NERDC, 2007), we need nothing short of good performance of our youth in sciences at all levels of schools. Unfortunately, however, performance of students in the sciences at the end of secondary education has not

improved in the past decade as reflected in the Chief Examiners' reports of both WAEC and NECO from 2007 to 2010.

Sam (2011) regrettably observed that academic excellence had since departed from the land. The harvest of academic failures has brought many students to their knees in tears. Every academic year, the nation is grieved by the below average performance of thousands of students in science. This issue of poor academic performance of students in Nigeria has been of much concern to all stakeholders. The problem is so much that it has led to the widely acclaimed fallen standard of education in Nigeria at large. Due to the observed deterioration in the academic performance of secondary schools students in science subjects, one wanders if such poor performance may be as a result of instructional and structural qualities of the schools or could it be as a result of teachers' ineffectiveness in classroom interaction with students. These questions are continually being asked by individuals and organizations.

2.3.7 Traditional Teaching Method and Students' Academic Performance

Traditional teaching method is concerned with the teacher being the controller of the learning environment. Power and responsibility are held by the teacher and they play the role of instructor (in the form of lectures) and decision makers (In regards to curriculum content and specific outcomes). They regard students as having "knowledge holes" that need to be filled with information. In short, the teacher views that it is him that causes learning to occur (Novak, 1989). Learning is chiefly associated within the classroom and is often competitive. The lesson content and delivery are considered to be most important and students master knowledge through drill and practice (such as role learning). Content need not be learned in context (Johnson & Johnson, 1991). The most common seating arrangement used by the traditional teaching method is rows.

Traditional teaching methods sometimes referred to as the “information dump” is a commonly used approach that involves presenting specific information for the majority of class time, allowing little opportunity for students interaction and expects students to have mastered the information by the time of the exams (Stewart *et al.*, 2005). Generally, traditional method of teaching consists of instructors introducing constructs and their definitions, examples of how phenomena work and other supporting information. This approach is beneficial because it is convenient and efficient way to introduce a vast amount of information, especially in large class where activities may be impractical (Michel *et al*., 2009). Consequently, traditional method has developed a reputation of being disengaging or monotonous (Dorestani, 2005).

The traditional teaching strategy is a conventional strategy that is referred to as the “talk-chalk” strategy. It is the oldest method of teaching used in most Nigerian schools. The teacher assumed the position of one who knows all he/she does it to "give out" the fact to students who are at the receiving ends. The teacher does much of the activity by talking while the students are relatively passive (Ajewole, 1997). In this method, material is presented topic by topic. All the information that is learned is learned by the teacher explaining it to the students. To supplement the traditional method, the students also perform labs. Labs involve students performing a predetermined procedure to learn how certain principles can be proven or arrived at experimentally. In the lab, the problem is always given to the students ahead of time and the method of solving it is usually also given ahead of time.

2.3.8 Guided Discovery Method and Student Academic Performance

An early advocate of active learning, Bruner (1961) hypothesized that, the act of discovery lead to acquiring information in a way that makes it readily available for

problem solving. Herman (1969) reviewed the literature on the efficacy of discovery and concluded that discovery learning leads to better transfer and long term retention than does the more traditional learning. Hirsch (1977) found that a class taught by guided discovery out performed classes taught by exposition method of learning. To an impressive demonstration of how active learning can lead to excellent long term retention, Canway *et al.* (1991) found that memory for research methods taught by having students design and conduct experiment did not decline over a period of 12 years.

Constructivist theoretical framework maintain that student learn well when they actively construct their own knowledge. According to this perspective, learning occurs through hands-on-interaction rather than through direct instruction in which the student passively receive knowledge (Cobb, 1994; Milk, 2003). Although, most educational researchers accept the notion that active learning is better than passive learning (Bransford *et al.*, 1999; Bruner, 1993; Lamber & Canbs, 1993 & Mayer, 2004) and that teaching and learning methods that provide direct instruction without engaging the learner can lead to good immediate performance but poor long term retention (Schmidt and Bjark, 1992).

In the lecture classroom, scientific ideas or theories are frequently presented as fixed and unchanging truth (Awodi, 1984). Such a presentation does not reflect the true nature of science. “Scientific theories are flexible, tentative and revisionary” (Awodi, 1984). This means that scientific ideas and theories subjects to change from time to time for science are not static. Science is a dynamic enterprise, characterized and nurtured by change. Such a change is dependent on validated empirical data, which on wide

acceptance form the basis of scientific laws and predictions. These laws and predictions rather than being dogmatic, immutable, infallible and therefore based on unalterable tenets, are based on assumptions, which are by their very nature subject to change. This stems from the fact that science is enquiry. If science is enquiry, for one to understand and learn science, there is need to approach it by the enquiry approach. This is not to discount other methods of teaching and learning science. Indeed, it may in various situations be found useful or even necessary to adopt. The point here is that, science is enquiry by nature. Teachers and students of science need to be actually aware of this fact and employ science process skills in learning science. First of all, science involves problem solving. Therefore, teaching science by guided discovery method involves showing students how to solve problems logically and systematically, employing scientific processes or skills. In this approach, students are encouraged to think. They are guided by the teacher to reason for themselves, to think through problem using the processes of science (Schauble, 1996).

2.4 Review of Empirical Studies

A number of studies have been carried out on the effect of guided discovery on student academic performance in selected secondary schools. Omiorrhieren (2002) carried out an investigation on the effect of guided discovery and traditional methods on the achievement of student in senior secondary school chemistry in Cross River State. A total of 95 students with an average age of 17 years constituted the sample size used for the study. The multiple choice and short answer type assessment constituted the achievement pre-post-test items used for the study. The investigator developed lecture note and learning activity packages. The experimental group used the guided discovery

while the control group had the same activities performed by the teachers. The study found out that the guided discovery method was more effective in enhancing the achievement of student in chemistry than the traditional method.

Similarly, Archibong (1997) studied the relativeness of activity-based approach and lecture method on the cognitive achievement of integrated science students in Edo State. Subjects in the experimental groups were subjected to activities and exercises using guided-discovery, guided inquiry and laboratory methods while student in the control group were taught with the expository method. The results showed that student with activity-based approach achieved better than those taught using lecture method.

Effiong (2010) carried out a study on the effects of guided discovery, student-centred demonstration and expository instructional strategies on students performance in chemistry and discovered that students taught with guided discovery method had the best performance. Shukry (2010) carried out a study to (a) design a suggested plan to teach the topic of equations to student using guided discovery method, (b) ensure the program's validity and reliability. (c) Study the effect of guided discovery method on the pupil's achievement. The sample consists of 115 pupils from the 2^{nd} class preparatory school in Doha, state of Qatar. The subjects were divided into two groups. The first which acted as the control one learnt the equations by the traditional expository method using the textbook, while the other group which acted as the experimental one, learnt the same topic by the discovery method using the suggested plan. The score of the experimental group were higher than those of the control group, with statistically significant difference. The comparative analytical result of the pupil's performance with the observations of those pupils were recorded while conducting the

experiment showed that the pupils of the control group made a greater number of common mistakes (error) on a wider scale than pupils of the other group.

Yusuf (2004) observed, in a study conducted on the effect of cooperative and competitive instructional strategies on performance of students. The samples consisted of all the third year students from two purposively selected secondary schools in Ilorin West Local Government Area of Kwara State. The treatment and control group were made up of 48 and 45 students respectively. The post test score were subjected to Analysis of Covariance to test the hypotheses generated for the study. The findings showed that the student taught using cooperative strategy (COOPIS) performed significantly better than their counterpart taught using the conventional instructional Strategy (CIS). This suggests that the method employed in teaching has a significant effect on student's performance.

In another related study, Olufunmilayo(2010) compared the effect of the Guided Discovery and concept mapping teaching strategies on senior secondary school students performance in chemistry. A total sample of 360 SSS chemistry students who has registered for SSCE drawn from four schools in Bauchi Local Government were selected for the study. A post test was administered on the two groups to test the instructional effectiveness of the two methods. Data were analyzed and the t-test statistics was used to test the hypotheses generated for the study. The findings show that both the guided discovery and the concept mapping strategies are equally powerful in terms of improving student's performance in chemistry. However, students taught using the concept mapping are likely to retain chemistry information better than those taught using the guided discovery strategy.

In a similar view, Edu and Idaka (2012) carried out a study to evaluate the influence of instructional method and aptitude effects on the psychomotor performance of students in Basic electricity among technical students in Southern Nigeria. The sample consist of 80 technical II students randomly selected using four(4) researcher made instruments, two(2) lessons plans, Basic Electricity Psychomotor Test (BEPT) and a fundamental Electricity Aptitude Test (FEAT). Data were analyzed using independent t-test and multiple classification analyses of variance (MANCOVA). The findings revealed that there was no significant difference in the joint effect of demonstration and project instructional methods and aptitude on psychomotor performance of students in basic electricity. Similarly, the results showed that there was no significant mean difference in the psychomotor performance of students with high and low aptitude in basic electricity in technical colleges when taught with demonstration and project instructional methods.

Agboghoroma (2005) in trying to ascertain the knowledge acquisition of urban and rural students in integrated science, used 360 JSS III students exposed to guided inquiry method as well as students exposed to the traditional lecture method, found that there was a significant difference (improvement) in the knowledge acquisition of those students exposed to the guided inquiry method. Obeka, (2010) in his study on the effect of inquiry and demonstration methods on students' achievement and retention in some Environmental Education Concepts of Geography. The study involved 225 SSS students in three intact classes of the three selected secondary schools in Otukpo L.G.A of Benue State. A quasi-experimental non-equivalent control group design was adopted. The finding revealed that inquiry method had significant effects on students overall

achievement.

Akanmu and Fajemidagba (2013) conducted a study on guided discovery learning strategy and senior school students' performance in mathematics in Ejigbo. Two hundred and two (202) SS I students from two selected public co-educational schools in Ejigbo Local Government Area of Ogun State constitute the sample of the study. The research was a quasi-experimental and main instrument for data collection was a 20 multiple choice Mathematics Achievement Test. The results of the study revealed a significant difference in favour of those exposed to guided discovery learning strategy compared to those exposed to mechanical method.

Yaki (2011) conducted a study on effects of computer animation and guided inquiry on secondary school students' learning outcomes in ecological concepts. The study employed quasi experimental design. The population is all senior secondary schools in Minna. Stratified random sampling technique was used to select three co-educational schools in Minna. The selected three co-educational schools were randomly assigned to each of two experimental and a control group. The result shows that those students in the second experimental group (guided discovery) performed better than those in the control group (traditional method).

2.5 Summary of the Review and Uniqueness of the Study

Guided discovery is an approach to instruction through which students interact with their environment by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments (Ormrod, 1995:42). The idea is that students are more likely to remember concept they discovers on their own. Teachers have found that guided discovery learning is most successful when students have a

prerequisite knowledge and undergo some structured experiences (Roblyer *et al.*, 1997:64).

In the reviewed of literature presented in the proceeding discussion shows that guided discovery was useful for improving science teaching and learning by developing inquiry and information processing skills and providing a sense of personal control over the lesson. Others found that guide discovery approach does not have effect on students' academic performance. Apparently, in the teaching and learning of ecological concepts in Nigeria and Sokoto State in particular, the major problem is the method of teaching for effective and meaningful learning. The research has been motivated by the less emphasis by teachers on the area of science teaching and learning to employ appropriate instructional strategy in teaching ecology.

Because of lack of appropriate teaching strategy, students encounter series of difficulties in understanding ecology, and thus reflected in their performance. The research has been motivated by the failure of teachers to employ appropriate instructional strategy in teaching ecology. The uniqueness of this research study can be found areas like the geographical scope of the study, sample size, subject area. Unlike the other studies that cover the southern part of the country, this research covers the northern part of the country i.e. Sokoto State.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with methods and procedures that was followed in the study, the research design, population of the study, sample and sampling techniques, instrument for data collection, validity of the instrument, reliability of the instrument and method of data analysis.

3.2 Research Design

The research design used for this study was Quasi-experimental design. This design was chosen among other designs because according to Cambell and Stanley (2007), it is an experimental design that does not require all the necessary conditions for controlling the influence of extraneous variables. This design is used where true experimental design is not feasible. In this study one intact class was selected from each sampled school and four intact classes were used as experimental while four intact classes were used as control group. The experimental groups were taught ecology using guided discovery while control group were taught with traditional method for six weeks, after which Ecology Performance Test was administered to both groups.

CG ⟶ TM ⟶ EPT

EG ⟶ GD ⟶ EPT

Where:

CG represent Control Group, EG represents Experimental Group, TM represents Traditional Method, GD represents Guided Discovery Method and EPT is the Ecology Performance Test.

3.3 Population of the Study

The population for this study comprised of the entire senior secondary school I (SSI) students offering Biology in Sokoto metropolis with total population of thirteen thousand and fourty five (13,045) students. The population comprised of students from five (5) Local Government Areas (LGAs) within Sokoto metropolis, namely: Sokoto South, Sokoto North, Wamakko, Dange Shuni and Kware. The number of schools, types of school and population of students per school varies from local government to local government. Some of the schools are located in the rural areas while others are in urban areas. Two third ($^2/_3$) of the population are Hausa speaking students. Only one third ($^1/_3$) of the population are Yoruba, Ibo and other tribes. The ages of these students range from 15 – 18 years. Table 3.1 shows a summary of the school.

Table 3.1: Schools and their Types According to Local Government Area

S/No	L.G.A.	No. of Schools	Total Population of Students	Type of School		
				Boys only	Girls only	Mixed
1.	Sokoto South	21	6692	9	4	8
2.	Sokoto North	7	1,865	1	-	6
3.	Wamakko	10	2,929	4	-	6
4.	Dange Shuni	2	613	-	-	2
5.	Kware	3	946	-	-	3
	Total	43	13,045	14	4	25

3.4 Sample and Sampling Techniques

Stratified random sampling technique was employed to select eight (8) secondary schools from the fourty three (43) secondary schools within Sokoto metropolis using state

owned schools, federal government owned schools and private schools as strata. Intact classes were used from each sampled school. Two private schools were selected, four state government schools because they are the majority and two federal government owned school were also selected because there only two of them within the metropolis. 270 students were selected from State Government owned Schools, 127 students were selected from Federal Government owned Schools while 124 students were selected from private schools which make a total of 521 students as the sample size for the study.

Table 3.2: List of Selected Schools

S/N	Name of school	Sex	School Type	Group	Intact classes	Sample	
						Males	Females
1	Federal Science College, Sokoto	Mixed	Federal	Experimental	65	40	25
2	Federal Gov't College, Sokoto	Mixed	Federal	Control	62	38	24
3	Blue Crescent Secondary School	Mixed	Private	Experimental	61	38	23
4	Alheri Secondary School	Mixed	Private	Control	63	33	30
5.	Sultan Bello	Boys	State	Experimental	63	63	-
6.	G.G.C. Sokoto	Girls	"	Control	70	-	70
7.	Nagarta College	Boys	"	Control	68	68	-
8.	Hafsat Ahmad Bello	Girls	"	Experimental	69	-	69
	Total				**521**	**280**	**241**

From the table above, one intact class was selected from each sampled schools. Four intact classes were used as experimental and four as control groups.

Table 3.2: Sample Table

Group	Males	Females	Total
Experimental	141	117	258
Control	139	124	263
Total	**280**	**241**	**521**

Eight intact classes at SSI level were used for the study. Federal Science College Sokoto, Blue Crescent Secondary School, Sultan Bello Secondary School and Hafsat Ahmad Bello Secondary School with one hundred and fourty one (141) males and one hundred and seventeen (117) females constituted the experimental group, while Federal Government College Sokoto, Alheri Secondary School, Government Girls College and Nagarta College with one hundred and thirty nine (139) males and one hundred and twenty four females (124) constituted the control group.

3.5 Instrumentation

The quality of a research is determined by the quality of the instrument used in the collection and analysis of the data (Ogunleye, 2000). The instruments used for this study are Ecology Performance Test (EPT), Teaching Modules and Lesson Plans.

Ecology Performance Test is a researcher-designed test. The instrument contained 20 multiple choice questions covering senior secondary school ecology syllabus. Each item contains four (4) options, one of which provides the correct answer. The remaining three responses are distractors. Teaching Module is conceptualized as self-contained "units" of content to be covered within the period of the lesson.

Lesson Plan is a detailed description of individual lesson that a teacher plans to teach in a given lesson. It is developed by the researcher to guide instruction throughout the study. The experimental groups were taught ecology using nine (9) guided discovery lesson plans while the control group were taught ecology using nine (9) lecture method lesson plan making eighteen lesson plans for both groups. After which the Ecology Performance Test was administered to both groups.

3.6 Validity of the Instrument

The instruments were validated by experts from the Department of Science and Vocational Education, Usmanu Danfodiyo University, Sokoto who are also members of the researcher's supervisory team. To ensure validity of the Ecology performance Test, the test items were also submitted to experienced Biology teachers at Government Girls College, Sokoto in order to ensure that the content taught was reflected in the test, thus ensuring its content. There were initially 30 items on the instrument, after giving the instrument to expert for vetting; it was reduced to 20 items due to ambiguous nature of some questions.

3.7 Reliability of the Instrument

The reliability of an instrument refers to the degree of consistency with which the instrument measures what it purports to measure, that is the degree to which the test measures the same thing, time after time and item after item (Ogunleye, 2000). At the end of a pilot study, achievement test was administered to twenty (20) SS I students from Army Day Secondary School, Sokoto and two weeks later, the instrument was re-administered to the same set of students and the two set of scores were correlated using Pearson Product Moment Correlation Co-efficient (r) and a reliability index of 0.89 was

obtained which shows that the instrument was reliable enough for the research work.

3.8 Procedure for Administering the Instrument

The teaching was done for six weeks. The teachers and students of Biology were informed of the objective of the research which was to improve the teaching of science especially ecology. The experimental group was taught ecology using guided discovery method by the researcher and three trained research assistants from the sample schools using guided discovery lesson plan, this was done because the researcher cannot cover all the Sample schools at the same time. The control group was taught by qualified teachers from the selected schools using the lecture method lesson plan. At the end of the teaching exercise, Ecology performance Test was administered on both the experimental and control groups.

3.9 Method of Data Analysis

The data collected from the study was analyzed using descriptive statistics and t-test was used to test the hypotheses. The researcher considered the use of t-test being a more versatile technique usually used to find out whether the difference between the two mean score is significant or by chance at 0.05 level of significance.

The hypotheses are as follows

H_{01} There is no significant difference in the performance of students taught ecology using guided discovery method and those taught using the traditional method. The t-test technique was used to test this hypothesis as well.

H_{02}: There is no significant difference in the performance of male and female students taught ecology using guided discovery method. T-test technique was also used to test this hypothesis.

H_{03}: There is no significant difference in the performance of public and private school students taught ecology using guided discovery. The statistics used for data analysis is t-test technique.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter deals with results, which include interpretation of findings of the study. It contains statistical tests that were selected from inferential and descriptive methods and the data obtained was presented in tabular form.

4.2 Answering of the Research Questions

The data relevant to the research questions were analyzed using descriptive statistics. Descriptive statistics of the findings of the study were presented in Tables 4.2.1, 4.2.2 and 4.2.3.

Research Question One: Is there any difference in the performance of students taught ecology using guided discovery and those taught using traditional method?

Table 4.2.1: Descriptive Statistics on the Performance of Students in Experimental and Control group

Variable	N	Mean	Std. Deviation
Guided Discovery	258	16.72	3.21
Traditional Method	263	11.19	5.45

Source: Researcher's Field Work, 2014.

Table 4.2.1 presents the data on students' performance in ecology between those taught using guided discovery (experimental group) those taught using traditional method (control group). Results showed that those taught using guided discovery method performed better as indicated by a mean of 16.72 (SD=3.21) than those taught using traditional method with a mean of 11.19 (SD=5.45). This answered research question one and it was concluded that there is a difference in the performance of students taught with guided discovery and those taught with traditional method in the study of ecology.

Research Question Two: Is there any difference in the performance of male and female students taught ecology using guided discovery?

Table 4.2.2: Descriptive Statistics on the Performance of Male and Female students in experimental group

Gender	N	Mean	Std. Deviation
Male	141	17.89	2.29
Female	117	16.63	2.84

Source: Researcher's Field Work, 2014.

Table 4.2.2 presents the data on the performance of male and female students taught ecology using guided discovery method. Results showed that among those students taught ecology with guided discovery method, males students performed better as indicated by a mean of 17.89 (SD=2.287) than the female students with a mean of 16.63 (SD=2.839). This answered research question two and it was concluded that there is a difference in the performance of male and female students taught ecology using guided discovery method.

Research Question Three: Is there any difference in the performance of state and private schools students taught ecology using guided discovery?

Table 4.2.3: Descriptive Statistics on the Performance of State and Private Schools Students in experimental group

School Type	N	Mean	Std. Deviation
Private	61	18.67	1.59
State	197	12.14	5.27

Source: Researcher's Field Work, 2014.

Table 4.2.3 presents the data in the difference of performance between private and state school students taught ecology using guided discovery. Results showed that among those taught ecology using guided discovery method, private schools students performed better as indicated by a mean of 18.67 (SD=1.589) than the state schools students with a

mean of 12.14 (SD=5.271). This answered research question three and it was concluded that there is difference in the performance of state and private schools students taught ecology using guided discovery method.

4.3 Hypotheses Testing

$H0_1$: There is no significant difference in the performance of students taught ecology using guided discovery method and those taught using the traditional method.

This hypothesis was tested by subjecting the performance scores of students taught with guided discovery and those taught with traditional method to a t-test analysis and were presented in Table 4.3.1.

Table 4.3.1: T-test Analysis of the Academic Performance of students in Experimental and Control group

Variables	**N**	**Mean**	**Std. Deviation**	**Df**	***t*-Cal**	***t*-Crit**	**Decision**
Guided Discovery	258	16.72	3.21	519	14.07	1.96	H_0 Rejected
Traditional Method	263	11.19	5.45				

Table 4.3.1 showed that there exists significant difference in the performance of students taught ecology using guided discovery and those taught using traditional method because the calculated t-value of 14.07 is higher than the critical t-value of 1.96 at 519 degrees of freedom. Therefore, $H0_1$, which states that there is no significant difference in the performance of students taught ecology using guided discovery method and those taught using the traditional method was rejected.

$H0_2$: There is no significant difference in the performance of male and female students taught ecology using guided discovery method.

This hypothesis was tested by subjecting the scores of the male and female students taught ecology using guided discovery method to a t-test analysis, which was presented in Table 4.3.2.

Table 4.3.2: T-test Analysis of the Academic Performance of Male and Female students in Experimental Group

Variables	N	Mean	Std. Deviation	Df	*t*-Cal	*t*-Crit	Decision
Male	141	17.89	2.29	256	3.93	1.96	H_0 Rejected
Female	117	16.63	2.84				

Table 4.3.2 showed that there exists significant difference in the performance of male and female students taught ecology using guided discovery because the calculated t-value of 3.93, is higher than the critical t-value of 1.96 at 256 degrees of freedom. Therefore, $H0_2$, which states that there is no significant difference in the performance of males and females students taught ecology using guided discovery method was rejected. In other words there is a significant difference in the performance of male and female students taught ecology using guided discovery method.

$H0_3$: There is no significant difference in the performance state and private schools' students taught ecology using guided discovery method.

This hypothesis was tested by subjecting the performance scores of the state and private schools students taught ecology using guided discovery method to a t-test analysis and were presented in Table 4.3.3.

Table 4.3.3: T-test Analysis of the Academic Performance of State and Private School Students in Experimental group

Variables	N	Mean	Std. Deviation	Df	*t*-Cal	*t*-Crit	Decision
Private Schools	61	18.67	1.59	256	9.54	1.96	H_0 Rejected
State Schools	197	12.14	5.27				

Table 4.3.3 showed that there exists a significant difference in the performance of state and private schools' students taught ecology using guided discovery because the calculated t-value of 9.54, is higher than the critical t-value of 1.96 at 256 degrees of freedom. Therefore, $H0_{3,}$ which states that there is no significant difference in the performance of state and private schools' students taught ecology using guided discovery method was rejected. Meaning that there exist a significant difference in the performance of students in state and private schools taught ecology using guided discovery method

4.4 Summary of Major Findings

The following are the major findings of the study:

1. The students taught ecology using guided discovery method performed better than those taught using the traditional method.
2. Male students taught ecology using guided discovery method performed better than their female counterparts
3. Students in private school performed better than their counterpart in state schools when taught ecology using guided discovery method.

4.5 Discussion of Findings

Table 4.2.1 showed that students taught ecology using guided discovery method performed better than those taught ecology using lecture method. This showed that students' academic performance improved after being subjected to guided discovery teaching strategy. This indicates that students learn better when they are allowed to interact with the environment by performing experiments. The idea is that students are likely to remember concepts they discover on their own rather than regurgitating facts they learn through lecture method.

This result agreed with the findings of Omorrheren (2002), who carried out an investigation on the effect of guided discovery and traditional methods on the achievement of students in senior secondary school chemistry in Cross River State and found out that the guided discovery method was effective in enhancing the achievement of students in chemistry than the traditional method. The result also agreed with the finding of Archibong (1997) who conducted a study on the relativeness of activity-based approach and lecture method on the cognitive achievement of integrated science students in Edo State, and discovered that students taught with activity-based approach performed better than those taught with lecture method. The result also agrees with the findings of Akanmu and Fajemidagba (2013) who conducted a study on guided discovery learning strategy and senior school students' performance in the mathematics in Erigbo. The findings revealed a significant difference in favour of those exposed to guided discovery method. The finding is also in agreement with the findings of Effiong (2010) who carried out a study on the effects of guided discovery, on students' performance in chemistry and

discovered that students taught with guided discovery method performed better than those taught with expository instruction method.

Table 4.2.2 showed that among students taught ecology using guided discovery method, male students performed better than their female counterparts. The results supported the findings of Yaki (2011) who conducted a study on the effects of computer animation and guided discovery on secondary school students learning outcome in ecological concepts and reported that male students performed better than their female counterparts.

The findings of this study is also contrary to the findings of Olufunmilayo (2010) in a study conducted a study on the effects of guided discovery and concept mapping teaching strategies on SSS students' chemistry achievement and reported that there is no difference in the performance of male and female students taught with guided discovery and concept mapping strategy.

Table 4.2.3 showed that among the students taught with guided discovery method, private school students performed better than the public school students in Ecology Achievement Test. This result agrees with the study of Afolabi (2005) on the comparison of private and public schools products performance in mathematics in Ilorin and discovered that private school students performed better than the public school students. The difference in the performance of public and private schools may be as a result of difference in the administrative principles of the public and private schools. No wonder, there is always movement of students from public to private schools, which may be as a result of private schools close monitoring of staff for effective result and better performance.

Table 4.3.1 showed that there exists a significant difference in the performance of students taught ecology using guided discovery method and those taught using lecture method. Therefore, the hypothesis that there is no significant difference in the performance of students taught ecology using guided discovery method and those taught using lecture method was rejected.

Table 4.3.2 showed that there exists a significant difference in the performance of male and female students taught ecology using guided discovery method and those taught using lecture method. Therefore the hypothesis that there is no significant difference in the performance of male and female students taught ecology using guided discovery was also rejected.

Table 4.3.3 showed that there exists a significant difference in the performance of public and private school students taught ecology using guided discovery. Therefore, the hypothesis that there is no significant difference in the performance of public and private school students taught ecology using guided discovery was also rejected.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDTIONS

5.1 Introduction

This study examined the effects of guided discovery on students' academic performance in ecology in Senior Secondary School students within Sokoto Metropolis. This chapter presents the summary of the work, the conclusion drawn and recommendations based on the findings of the study.

5.2 Summary

The study was conducted to investigate the effect of guided discovery on students' academic performance in ecology among Senior Secondary School Students within Sokoto Metropolis. The study focused on SSI students of eight (8) selected Secondary Schools. Three research objectives were raised which were translated to three null hypotheses. Relevant literatures were reviewed on theoretical framework of guided discovery, concept of guided discovery, processes of guided discovery, concept of ecology, concept of ecology and learning, traditional teaching method and review of empirical studies.

Quasi experimental design was employed for this study. Stratified Random sampling technique was adapted to obtain eight secondary Schools out of 43 Secondary Schools within the Metropolis and purposive sampling technique was employed to select intact classes from each sampled school. Two private, four state government schools and two federal governments owned schools were selected with one private school as experimental and the other as control, two government owned school as experimental and the other two as control. One federal government owned school as experimental and the

other one as control. An intact class was selected from each sampled schools. Four intact classes were used as experimental group and four intact classes were used as control group and a total of five hundred and twenty one (521) senior secondary school one (SS I) students were involved in the study. The instruments used for data collection were Ecology performance Test (EPT), lesson plans and teaching modules. Pearson Product Moment Correlation Coefficient was used to calculate the reliability of ecology performance test and an index 0.89 was obtained. The null hypotheses were tested using T-test technique. The research questions were answered using descriptive statistics. The results indicated that all the null hypotheses were rejected.

5.3 Conclusion

The findings of the study have shown that there is significant difference between the academic performance of students taught ecology using guided discovery and those taught using traditional method. It was also discovered that the male students in experimental group performed better than the female students in the same group and also private school students taught ecology using guided discovery performed better than the public school students taught ecology with the same method. Therefore, contrary to traditional method, guided discovery method help students to be responsible in self-learning and it is an appropriate method for teaching ecology since students are actively involved in teaching-learning process.

5.4 Implications of the Study

The findings from this study suggested that guided discovery method can improve students' performance in ecology. The implications of the study could be stated as follows:

1. According to the results obtained from Ecology performance Test, students demonstrated a high degree of Performance when guided discovery method was used to teach them. Therefore, the use of guided discovery method in ecology instruction could enhance understanding of the subject
2. Biology teachers would be motivated to teach ecology well and also learners would be motivated to learn better as they interact with materials, if guided discovery method is adopted as medium of instructions.
3. The use of guided discovery teaching strategy will not only improve academic performance but provide opportunity for students to engage in critical thinking and problem solving, as well as stimulate their desire to learn

5.5 Recommendations

The following recommendations were made based on the findings of this study.

1. Since guided discovery method has been found to improve students' academic performance, there is need for in service training of biology teachers to be exposed to the use of guided discovery method in teaching ecology and other biological concepts.
2. Teachers in public and private schools should be encouraged by the government and their proprietors to learn how to use guided discovery method in teaching not

only ecology but other areas in biology. They should also provide conducive environment for effective teaching and learning to take place.

3. Biology teachers should encourage female students to be active and participate in the classroom like their male counterparts

5.6 Limitations of the Study

1. The Ecology Performance Test has only 20 multiple choice items. A more detailed instrument may yield a better finding
2. Inability of the researcher to give pre-test to determine group equivalence of the experimental and control groups is another limitation of the study.

5.7 Suggestions for Further Research

The following suggestions were made for further research:

1. Studies of this nature should be conducted on other content areas of school Biology especially difficult concepts like genetics and evolution.
2. Studies of this nature should be conducted using larger samples and a different geographical area
3. Studies of this nature should be conducted using other variables like ability level and retention.

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Appendix I

ECOLOGY PERFORMANCE TEST (EPT)

Instructions: Answer all questions by ticking the correct option from A - D

1. Population is defined as:
   a) Number of individual organism per unit area
   b) Progressive series of changes over a period of time in human community
   c) Total number of organisms of the same species living together in a given period of time
   d) Total number of different species of community living in an environment in a given period of time.

2. Which of the following soil types has the highest water holding capacity
   a) Sandy soil
   b) Loamy soil
   c) Clay soil
   d) Humus soil

3. The number of particular organisms in relation to a unit area is
   a) Population growth
   b) Population size
   c) Population density
   d) Population cover

4. The soil type with the highest degree of porosity is
   a) Clay soil
   b) Loamy soil
   c) Humus soil
   d) Sandy soil

5. The following are types of soil except
   a. Sandy soil
   b. Stony soil
   c. Loamy soil
   d. Clay soil

6. Which of the following terms refers to a dwelling place of an organism
   a) Habitat
   b) Niche
   c) Biosphere
   d) Ecosystem

7. The following are types of terrestrial habitat except
   a) Arboreal
   b) Ground
   c) Underground
   d) Ocean

8. The organisms that live on trees are referred to as
   a) Ground organisms
   b) Underground organisms
   c) Sea organisms
   d) Arboreal organisms

9. Which of the following organisms is a primary producer
   a). Dog b). Sheep c). Grass d). Fungus

10. A self sustaining unit produced by an interaction between biotic and abiotic component is best described as
    a) Community
    b) Habitat
    c) Ecosystem
    d) Niche

11. Which of the following is not a biotic factor
    a) Parasite
    b) Predators
    c) Grazers
    d) Pressure

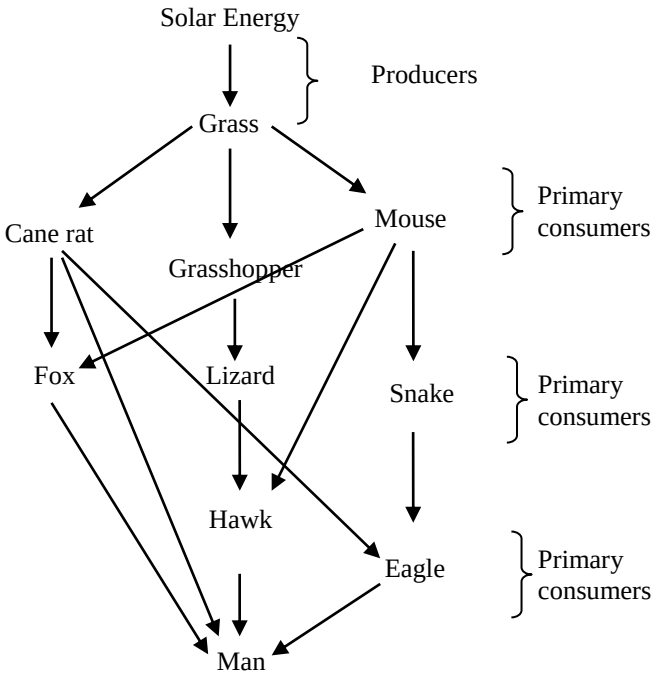
12. In an ecosystem the organism which changes light into stored chemical energy is the
    a) Consumer
    b) Producer
    c) Decomposer
    d) Carnivore

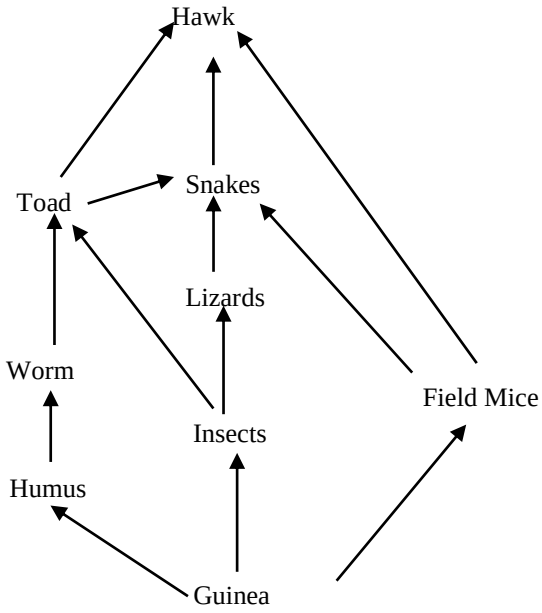
13. The linear feeding relationship between organisms is called
    a) Food web
    b) Food level
    c) Food chain
    d) Production level

14. Each stage in a food chain is referred to as
    a) Food level
    b) Trophic level
    c) Pyramid of number
    d) Production level

15. The decreasing number of individual from one trophic level to another is called
    a) Interaction
    b) Pyramid level
    c) Food web
    d) Pyramid of number

Use the diagrams below to answer questions 16 & 17





16. The above diagram represent
    a) Food chain
    b) Ecosystem
    c) Food web
    d) Feeding relationship

17. Which of the following animals in the diagram above is not a primary consumer
    a) Snake
    b) Insect
    c) Toad
    d) Field mice

18. The factors that lead to increase in population include all the following except
    a) Natality
    b) Mortality
    c) Immigration
    d) Food availability

19. The ultimate source of energy for all living organisms in an habitat is
    a) Sunlight
    b) Green plant
    c) Decomposers
    d) Micro organisms

20. Soil factor is referred to as
    a) Biotic
    b) Edaphic
    c) Climatic
    d) Topographic

Ecology Performance Test (EPT) Marking Scheme

1.	C	1 mark
2.	C	1 mark
3.	C	1 mark
4.	D	1 mark
5.	B	1 mark
6.	A	1 mark
7.	D	1 mark
8.	D	1 mark
9.	C	1 mark
10.	C	1 mark
11.	D	1 mark
12.	B	1 mark
13.	C	1 mark
14.	B	1 mark
15.	D	1 mark
16.	C	1 mark
17.	A	1 mark
18.	B	1 mark
19.	A	1 mark
20.	B	1 mark

TOTAL MARKS **20 Marks**

Appendix II

TEACHING MODULES ON ECOLOGY

1. MODULE ONE

a. Definition of population

b. Definition of census

c. Characteristic features of a population

ACTIVITIES

- Conducting population studies using quadrat
- Conducting population studies by Capture Recapture Method

2. MODULE TWO

a. Definition of soil

b. Types of soil

c. Soil composition

d. Characteristics of soil

ACTIVITIES

- Experiment to determine the weight of water in a soil sample
- Experiment to show that soil contains different sizes of particles
- Experiment to compare the porosity and water holding capacity of different soil types.

a. MODULE THREE

a. Ecological instruments and their uses

b. Thermometer

c. Hygrometer

d. Barometer

e. Sweep net

f. Rain gauge

g. Wind vane

h. Secchi disc

Appendix III

Teaching Modules

1. Ecosystem
    a. Definition of ecosystem
    b. Components of ecosystem
    c. Relationship among living organism in an ecosystem
2. Food chain/Food web
    a. Definition
    b**.** Components of food chain/web
    c. Role of producers in food chain
    d. Trophic level
3. Habitat
    a. Definition of habitat
    b. Types of habitat
    c. Characteristics of habitat
4. Population
    a. Definition of population
    b. Population size
    c. Population density
    d. Factors affecting population
5. Soil
    a. Definition of soil
    b. Types of soil
    c. Composition of soil
    d. Characteristics of soil
    e. Experiment to show that soil contains different size of particles
    f. Experiment to compare the porosity and water holding capacity of different soil

Appendix IV

EXPERIMENTAL GROUP 1

Subject: Biology

Topic: Ecology

Subtopic: Ecosystem

Duration: 80 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: An Aquarium

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

i. Define ecosystem
ii. Identify and list the component of ecosystem
iii. Explain relationship among living organism in an ecosystem.

Entry Behaviour: The students have learned the preliminary aspect of ecology concept.

Introduction: The teacher introduces the lesson by asking the students what kind of relationship exists between them and their environment.

Presentation:

Step I: The teacher writes the meaning of ecosystem on the chalk board.

Step II: The teacher will have four stations (aquarium sandwich) setup for students to visit in small groups. Each group will decide whether or not each station is an ecosystem.

Step III: The teacher asks the students what part of the system is biotic and abiotic. The teacher instructs the students to discuss whether or not the station fits the definition of an ecosystem.

Step IV: The teacher instructs the students to observe a working aquarium and list the entire element in the aquarium.

Step V: The teacher guides the students to write the different types of interaction that might occur between the organisms in the ecosystem and the non living part of the environment.

Step VI: The students discuss their findings with the class.

Summary: The teacher summarizes the lesson by defining an ecosystem as the basic functioning unit of nature. It comprises a group of interrelating living organisms, non-living organisms and their environment.

Evaluation: The teacher evaluates the lesson by asking the students the following questions like which of the following is a producer.
a). Fungus b). Dog c) Sheep d) Grass

CONTROL GROUP 1

Subject: Biology

Topic: Ecology

Subtopic: Ecosystem

Duration: 80 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: A chart of an ecosystem

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

iv. Define ecosystem

v. Identify and list the component of ecosystem

vi. Explain relationship among living organism in an ecosystem.

Entry Behaviour: The students have learned the preliminary aspect of ecology concept.

Introduction: The teacher introduces the lesson by asking the students to define ecosystem as the basic functional units of nature that comprises that comprises group of interrelating living organisms, non-living organisms and their environment.

Presentation:

Step I: The teacher gives examples of interrelating living organisms and their non-living environment; that in aquatic environment the fish absorbs oxygen dissolved in water through the gills and gives back carbon dioxide into the water. In terrestrial environment animals breadth in oxygen and gives out carbon dioxide which in turn taken in by plants during photosynthesis and oxygen is released as by product for animals to take in.

Step II: The teacher explains the components of ecosystem which is generally classified into: biotic or living and abiotic or non-living the biotic are classified into three kinds known as producers, consumers and decomposers all things in an ecosystem forms a community.

Step III: The teacher explains to the students that producers are green plants which make their food through the process of photosynthesis they are also called autotrophs.

Step IV: The teacher explains to the students that consumers are animals which feed in plants and other animals. Consumers are divided into primary, secondary and tertiary consumers.

Step V: The teacher explains decomposers; organism that feed on read producers and consumers. The importance of decomposers is to breakdown dead organic water and release simple chemical compounds which plants can absorb and use again. The teacher explains interaction between living organism and the non-living things of the ecosystem.

Evaluation: The teacher evaluates the student by asking the following questions:

1. Which of the following is not an abiotic factor

a) Parasite b) Predators c) Grazers d) Pressure

2. In an ecosystem the organism which changes light into stored chemical energy is the

a) Consumer b) Decomposer c) Producer d) Carnivore

EXPERIMENTAL GROUP 2

Subject: Biology

Topic: Ecology

Subtopic: Food Chain/ Food Web

Duration: 80 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Charts of food web and food chain

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

i. Define food chain and food web
ii. Identify and list the components of food chain and food web
iii. Explain the role of producer in a food chain

Entry Behaviour: The students have learned about ecosystem in their previous lesson.

Introduction: The teacher introduces the lesson by asking the students what is an ecosystem.

Presentation:

Step I: The teacher provide the students with a chart containing the sun, green grass, rat and cat and ask the students to give the reasons why they think these four things would be placed together and what they have in common.

Step II: The teacher provide charts of food chain to students and ask them what it is? What is a primary producer and what animals are in each of the categories?

Step III: The teacher draw a "connection web" on the board (The animal such as mouse) start by writing the names of the animals on the board and circling it and also the teacher asks students to name things that are connected to the animal (Interaction with other organism as food shelter). Draw lines to the other factors until the web is very complex. Point out that the web has abiotic and biotic factors.

Step IV: The teacher asks the students to make a list of different organisms. The students are then guided by the teacher to form a feeding relationship with

the listed organisms. The teacher asked the students to discuss the feedings with the entire class.

Step V: The teacher guides the students to understand that each step in the feeding relationship is called the tropic level.

Evaluation: The teacher evaluates the lesson by asking the students questions based on the topic.

CONTROL GROUP 2

Subject: Biology

Topic: Ecology

Subtopic: Food Chain/ Food Web

Duration: 80 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: Charts of food web and food chain

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

i. Define food chain and food web
ii. Identify and list the components of food chain and food web
iii. Explain the role of producer in a food chain

Entry Behaviour: The students have learned about ecosystem in their previous lesson.

Introduction: The teacher introduces the lesson by asking the students as:

In an ecosystem the organism which changes light into stored chemical energy is the (a) Consumer (b) Decomposers (c) Producer (d) Carnivore

Presentation:

Step I: The teacher begins by defining a food chain; as a linear feeding relationship among organism in the same community. A food chain can be represented as follows:

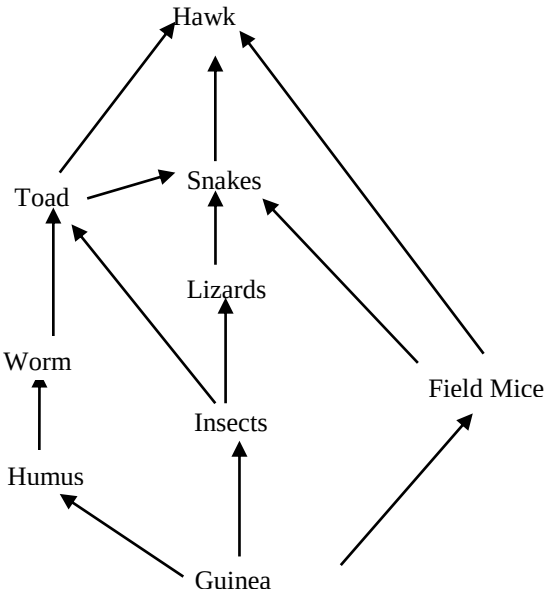
Guinea grass → Grass hopper → Toad → Snake →hawk

Humus → Earthworm → Domestic Fowl → Man

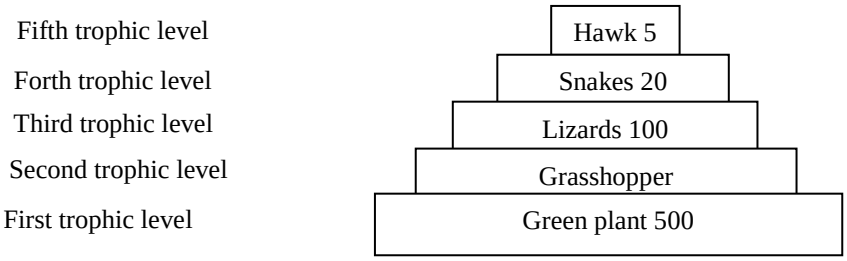
In an aquatic habitat a food chain is represented as follows

Diatoms → Mosquito larvae → Tilapia fish → Whale

Step II: The teacher defines food web as a complex feeding relationship consisting of interrelated food chain.



Step III: The teacher explains pyramid of number as the decreasing number of individuals from one trophic level to another in a food chain is called pyramid of numbers. The number of green plants are more than the grasshoppers the number keep decreasing up to last trophic level.



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

Define the following terms:

i. Food chain

ii. Food web

iii. Trophic level.

.

EXPERIMENT GROUP 3

Subject: Biology

Topic: Ecology

Subtopic: Habitant

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Charts, Diagrams of habitats

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

i. Mention the meaning of habitat
ii. Identify their own habitat
iii. Identify different organisms and their habitats
iv. Mention the types of habitats

Entry Behaviour: Students have idea about the place they live e.g. home

Introduction: The teacher introduces the lesson by asking the students questions on their previous lesson. E.g. where do animals find the food they eat? From the student response, the teacher mentions the places where foods are found e.g (environment)

Presentation:

Step I: The teacher ask the students to mention where they live from the students response, the teacher now mentions that the dwelling place of an organism is known as habitat. Therefore, where the students and other animals live is referred to as Habitats.

Step II: The teacher groups the students and guides them to identify and write their individual habitats and then make a list of different organisms and where they live.

Step III: The teacher goes round the classroom to see what the students are listing, then from the students list, the teacher ask the students to mention those organisms that live on land and those that live in water. The teacher then tells the students that water habitat and land habitat is known as Terrestrial Habitats.

Step IV: The teacher asks the students to list the characteristics of the habitats after giving them are e.g. salinity

Evaluation: The teacher evaluates the students by asking them the following questions.

1. Define habitat
2. List the types of habitat and mention organism common to each listed habitat.
3. Mention two (2) characteristics common to each listed habitat.

Summary: The Teacher summarizes the lesson by briefing them the lesson taught.

CONTROL GROUP 3

Subject: Biology

Topic: Ecology

Subtopic: Habitant

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: Charts

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

i. Mention the meaning of habitat
ii. Identify their own habitat
iii. Identify different organisms and their habitats
iv. Mention the types of habitats

Entry Behaviour: Students have idea about the place they live e.g. home

Introduction: The teacher introduces the lesson by asking the students questions on their previous lesson. E.g. where do animals find the food they eat?

Presentation:

Step I: The teacher defines the term habitat as the dwelling place of an organism.

Step II: The teacher explains to the student that habitat is classified into two (2) main groups namely:

1. Aquatic (water) habitat
2. Terrestrial (land) habitat

Step III: The teacher gives example of organisms that live in water as; fish, frog, toad, crabs etc and the organisms that lives on land as: man, goat, lizard, dog etc.

Evaluation: The teacher evaluates the students by asking them the following questions.

1. Define habitat
2. List the types of habitat
3. Give examples of organisms that lives on both aquatic and terrestrial habitat.

EXPERIMENT GROUP 4

Subject: Biology

Topic: Ecology

Subtopic: Habitant

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Charts, pictures and Diagrams showing different habitat.

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

i. Classify Terrestrial and Aquatic habitat into various sub-classes or groups.
ii. List some organisms found in each sub-group of the habitats.
iii. Identify those groups of habitat using some features.

Entry Behaviour: Students have learnt the two major types of habitats.

Introduction: The teacher ask the student to mention the two (2) classes of habitat

Presentation:

Step I: The teacher ask the students to list ten (10) organisms each of terrestrial and aquatic habitats.

Step II: The teacher guides the student to identify from their list, the organism that live in land and tree.

Step III: The teacher guides the student to identify the organisms that lives on trees, ground and underground.

Step IV: The teacher leads the students to knowing that those organisms that live on trees are called arboreal organisms.

Step V: The teacher guides the student to classify those organisms listed by them under aquatic habitats into:-

a. Fresh water habitat
b. Marine habitat
c. Estuarine habitat

Evaluation: The teacher evaluates the students by asking them the following questions.

a. Mention the classification of terrestrial habitat and two (2) examples of organisms found in each habitat.
b. List the various classification of aquatic habitat.

CONTROL GROUP 4

Subject: Biology

Topic: Ecology

Subtopic: Habitant

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: Charts

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

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

i. Classify terrestrial and Aquatic habitat into various sub-classes or groups
ii. List some organisms found in each sub group of the habitat.
iii. Identify those groups of habitat using some features.

Entry Behaviour: Students have learnt the two (2) major types of habitats.

Introduction: The teacher ask the students to mention the two (2) classes of habitats

Presentation:

Step I: The teacher explains to the student that aquatic habitat could be classify into various groups depending on the salinity of the water. The habitat includes: fresh water, marine, and estuarine habitat.

Step II: The teacher gives examples of habitat as follows:-

1. Fresh water e.g. Tadpole, Tilapia etc
2. Marine e.g. sharks, Wales etc
3. Estuarine e.g. crabs, fish etc.

Step III: The teacher explains the characteristics of fresh, marine and estuarine habitats to the students.

Evaluation: The teacher evaluates the students by asking them the following questions.

1. Mention the classification of terrestrial habitat and two (2) examples of organisms that are found in each habitats.
2. List the various classification of aquatic habitat

EXPERIMENT GROUP 5

Subject: Biology

Topic: Ecology

Subtopic: Population Studies

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Charts, Textbooks and Diagrams.

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

1. Define population
2. Describe the size of a given population
3. Identify the dominant organism found in a given population.

Entry Behaviour: Students are aware of changes in population of their family members.

Introduction: The teacher asks the student to mention the number of their family members.

Presentation:

Step I: The teacher groups the students and distributes the charts showing different population to each group.

Step II: The teacher guides the student to compare the charts from their group and discuss the difference they observed in the charts.

Step III: The teacher guides the student to define population and describe population size using the charts.

Step IV: The teacher asks the students to identify those organisms that appear most from the chart.

From the students response the teacher inform the student that those organism appear most from the chart are known as dominant organisms.

Evaluation: The teacher evaluates the lesson by asking following questions.

1. What is population?
2. Describe population size
3. Describe a dominant organism in a particular population.

CONTROL GROUP 5

Subject: Biology

Topic: Ecology

Subtopic: Population Studies

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: Charts, Textbooks and Diagrams.

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

1. Define population
2. Describe the size of a given population
3. Identify the dominant organism found in a given population.

Entry Behaviour: Students are aware of changes in population of their family members.

Introduction: The teacher introduces the lesson by asking the student to mention the number of their family members.

Presentation:

Step I: The teacher defines population as the total number of organisms of the same species living together in a given area.

Step II: The teacher defines population size and population density as:

Population size: This indicates how large the total number of individuals in a population is. Thus, it can be said that Nigeria has a human population of 88 million people.

Population Density: this is the number of organisms per unit area.

Step III: The teacher explains to the students that those species that have a major controlling influence on the nature of the community is said to be Dominant.

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

Define the following terms

a. Population
b. Population size
c. Population density
d. Dominance

EXPERIMENTAL GROUP 6

Subject: Biology

Topic: Ecology

Subtopic: Population density and factors affecting population

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Charts, Maps and Diagrams.

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

1. Define population Density
2. Mention the factors that affect population.

Entry Behaviour: Students have learnt about population and population size.

Introduction: The teacher asks the student to define population and population size

Presentation:

Step I: The teacher groups the students and asks them to observe the charts and discuss the features of their charts.

Step II: The teacher guides the student to define population density using the response from the students.

Step III: The teacher guides the students to identify some factors that affect population using the charts from the student responses, the teacher guides the students that population density: is defined as *the number of individual species per unit area.* Also the teacher guides the students to classify factors affecting population as:

1. Dependant factor
2. Independent factor
3. Others such as
   a. Emigration
   b. Immigration
   c. Migration

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

1. Define population Density
2. Mention the factors that affect population

CONTROL GROUP 6

Subject: Biology

Topic: Ecology

Subtopic: Population density and factors affecting population

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: Charts, Maps and Diagrams.

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

1. Define population Density
2. List and describe the factors affecting population.

Entry Behaviour: The Students have learnt about population and population size.

Introduction: The teacher introduces the lesson by asking the student to define population and population size

Presentation:

Step I: The teacher defines population density as the density of a species as the number of individual of that species which are found per unit area.

Step II: The teacher lists the factors that affect population as

1. Natality (Birth rate) 2. Mortality (death rate) 3.Immigration 4.Emigration 5. Availability of food 6. Seasonal Climatic change 7.Breeding period 8. Natural Disaster e.g. fire, drought and floods etc.

Step III: The teacher explains the factor as follows:

1. *Natality (Birth rate):* When a child is given birth to in a family, the population of that family increases.
2. *Mortality (death rate):* When a member of a family dies the population of that family decreases.
3. *Immigration (Dispersed):* When people or animals move away from a particular area so the population of that area will decrease.
4. *Availability of Food:* When food is available in a particular area, the population of that area increase but when there is shortage of food, the population decreases.

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

1. Define population Density
2. Mention the factors that affect population

EXPERIMENTAL GROUP 7

Subject: Biology

Topic: Ecology

Subtopic: Soil

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Soil sample, Cylinder.

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

1. Define Soil
2. Mention the types of soil
3. Mention the soil compositions
4. State the characteristics of soil

Entry Behaviour: The students are already familiar with soils.

Introduction: The teacher and the student go round the school premises to take soil samples. The teacher guides the students concerning where to take the sample from.

Presentation:

Step I: The teacher ask the students where they got the soil from

Step II: From the student response, teacher guides the student to define soil as the upper most layer of the earth surface.

Step III: Students are called in turns to identify the different soil types and mention the component of each under the guidance of the teacher the characteristics of the soil retrieved.

Step IV: The teacher asks the students to mention the characteristics of the soil. The teacher supervises them against mistake and corrects them where necessary with suitable explanation.

Summary: The teacher summarizes briefly by defining soil as the upper most layer of the earth surface. It is of three (3) types i.e. Sandy, Loamy, and Clay soil.
Sandy Soil: It has low water retaining capacity. It has layer particles.
Loamy Soil: it has moderate water holding capacity. It is a good soil for cultivation.
Clay Soil: It has high water holding capacity. It has fine particle.

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

1. Define soil
2. What are the three types of soil? and
3. Mention two characteristics of each

CONTROL GROUP 7

Subject: Biology

Topic: Ecology

Subtopic: Soil

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material:

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

1. Define Soil
2. Mention the types of soil
3. Mention the soil compositions
4. State the characteristics of soil

Entry Behaviour: The students are already familiar with soil.

Introduction: The teacher introduces the lesson by asking the students questions on the previous lesson.

Presentation:

Step I: The teacher defines soil as the uppermost layer from most layer of the earth crust which provides support and nutrients for plant growth and animals.

Step II: The teacher explain to the students that there are three (3) types of soil namely (1)Sandy (2)Loamy, and (3) Clay soil.

Step III: The teacher mentions the soil composition as organic matter, micro-organisms, water, mineral matter and living organisms.

Step IV: The teacher explains to the students that the common soil characteristics are

1. Soil Colour
2. Soil Texture
3. Soil Structure
4. Soil Constituents

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

1. Define soil
2. Mention the types of soil
3. State the soil composition

EXPERIMENTAL GROUP 8

Subject: Biology

Topic: Ecology

Subtopic: Soil

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Soil sample, Cylinder, funnel, cotton wool and water.

Behavioural Objectives: At the end of the lesson, the student should be able to conduct an experiment showing that soil contains different sizes of particles.

Entry Behaviour: The students have learned about soil types and characteristics.

Introduction: The teacher asks the students question from the previous lesson e.g. what is soil and what are types of soil.

Presentation:

Step I: Teacher group the students and provide instructional materials to each group

Step II: Teacher writes down the procedures of the experiment on the board as follows:

i. Put some quantity of soil sample into a graduated cylinder.
ii. Add sufficient water to its to cover the soil sample
iii. Add some hydrogen peroxide to quicken the dispersion of soil particles.
iv. Cover the open and of the cylinder with your palm and shake well for few minutes
v. Place the cylinder on the table to allow the content to settle

Step III: Student conducts the experiment under the guidance of the teachers.

Step IV: The teacher asks each group to make their observations on the experiment and discuss with the rest of the class.

Step V: The teacher discusses with students that when the soil settles in water. The larger and heavier particles settle first. Light organic matter float on top of the water surface. Thus, shows that soil is a mixture of different sizes of

particles.

Evaluation: The teacher evaluates the lesson by asking the students to mention the procedure for conducting an experiment to show that the soil contains different sizes of particles.

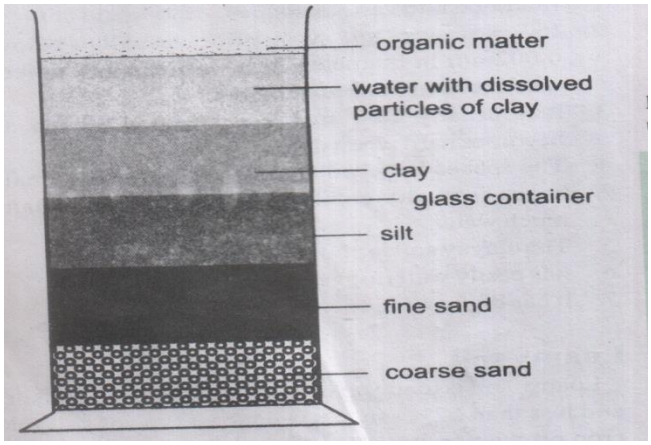


Fig. 2: Experiment to show that soil contain different sizes of particles

CONTROL GROUP 8

Subject: Biology

Topic: Ecology

Subtopic: Soil

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material:

Behavioural Objectives: At the end of the lesson, the students should be to mention the procedures for conducting an experiment to show that soil contains different sizes of particles.

Entry Behaviour: The students have learned about soil types and characteristics.

Introduction: The teacher introduces the lesson by asking the students question from the previous lesson

Presentation:

Step I: The teacher explains the method of conducting the experiment to show that coil contains different sizes of particle as follows:

i. Some quantity of soil sample is put into a graduated cylinder.
ii. Sufficient water is added to cover the soil sample
iii. Some sodium carbonate or hydrogen peroxide is added to quicken the dispersion of soil particles.
iv. The open end of the cylinder is to be covered with the palm and shaken well for few minutes
v. The cylinder is then placed on a table for few minutes to allow the content to settle

Step II: The teacher explains the expected result as follows, the content settles in layers.

1. The larger and heavier particles settle first i.e. coarse sand, fine sand, silts and clay.
2. Light organic matter float on top of water surface

Step III: The teacher explain to the students that soil is a mixture of different sizes of particles.

Evaluation: The teacher evaluates the lesson by asking the students to mention the procedure for conducting an experiment to show that the soil contains different sizes of particles.

EXPERIMENTAL GROUP 9

Subject: Biology

Topic: Ecology

Subtopic: Soil

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Guided Discovery Method

Instructional Material: Soil sample, Measuring Cylinder, funnel, cotton wool and water.

Behavioural Objectives: At the end of the lesson, the students should be able to conduct an experiment to compare the porosity and water holding capacity of different soil types.

Entry Behaviour: The students have learned how to conduct an experiment to show that soil contains different sizes of particles.

Introduction: The teacher asks the students question on the previous lesson e.g. what are the procedures for conducting an experiment to show that soil contains different sizes of particles.

Presentation:

Step I: The teacher groups the students and provides instructional materials to each group

Step II: Teacher writes down the procedures of the experiment on the board as follows:

i. Setup three graduating cylinder with funnel in each
ii. Plug the neck of the filter funnel with cotton wool and put equal weight of soil samples into each of them.
iii. Pour equal volume of water into each sample at the same time using a stop watch and record the volume of water collected by each cylinder and the time taken for the water to drain after no more water drains through each of the tunnel.

Step III: Student conducts the experiment under the guidance of the teachers.

Step IV: The teacher asks each group to make their observations on the experiment and discuss with the other groups.

Summary: The teacher summarizes the lesson by guiding the students into knowing

that clay soil retains more water than other soil and therefore, the porosity is low, sandy soil retains less water and therefore, has the highest water retaining capacity.

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

i. Which of the soil types is more porous?

ii. Which of the soil types has the highest water retaining capacity?

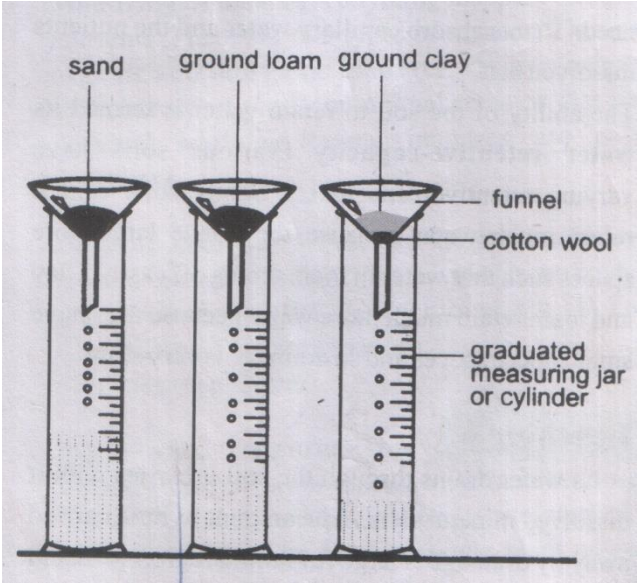


Fig. 3: Experiment to compare porosity and water holding capacity of different soil types.

CONTROL GROUP 9

Subject: Biology

Topic: Ecology

Subtopic: Soil

Duration: 40 minutes

Age: 15 – 17 years

Methods of Teaching: Lecture Method

Instructional Material: Soil sample, Measuring Cylinder, funnel, cotton wool and water.

Behavioural Objectives: At the end of the lesson the students should be able to mention the procedure conducting an experiment to compare the porosity and water holding capacity of different soil types.

Entry Behaviour: The students have learned the procedures of conducting a soil experiment.

Introduction: The teacher asks the students question on the previous lesson

Presentation:

Step I: The teacher defines porosity as the pores spaces of the soil. Pores spaces are those portion of soil occupied by water and air.

Step II: The teacher explains the method of conducting the experiment as follows:

i. Plug the neck of the filter funnel with cotton wool and put equal weight of soil samples into each of them.

ii. Pour equal volume of water into each soil sample and recorded the volume of water collected by each cylinder after no more water drains through each of the funnel.

Step III: The teacher explains the expected result of the experiment as follows: it will be observed that clay retains most of its water while more volume of water is collected in the measuring cylinder carrying the sandy soil. This shows that clay retains more water than the two others. While loamy soil retains more water than the sandy soil.

Step IV: The teacher explains that sandy soil is more porous than loamy soil and loamy is more porous than clay.

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

i. Which of the soil types is more porous?

ii. Which of the soil types has the highest water retaining capacity?

Appendix V

Table 3.3: List of Secondary Schools in Sokoto Metropolis

S/NO	Name of School	Sex	School Type	Population of SSII
I	Abdulrasheed Adisa Raji Special School, Sokoto.	Mixed	Public	317
2	Army Day Secondary School, Sokoto.	Mixed	Public	493
3	Ahmadu Bello Academy, Sokoto,	Boys	Public	375
4	Alheri Secondary School, Sokoto	Mixed	private	129
5	Bassman Secondary School, Sokoto	mixed	private	135
6	Blue Crescent Secondary School, Sokoto	Mixed	private	132
7	C.O.E Secondary School, Sokoto	Mixed	Public	225
8	F.G.C, Sokoto	Mixed	Public	342
9	F.S.C. Sokoto	Mixed	Public	326
10	Government Technical College, Farfaru.	Boys	Public	417
11	Government Technical College, R/Sambo	Boys	Public	423
12	Government Girls College, Sokoto.	Girls	Public	350
13	Government Day Secondary School, Mabera	Mixed	Public	388
14	Giginya Memorial Secondary School, Sokoto	boys	Public	388
15.	Government Day Secondary School, Tudun wada	Boys	Public	576
16	Government Secondary School, Kofar Marke, Sokoto	Mixed	Public	332
17	Government Day Secondary School, Arkilla	Mixed	Public	414

18	Government Secondary School, Runjin Sambo	Mixed	Public	334
19	Government Day Secondary School More,Sokoto	Mixed	Public	315
20	Government Day Secondary School ,Dundaye, Sokoto	mixed	Public	318
21	Hafsatu Ahmadu Bello Secondary School, Sokoto	Girls	Public	480
22	I.C.E Secondary School, Sokoto	mixed	private	118
23	Iman International School, Sokoto	Mixed	private	213
24	Marshal Institute of Commerce	Mixed	private	132
25	Nana Girls Secondary School, Sokoto	Girls	Public	430
26	Nagarta College, Sokoto	Boys	Public	478
27	Nana Asma'u Islamic Secondary School, Sokoto	Mixed	Private	315
28	Royal Comprehensive School, sokoto	mixed	Private	120
29	Rozel Secondary School, Sokoto	Mixed	private	113
30	Sultan Bello Secondary School,Sokoto	Boys	Public	313
31	Success Secondary School. Sokoto.	Mixed	Public	128
32	Sultan Attahiru Secondary School,Sokoto	Boys	Public	350
33	Sultan Abubakar Secondary School,Sokoto	Boys	Public	338
34	Sultan Maccido Quranic Institutes , Sokoto	Boys	Public	330
35	Sultan Atiku Secondary School, Sokoto	Boys	Public	325
36	Sheikh Abubakar Gummi Secondary School, Sokoto	Boys	Public	330
37	Sokoto Teachers College, Sokoto	Boys	Public	320
38	Sani Dingyadi Unity Secondary School, Sokoto	Boys	Public	380

39	Total Child Secondary School, Sokoto	mixed	Private	120
40	Unity comprehensive School, Sokoto	Mixed	Private	211
41	Usmanu Danfodiyo University Model Secondary School, Sokoto	Mixed	Public	305
42	Women Center For Continuing Education, Sokoto	Girls	Public	352
43	1st Baptist Secondary School, sokoto	Mixed	Private	115
	Total			13,045

Source: Ministry of Education Sokoto, 2013.

Appendix VI

Reliability Index

Pre-test X	Post-test Y	XY	X^2	Y^2
14	17	238	196	289
14	18	252	196	324
19	20	380	361	400
8	14	112	64	196
7	13	91	49	169
9	16	144	81	256
12	17	204	144	289
15	20	300	225	400
14	17	238	196	289
9	15	135	81	225
8	14	112	64	196
11	17	192	121	289
8	13	104	64	169
7	11	27	49	121
13	15	195	169	225
12	15	180	144	225
6	10	60	36	100
10	16	160	100	256
9	13	117	81	169
8	13	104	64	169
213	**304**	**2390**	**2485**	**4756**

$$r = \frac{\sum_{XY} - \frac{\sum_X \sum_Y}{n}}{\sqrt{\left[\sum_{X^2} - \frac{\sum(X)^2}{n}\right]\left[\sum_{Y^2} - \frac{\sum(Y)^2}{n}\right]}}$$

Where $\sum X = 213, \sum Y = 304, \sum XY = 3390, \sum X^2 = 2485, \sum Y^2 = 4756 \quad n = 20$

$$= \frac{3390 - \frac{(213)(304)}{20}}{\sqrt{\left[2485 - \frac{(213)^2}{20}\right]\left[4756 - \frac{(304)^2}{20}\right]}}$$

$$= \frac{3390 - 3237.6}{\sqrt{[2485 - 2268.45][4756 - 4620.8]}}$$

$$= \frac{3390 - 3237.6}{\sqrt{[2485 - 2268.45][4756 - 4620.8]}}$$

$$= \frac{152.4}{\sqrt{[216.55][135.2]}}$$

$$= \frac{152.4}{\sqrt{[29277.56]}}$$

$$= \frac{152.4}{171.1068672} = \frac{152.4}{171.11}$$

r = 0.890671441

r = 0.89

APPENDIX VII

RESULT OUTPUT

T-Test

Group Statistics

	Var5	N	Mean	Std. Deviation	Std. Error Mean
Resp5	9.00	141	17.8865	2.28689	.19259
	10.00	117	16.6325	2.83937	.26250

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Resp5	Equal variances assumed	16.535	.000	3.929	256	.000	1.25405	.31916	.62554	1.88255
	Equal variances not assumed			3.852	221.352	.000	1.25405	.32557	.61243	1.89567

T-Test

Group Statistics

	variable	N	Mean	Std. Deviation	Std. Error Mean
Response	1.00	258	16.7171	3.21254	.20000
	2.00	263	11.1863	5.45204	.33619

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Response	Equal variances assumed	134.099	.000	14.073	519	.000	5.53074	.39301	4.75866	6.30283
	Equal variances not assumed			14.139	425.891	.000	5.53074	.39118	4.76186	6.29963

T-Test

Group Statistics

	Var4	N	Mean	Std. Deviation	Std. Error Mean
Resp4	7.00	61	18.6721	1.58872	.20342
	8.00	197	12.1371	5.27088	.37553

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Resp4	Equal variances assumed	113.547	.000	9.539	256	.000	6.53508	.68511	5.18591	7.88424
	Equal variances not assumed			15.301	255.919	.000	6.53508	.42709	5.69402	7.37613

Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
exp	258	10.00	20.00	16.7171	3.21254
cnt	263	2.00	20.00	11.1863	5.45204
male	141	12.00	20.00	17.8865	2.28689
fem	117	10.00	20.00	16.6325	2.83937
pri	61	13.00	20.00	18.6721	1.58872
pub	197	4.00	20.00	12.1371	5.27088
Valid N (listwise)	61				