

**IMPACT OF LABORATORY AND PROBLEM-SOLVING STRATEGIES ON  
ATTITUDE, RETENTION AND PERFORMANCE IN BIOLOGY AMONG  
VARIED ABILITY SECONDARY SCHOOL STUDENTS IN ZARIA, NIGERIA**

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**JANUARY, 2018**

## DECLARATION

I hereby declare that this thesis entitled “**Impact of Laboratory and Problem-Solving Strategies on Attitude and Performance in Biology among Varied Ability Secondary School Students in Zaria, Nigeria**” has been carried out by me, in the Department of Science Education, Faculty of Education, Ahmadu Bello University, Zaria under the supervision of Prof. S.S Bichi, Dr. S.S Obeka (Very Rev.), and Dr, F.K. Lawal. The information derived from the literature has been duly acknowledged in the text and lists of references provided. This thesis has not been previously presented for another degree in any university.

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**Date**

## CERTIFICATION

This thesis entitled **“Impact of Laboratory and Problem-Solving Strategies on Attitude and Performance in Biology among Varied Ability Secondary School Students in Zaria, Nigeria”** by Uchechukwu Maria OBOCHI(Ph.D/9373/2011-2012) meets the regulations governing the award of the Degree of Doctor of Philosophy in Science Education, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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## **DEDICATION**

This work is dedicated to my husband, Mr. Obochi, T. Chijioke, my children Kossy Sandra and Chinelo Favorand my mother Mrs. Cordelia Ibe for their prayers and moral support throughout the period of this study.

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## **LIST OF ABBREVIATIONS**

ADP:	Adenosine Diphosphate
ATP:	Adenosine Triphosphate
BASQ:	Biology Attitude Scale Questionnaire
BPT:	Biology Performance Test
CAI:	Computer Assisted Instruction
EASQ:	Ecology Attitude Scale Questionnaire
EPT:	Ecology Performance Test.
ERT:	Ecology Retention Test
FI:	Facility Index
NPE:	National Policy On Education
PoERT:	Posttest Ecology Retention Test
PPMCC:	Pearson Product –Moment Correlation Co-efficient
PrEPT:	Pretest Ecology Performance Test
PSI:	Problem Solving Inquiry
RMBT:	Researcher Made Biology Test

## **OPERATIONAL DEFINITION OF TERMS**

The following terms are operationally defined as used in this study.

**Impact:** the ability and readiness of the teacher to convey a meaningful learning experience and knowledge in a practical means to students effectively and confidently in such a way that they are able to understand the concepts that were taught.

**Lecture method:** method of teaching in which the teacher delivers the lesson to students with little or no active participation by the students. It is a teacher-centered approach involving largely a one –way form of communication from teacher to student. Lecture method most often does not give room for teacher-student interaction during instruction.

**Laboratory strategy:** describes a strategy that allows the learner to perform and carry out practical class by applying science process skill and exhibit scientific attitudes. It is an activity designed to be carried out by an individual or a group of students for the purpose of making personal observations and able to arrive at a logical conclusion by them.

**Problem-solving strategy:** a guide that motivates learners to find out solutions to existing problems by pulling together information and generalizing knowledge. This teaching method encourages “learning by doing” through cognitive and psychomotor domain.

**Attitude:** the predisposition to react positively or negatively towards objects, ideas, institution or people.

**Varied ability:** this is the ability level of individual student according to the cognitive and retention of learned concept. Varied ability can either be in higher, middle or lower performance/achievement.

## ABSTRACT

This study investigated the impact of Laboratory and problem-solving strategies on attitude, retention and academic performance in biology among varied ability secondary school students in Zaria, Kaduna State Nigeria. All the senior secondary II students of the schools in Zaria Educational Zone under study with total number of one thousand six hundred (1600) were the population for the study. Three out of the six co-educational SSII in the area with a total number of one hundred and eighty-five (185) i.e. (113 male and 72 female) students were selected as sample of the study using simple random sampling technique involving balloting method. Two schools formed the experimental groups that received treatments via laboratory and problem-solving strategies respectively, while the third school was used as the control group. High, average and low ability levels were determined using their class work and continuous assessment result and pre-test scores. The top 25% were ranked the high, middle 50% were the average while lower or bottom 25% were low ability group. The intact classes of the three schools were used so as to take care of the issue of gender. The experimental groups were taught using laboratory and problem-solving strategies while the control group was taught using lecture method. Two instruments were developed for this study i.e. Ecology Performance Test (EPT) and Student Attitude Questionnaire, (SAQ). These instruments were used for data collection. Five research questions and five null hypothesis were formulated and tested at 0.05 level of significance. The data collected were analyzed using t-test and Kruskal Wallis statistics to determine the significant difference of the three groups, at  $P < 0.05$ . The finding of the study showed that laboratory strategy had significant effects on the attitude and academic performance of the students of varied abilities. Low ability students that were taught ecology using problem-solving strategy improved in their academic performance and retained the learnt concepts better than those taught using lecture method. Neither male nor female in the two experimental groups performed significantly better than the other in biology after treatment. Based on the findings of the study, it is recommended that laboratory and problem-solving strategies should be used to teach ecology at secondary school level.

## CHAPTER ONE

### THE PROBLEM

#### 1.1 Introduction

Science (from Latin *Scientia* meaning knowledge) is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and knowledge that can be rationally explained and reliably applied to everyday life. A practitioner of science is known as a scientist (Thompson, 2006).

Science education, is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community (Borich, 2004). The field of science education includes work in science content, science process (scientific Skill) some social science and some teaching pedagogy (Yeung, 2006). The public image of science education may be one of the simple learning facts by rote science education. Recent history also generally concerned with treatment on the teaching of science concepts and addressing issues those learners may hold regarding science concepts or others influenced by constructive thinking (Borich, 2004). Bichi, (2008) stated that the purpose of education is not just making a learner literate, but adds rationale thinking, knowledge, skills, self-efficiency and self-independent. Thus, in every human society, education is meant to pass onto new generations the existing knowledge of their physical environment, to introduce them to the organization of the society and teach them skills for performing their daily jobs with ease.

Egbunonu and Ugbaja (2011), observed that, the education standards call for more than science as a process in which students learn such skills as observing, inferring, experimenting etc. Inquiry is central to science learning, when engaged in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge and communicate their ideas to others,

they identify their assumptions use critical and logical thinking and consider alternative explanations (Thomas, 2002., Yeung, 2006). In this way students actively develop their understanding of science, combining scientific knowledge with reasoning and thinking skills. To achieve these goals as desired, it is highly required of teachers at all levels to have high sense of self confidence for the enhancement of teaching and learning of scientific concepts and principles that can lead to positive scientific and technological development.

Biology is one of the core science subjects taught in Nigerian secondary schools. It is the backbone of science as it is the study of life and therefore plays an essential role in harnessing interaction between living things and its environment. Thompson (2006) observed that no science subject forms a binding force among various science courses like biochemistry, pharmacy, veterinary etc. as biology. It plays vital roles not only in economy but even in contemporary society and essential for continuing one's profession or to understanding one's personal affairs. Moreover, the increase in student enrollment in the universities and the rapid development in science and scientific techniques have to be taken into consideration. This situation is creating a greater impetus for teaching reform in order to improve the quality of higher education. However, Ecology is one of the branches of biology that deals with the study of interrelationship among plants, animals and their non-living environment. According to Ige (2001), ecology provides knowledge and understanding of the mechanism of change brought about by the interaction of the living things and its effects on their external environment.

Biology gives students the opportunity to relate with some of the most important ecological issues affecting the environment. These include the influence of human activity in altering human ecological relationship and difficulties arising from the stress of modern day life. In secondary school biology curriculum, it was observed that ecological

concepts play very important role in scientific advancement that affects the lives of mankind. Despite its importance in the society, available statistics from the West African Examination Council (WAEC 2009, 2010, 2011, 2012, 2013, 2014, 2015 and 2016) on senior secondary school students' academic performance in biology revealed that although biology had the highest enrolment relative to other science subjects, it recorded very poor performance at senior School Certificate Examination (Anyanwu, Obochi and Isa 2015).

According to Nwagbo andChukelu (2011), the poor performance as attributed to ecological concept with evidence from Chief Examiners Report was traced to one of the ecological questions asked in WAEC 2008. The students were asked to state five important uses of water to organism in the rainforest. The Chief Examiners Report shows that in stating uses of water to rainforest organisms, most students wrote on the uses of water to man example "drinking, washing and cooking", rather than maintaining body temperature, essential for plant turgidity, necessary for photosynthesis etc. In 2007 WAEC question, students were asked to describe three ways each by which animals in arid habitat are adapted to drought and high temperature. The examiner's report shows that students could not attempt the questions. Nwagbo and Chukelu (2011).

Also in 2013, students were asked to list and explain uses of five ecological instruments/tools that can be used in population studies. The chief examiners report also showed that the students could not respond to these questions satisfactorily.

The senior secondary school biology curriculum is designed to serve the needs and interest of the students of different abilities. Consequently, upon the introduction of the 6-3-3-4 system of education, the new curriculum recommended among others that experimentation, demonstration, problem-solving and even field trip resting on practical activities of the students should be used in the teaching of science subjects(FME, 2005 in

NPE, 2013). The expectation could be that a successful implementation of the curriculum objective is based on the recommended teaching techniques. The learner would be equipped with adequate knowledge, positive attitude and science process skills that would enhance his performance, sustain his interest and also serve as springboard for the nation's scientific and technological breakthrough. Contrary to these expectations, the level of performance among secondary school biology students has not been encouraging. However, review of literature reveals low performance of students at S.S.C.E levels of education in science subject and biology in particular. (Nwosu,2004., Moore,2006 and Uza, 2014).

The teaching of biology starts from nursery through primary, secondary and tertiary institutions and thus form the basis for courses such as biochemistry, medicine, botany, zoology, microbiology and even pharmacy. The objectives of biology education curriculum as provided in the National Policy of Education (NPE, 2013) include the following:

Adequate laboratory and field skills in biology; inculcate in the learners meaningful relevant knowledge in biology and functional scientific attitudes.

However, in spite of these objectives and numerous efforts aimed at improving students' performance in biology, the subject has continued to witness low rate of academic performance especially in ecology questions. This poor performance has been attributed to the methods the teachers use in teaching the subject. Researchers like Moore, (2006), Uza, (2014) stated that lecture method is the most commonly used method by science teachers.

Lecture method is a method of teaching which involves verbal presentation where the teacher delivers the lesson to the students with little or no active participation by the students. It is a teacher centered approach involving largely a one-way form of

communication from the teacher to the students. For this reason, it is termed didactic approach because most of the talking is carried out by the teacher while the students remain passive listeners, taking down notes. Lecture method encourages rote learning and regurgitation of information without aiding assimilation of the information. The persistent poor performance of students in biology, specifically in ecological concepts at SSCE leaves one in doubt on effectiveness of the teaching methods popularly used by the biology teachers for teaching the subject. However, from a didactical point of view, suitable learning materials are necessary to convert the complexity of natural systems into linear conceptions, (Thomas, 2002., Adeyemo, 2005). Hence the teaching of ecology is faced with the dilemma of either using simplified or more complex materials. Therefore, teaching certain ecology concept requires basic knowledge about the species involved and their natural environment. Samara, Giouvanakis, Bousiou and Tarabansi (2006) and Adeniyi, (2009) suggested that the biology teacher is expected to use different techniques, approaches and methods to facilitate learning in the classroom and outdoor. Bichi, (2008) opined that when learning is augmented by method such as experimentation via practical experience, demonstrations and visual presentation, teaching becomes more appropriate and meaningful learning takes place.

**Laboratory teaching strategy:** Recently, advances in ecology, biochemistry, microbiology and molecular biology have made biology a central focus in most human activities including problem of water, pollution, health hazard, ecosystem management and conservation of natural flora and fauna. Laboratory method has been advocated as part of science curriculum reform by educators and the rationale, the emphasis was that students would be more interested in science especially biology if they are involved actively in “learning by doing” (Ajaja, 2013).

Laboratory teaching strategy is a strategy that allows the learner to perform experiments in the laboratory. According to Adeyemo (2005) “it is an activity-based method designed to be carried out by an individual student or a group of students for the purpose of making personal observations from experiments in which students or learners can draw conclusion by themselves”. This strategy has the advantages of reinforcing theoretical learning, improving cognitivism, promoting self-reliant and process skills ability, developing in the student’s scientific knowledge and attitudes and developing in them manipulative skills (psychomotor). Volkmann and Abel (2003) and Abdullahi (2013) observed that the intrinsic value of a strategy including the capacity to add meaning and values to what is learned, make learning more interesting and simple, discourage rote learning and enable the individual to achieve a good level of freedom that is necessary to enhance the performance of rudimentary levels of knowledge acquisition. According to Gungor, (2014) Gungor and Morgil (2015), laboratory strategy also serves as a functional key to greater educational development. Indeed, a laboratory strategy is considered to be effective if it enhances the learner’s capabilities for self-study and stimulate his interest in learning. The laboratory should help the students develop a broad array and experience on basic skills and tools of experimental and data analysis in biology. A growing body of research in biology education indicates that majority of students have difficulty in learning basic biology concepts in courses built around conventional teaching methods, text book problems and verification of experiments. Effective learning may also be assisted by close interaction of students with their peers in the process.

A laboratory can be an excellent environment for active learning. Thus, Morgil, Gungor and Secken (2009), stated that in a well-designed laboratory, students interact closely with teachers and peers, so that learning can be enhanced, monitored and assessed effectively. Also when students were given a well-designed laboratory exercise, they can

experiment and engage, both individually and collaboratively, in open-ended laboratories and inquiry-based learning activities that apply theoretical concepts to relevant real life problems. The aims of laboratory practices in biology education have been classified under four categories namely: actualizing the conceptual learning, attaining technical skills, attaining research skills and producing effective learning products. Furthermore, laboratory experiments can help students to understand abstract concepts in biology. Practical work is fun, interesting to the students, and as such they are motivated to explore the material which related to the topics in the classroom. Practical work in the laboratory encourages students to approach problems and solve it, find the facts and new principles, develop ability to cooperate and develop critical thinking and positive attitude towards the subject.

**Problem Solving Strategy:** If students are to successfully grapple with authentic, complex biological problems as scientists and citizens, they need to practice solving such problems during their Secondary years. Physics education researchers have investigated students problem-solving ability for the past three decades. Although physics and biology problems differ in structure and content, the instructional purposes align closely: explaining patterns and processes in the natural world and making predictions about physical and biological systems are the problems that biology students are typically asked to solve with authentic, complex problems (Inceaka, Guven and Aydogdu, 2010). The researchers described the development of research-validated physics curricula emphasizing process skills in problem solving and showed that solving authentic, complex biology problems requires many of the same skills that practicing physicists and biologists use in representing problems, seeking relationships, making predictions, and verifying or checking solutions. Thus acquiring these skills can help biology students become competent problem solvers (Jenkin, 2013; Laird, 2014).

In a study by Bichi (2008), he observed that the prevalent use of lecture methods in instruction may be another factor that impedes meaningful learning of biology concepts as reflected in low achievement and high misconception of biology concepts. Thus, if students are to acquire basic science skills, concepts and principles of biology, the need for teachers to employ students' activity based approach via problem solving and laboratory method of teaching must be taken seriously. To ensure effective teaching of science in our schools, Obeka (2010), Ameh and Dantani (2012) stressed the fact that science is better taught by "doing" in order to promote and develop scientific and manipulative skills, interest and attitude in the subject. This study thus employs the use of laboratory and problem-solving strategies to see if academic performance and attitude of SSII biology students in Zaria educational zone would improve.

Attitude is another factor that affects learning. According to Ahmed (2011), attitude is the predisposition to react positively or negatively towards object, ideas, institution or people. By predisposition it means the state of readiness to respond in some preferential manner towards a specific object, event or idea. Chen and Howard (2010) defined attitude as relatively endeavoring tendency to respond to somebody or something in such a way that reflects a positive or negative evaluation of that person or thing. Elijah, Lynn and Jason (2015) stressed that the concept of attitude arises from attempts to account for observed regularities in the behavior of individual persons. Thus, attitude can be positive, favorable, neutral, negative or unfavorable, one's inner experiences are evidence of one's own attitude. Therefore, if students experience some difficulties in learning geometry, they will manifest unfavorable attitudes towards the subject. Favorable and positive attitude of students towards geometry is facilitated by good and suitable instructional approach. Hence it will yield high level of performance and retention of the concept (Elijah, Lynn and Jason 2015). Justus (2005) observed that major

determining factors for attitude formation are the individual wants, information on group affiliation and personality. He further asserted that the importance of attitude arises from the fact that it has strong influence upon behavior and kinds of satisfaction and values the individual chooses. Amedu (2015), believes that method of instruction influences attitude of students towards learning in the classroom. Sambo (2008) argued that the measurement of attitude is a complex matter and cannot be observed directly, but can be inferred from the way individual student reacts to a particular stimulus or situation. Sambo, (2008) also attempted to analyze attitude of students towards mathematics in his study by using mean scores. He said, 'if mean score lies between 0.00 and 1.5 Linkert, it shows negative attitude, while if the mean scores lies between 1.50 and 5.0 Linkert it shows positive attitude'. His study revealed that students' attitude towards mathematics is believed to affect their performance either negatively or positively. He went further to say that attitude determines readiness or reluctance of students to embrace any new idea. It also facilitates or hinders students' desire to learn or acquire new idea or techniques. White (2009) and Balani (2010) reported that attitude is a critical factor in learning and stated that attitude is the basis for motivation in learning.

**Varied ability:** In a normal science class, the entire population of the students have varieties of learning abilities. Their abilities are referred to as varied abilities. It is well known that every student has a different way of learning and progresses at different speeds. Thus, while some students may find the learning task easy to complete, others may find it difficult to understand. The weakness of candidates in biology generally was linked to the fact that candidates lack basic concepts and not able to link biological concepts to real life situation (Lakpini, 2006, Lakpini and Atadoga 2012). Learning also depends on what students have brought with them into class. Since each student comes from a different family, a different environment and/or a different nation, the multi-

cultural population of the classroom may be an obstacle for the teachers in reaching the students, which eventually results in ineffective learning. Moreover, although it is quite difficult for the teacher to know about each student and to follow what each one does during the lessons even in small classes, it is important for teachers to monitor each and every student and to reach their needs in a variety of ways to achieve effective teaching. According to Lakpini, (2006) varied ability can be determined in three levels (i) High achievers, (ii) middle/average achievers and (iii) low achievers.

Gender is one of the factors interacting with performance, gender issues both on the part of the teacher and the students have been documented to affect academic performance and some other learning outcomes (Erinosho,2005, Obochi, 2016). The finding of Mari (2002), confirmed that the initial gap between the male and female students of different abilities was bridged in all the Schemata (conservation, control of variables, proportional reasoning and probability reasoning) except in correlation reasoning. Abdulraheem (2012), noted that gender inequalities are interwoven with social class, ethnicity, sexuality, disability and other factors identified as influencing attainment.

Adebanjo (2014), linked gender and academic achievement with patterns of behavior. He noted that there are signs of boys being vulnerable to becoming disaffected. He stated further that boys tend to be less careful about rules and more indifferent to being reprimanded. Thus, this study investigated the Impact of Laboratory and Problem-solving Strategies on Attitude,Retention and Academic Performance in Biology among varied ability Secondary School Students in Zaria Kaduna State.

### **1.1.1 Theoretical Framework**

This study is hinged on the theory of constructivism which depends on a philosophy of learning founded on the premise that learners construct their own understanding of the world and also a way of understanding how students learn.

Constructivism is a learning theory based on the idea that the conceptions the learner already holds have a considerable influence in the learning process (Lakpini, 2006).Lorsbach and Tobin in Okebukola (2004) defined constructivism as an epistemology, a theory of knowledge used to explain how we know what we know. According to this theory, learning is the result of the constructive activities of the students where students/learners are expected to form the concept of what he/she learnt. Students who are confident of their abilities can make sense of things by themselves, rather than waiting for a teacher, a book, or a set of data collected by someone else. The theory of constructivism thus states that students actively construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. According to Bajah and Asim (2000), the constructivist view is not new in education, as far back as early nineteenth century, renowned psychologists like Piaget, Ausubel and Bruner (1961) stressed the importance of prior knowledge or preconception in learning.

Laboratory teaching strategy is a strategy that allows students or learners or group of students to perform experiments in the laboratory. According to Adeyemo (2005), “it is an activity designed to be carried out by an individual student or group of students for the purpose of making personal observations from experiments in which students or learners can get conclusion by themselves”. Problem solving is a guide that motivates learners to find solutions by pulling together information and generalizing knowledge. Problem – based learning cannot be discussed without recourse to John Dewey’s philosophical perspective on education. Obeka, (2010 and 2011) stressed the importance of learning through experience, which is the basis of motivation in students. He also believes that students learn best by doing, by discovery, by experimenting and by thinking through problems which are at the root of problem-based learning. Nevertheless, the cognitive

scientists like Robert Gagne, Schumann and pragmatist like John Dewey can be said to pioneer studies in problem- solving based learning (Fosnot, 1996).

Problem-solving according to Gagne, (1970) can be viewed as a process by which the learner discovers the combination of previously learnt rules that can be applied to achieve a solution for a novel situation, in form of hierarchy of knowledge which is also a process that yields new learning. Teaching will therefore be more effective when it supports those activities appropriate to achieving the curriculum objectives, encouraging the students to adopt a deep approach to learning. Being a good teacher one requires taking on new roles to ensure that students learn. For example, the teacher, as a constructor, should understand the subject matter well and appreciate different ways to teach it in order to accommodate students' various ways of learning. The teacher, as an inquirer, should depend heavily on assessment to find out what students have learned and what they need to learn more about.

Problem-solving teaching/learning strategy encourages critical thinking, acquisition of skills and problem solving skills along with content knowledge through the use of real world situations or problems. This is an effective strategy in science teaching because, in this case, learning is driven by the problem the learner is interested in solving, and learning is active, integrated, cumulative, and connected. Students gain an appreciation of how important questions about human experience are interrelated across discipline lines and areas of interest within disciplines. These strategies are widely applied to make the students realize that they are responsible for finding the information necessary to solve problems. The teacher's role is supportive, not directive. Teachers act as facilitators and provide resources, guidance and instruction to students as they develop content knowledge and problem-solving skills, and give frequent feedback to students about their perceptions of the problem being studied. Problem based learning may take

various forms, such as group discussion of cases or problems and/or projects designed and developed by students. It is more important for the teacher to assess the students by emphasizing the process of the learning experience and the quality of the integration of knowledge reflected in the solution of the problem.

Bruner on the other hand introduced the concept of learning by discovery via activity or experimenting and problem-solving strategies. The theory stresses cognitive effectiveness and development. Bruner declares that “students should be encouraged to use active techniques via experiments, real-world problem solving to create more knowledge and then to reflect on what they are doing and how their understanding is changing. According to Bruner, (1996) learning is an active process in which learners construct new ideals or concepts based on their current and past knowledge. Thus the learner selects and transforms information, constructs hypotheses and makes decisions, relying on his cognitive structure to do so. Bruner (1961) further stressed that there are two forms of discovery processes; viz:

- Assimilation
- Accommodation

According to him, assimilation occurs when the learner recognizes a new situation that is familiar to one of the elements in the existing structure of knowledge (cognitive structure) and he easily assimilates it.

Accommodation on the other hand occurs when a new situation or new knowledge is incompatible to the existing structure of knowledge the learner first restructures and reorganizes his cognitive frame work in order to be able to accommodate the new knowledge. Abdullahi (2013) observed that the intrinsic value of a strategy including the capacity to add meaning and values to what is learned, make learning more interesting and simple, discourage rote learning and enable the individual to achieve a good level of

freedom that is necessary to enhance the performance of rudimentary levels of knowledge acquisition, and serves as a functional key to greater educational development. Indeed, laboratory and problem-solving strategies are considered to be effective if it enhances the learner's capabilities for self-study and stimulate interest in learning. Thus it is on this note that the researcher employs the use of laboratory and problem-solving strategies to see if the retention, attitude and performance of SSII biology students of low ability would improve.

## **1.2 Statement of the Problem**

Many studies have shown that there is an alarming crisis in relation to students' attitude and academic performance in science subjects and especially Biology (Adeniyi, 2009). Biology is one of the major core science subject taught in senior secondary school level. Thus, poor performance of students in the subject has been a major concern to many stakeholders in education. Like any other science subject, the syllabus of this activity based subject emphasis the use of activity-based method of instruction. Unfortunately, as reported by researchers such as Lakpini (2006) and Lawal, (2009) teachers shy away from activity-based teaching method and rely mostly on easy goes lecture method which in most cases are often inadequate and inappropriate for meaningful learning to take place. However, students continue to perform poorly in science subject and biology in particular.

Other studies such as Okebukola, (2004) and Obeka, (2010) revealed that students generally perform poorly in sciences due to lack of appropriate teaching methods. Hence the question of how students' academic performance in biology can be improved is still a pedagogical problem. Moreover, laboratory and problem-solving teaching strategies have been identified by Bichi, (2008), Ojediran, Oludipe and Ehindero (2014) as activity-oriented methods which allow students in senior secondary school to have experience

which are consistent with the goals of scientific literacy. When students are taught biology theoretically, without the practical aspects done in the laboratory, meaningful learning will not take place (Bichi, 2008 and Lawal, 2009). In the United Kingdom, the publication of the Denton Report (Department of Education Science (DES) which examined the flow of candidates in science and technology into higher education documented a swing from science in the school-age population as a whole. The list of countries experiencing declining in academic performance of students in science is on the increase particularly among the developed countries (Blevins, 2009). One factor which has contributed to low performance in science by students of varied ability levels is the method adopted for teaching and learning science (Lawal, 2009., Obeka, 2010.,Lakpini and Atadoga 2012). The views of students which contribute directly to low performance in science are; (i) Science teaching is predominantly trans-missive, (ii) The content of school science subject has an abstractness that makes it irrelevant, (iii) Learning science is relatively difficult, for both successful and unsuccessful students.

Teachers at all academic levels are faced with the task of making learning meaningful to students. For most teachers and educators, there is continual internal struggle associated with making choices related to both content and method of teaching the subjects (Chiappetta and Koballa 2002; Moor,2006; Anyanwu, Obochi and Isah 2015). It is on this note that the present study is aimed at investigating whether laboratory and problem solving-strategies would have any effects on the academic performance, retention and attitude in biology among secondary school students of varied ability levels. The motivation to conduct this research is the dwindling poor performance of students in biology examinations as confirmed by WAEC Reports of (2009, 2010, 2011,2012,2013, 2014, 2015 and 2016).



**Table 1.1: Students' Performance in SSCE Biology 2008-2014 Sessions in Zaria**

Year	Total No of Students	No of Pass	% passes	No of failure	% Failure
2009	238	108	45.4	130	54.6
2010	140	65	46.4	75	53.6
2011	325	140	43.1	185	56.9
2012	270	120	44.4	150	55.6
2013	273	103	37.7	170	62.3
2014	258	98	38.0	160	62.0
2015	283	105	37.10	178	62.90
2016	305	111	36.39	194	63.61

Source:Ministry of Education, Zaria Educational Zone (2016)

Nwagbo and Chukelu (2011) opined that some concept of ecology which deals with ecosystem, water cycle, nitrogen cycles, survivorship and food chain which are major sub concepts in biology at ordinary level is perceived by students as abstract and difficult to understand. Other problems facing the teaching /learning of biology in Nigeria secondary schools have been identified as:

Improper exposure to laboratory activities,Poor science background at the junior secondary,Lack of problem solving ability,students' perception of biology as a difficult subject, Lack of teaching facilities, and of equipped laboratories.Persistent use of lecture or traditional method of teaching (Kalu and Ndokwo 2006).

Thus, the rational of this study is to investigate the Impact of laboratory and problem- solving strategies on attitude, performance and retention in biology among varied ability senior secondary school students in Zaria, Kaduna state Nigeria.

### **1.3 The Objectives of the Study**

The objectives for this study are as follows, to:

1. examine the effects of laboratory and problem-solving teaching strategies onacademic performance in ecology among students of varied abilities.

2. investigate if there is any difference in the attitude of students of varied abilities when taught ecology using laboratory teaching strategy and lecture methods.
3. determine the effects of laboratory and problem-solving teaching strategies on retention of varied ability students in ecology.
4. examine the effects of laboratory teaching strategies on academic performance of male and female students and that taught using lecture method.
5. examine the effects of problem-solving teaching strategy on academic performance of male and female students in ecology and those taught using lecture methods

#### **1.4 Research Questions**

The study investigated the following research questions:

1. Are there differences in the mean scores of students in the high, middle and low ability levels taught ecology using laboratory, problem-solving teaching strategies and their counterparts taught using lecture method?
2. Are there differences in the attitude of students in the high, middle and low ability levels taught ecology using laboratory and those taught same concept using problem-solving teaching strategies?
3. Are there differences in the mean retention scores of high, middle and low ability students taught ecology using laboratory and problem solving teaching strategies and their counterparts taught using lecture method?
4. What are the differences in the mean academic performance of male and female students taught ecology using laboratory teaching strategy and those taught with lecture method?

5. What are the differences in the mean academic performance scores of male and female students taught ecology using problem-solving teaching strategy and those taught with lecture method?

### **1.5 Null Hypotheses**

The study has the following null hypotheses.

HO<sub>1</sub>: There is no significant difference in the mean academic performance scores of High, middle and low ability biology students taught ecology using laboratory and problem-solving strategies and those taught using lecture methods.

HO<sub>2</sub>: There is no significant difference in the mean attitude scores of high, middle and low ability biology students taught ecology using laboratory and problem-solving teaching strategies and those taught using lecture methods.

HO<sub>3</sub>: There is no significant difference in the mean retention scores of high, middle and low ability students taught ecology using laboratory and problem solving strategies and those taught using lecture methods.

HO<sub>4</sub>: There is no significant difference between the mean academic performance scores of male and female students taught ecology concept using laboratory teaching strategy and those taught using lecture methods.

HO<sub>5</sub>: There is no significant difference in the mean academic performance scores of male and female students taught ecology using problem-solving teaching strategy and those taught using lecture methods.

### **1.6 Significance of the Study**

This study investigates the impact of laboratory and problem-solving strategies on attitude, retention and academic performance, of secondary school biology students with varied abilities which lies on practical value and its contributions to the pedagogical body of knowledge was carried out to find out if the performance of the three ability level

students particularly that of low ability students would be improved. The findings would hopefully benefit the following groups of people:

Biology Teachers, Students/learners, Tertiary Institutions, Curriculum developers, Professional Bodies and Researchers, Educational Counselors and Psychologists. Publishers and School administrators in the following ways:

**Biology Teachers:** It is hoped that the findings of this study would sensitize biology teachers to address issues on student's inability to comprehend ecology concepts. Consequently, such teachers are expected to acquire and apply the knowledge of instructional strategy for dealing with the problem. The result would also hopefully benefit biology teachers in the area of creating awareness on the need to conduct laboratory practical and apply problem-solving teaching strategy which would motivate and arouse the interest of students to participate in the class. The strategies would also hopefully enhance attitude and academic performance of students in biology and thus reduce the stress teachers face when students turn into passive listeners. Such change orientations are expected to help students to relate concepts to real life situations as they affect personal and societal needs.

**Students/Learners:** It is also hoped that the result of this research would develop in the learners' positive attitude and manipulative skills which will help them to acquire science process skills e.g. observation, measuring, inferring, interpreting results, hypotheses, collecting data, analyzing the data, reporting biology phenomena and relating it to their day to day activities.

**Tertiary Institutions:** institutions of higher learning where biology teachers are trained would make use of these instructional strategies so as to equip them to produce more effective teachers who would in turn help students reconstruct knowledge on their own.

**Curriculum Developers and Authors** who develop curricula and recommend effective methods of instruction, may also incorporate the use of these strategies in biology curriculum to clarify and enhance students understanding and performance of ecology terms and concepts. Text book publishers may find the study useful to design activities that involve the use of these strategies to enhance meaningful learning in biology.

**Professional Bodies and Researchers:** The study would be useful to professional bodies, researchers and associations concerned with outcomes of research especially those interested in instructional innovations such as Science Teachers Association of Nigerian (STAN), Nigerian Educational Research and Development Council (NERDC) and other educational agencies that carry out seminars, conferences, workshops and research activities might find the results of this study useful and incorporate them into their instructional package. The result of this study may also serve as literature review and reference in related field for other researchers.

**Education Counselors and Psychologists:** Academic performance among students has been the concern of Nigerian educational endeavor, as such a study involving student's performance would be of paramount interest to instructors, students, parents, education agencies, and other stakeholders in education.

Studies on attitude of students to science subjects and concepts are important to teachers, guidance and counselors and other psychologists who help students decide their future careers' hence the relevance of this study to such category of people. Varied abilities and retention of students in science subjects has been a topical issue and hence of vital importance to educational psychology, relevant to classroom practice and teaching strategies. Thus, study that might change the mindset of students about a particular

subject and throws more light in the right direction would be potentially useful to education.

### **1.7 Scope of the Study**

This research work was undertaken to determine the impact of using laboratory and problem solving teaching strategies on attitude, retention and performance of secondary school biology students with varied abilities. The students used for this study were SSII students with varied abilities drawn from three co-educational schools in Zaria Educational Zone of Kaduna State.

Zaria educational zone has schools from Zaria, Sabon-Gari and Soba local government areas under its jurisdiction. Subjects for experimental group one and two were drawn from Government Secondary schools Tudun Jukun in Tudun Wada and GSS Aminu in Sabon- Gari respectively, while subjects for control group were drawn from GSS Magaji in Zaria city since they were found to be equivalent based on pretest scores. The study was limited to ecological concepts under SSII syllabus for students of Zaria Educational Zone of Kaduna State, this is due to time constraints and vast size of Kaduna State. It is delimited to Government owned/Public Secondary Schools to ensure same conditions with regards to funding, curriculum and teaching quality. In carrying out the study, the following sub-topics are the topic to be treated in SSII at the time of this study.

- Ecological succession.
- Population size/estimate
- Food shortage
- Overcrowding
- Population studies and Balance in Nature

Laboratory and Problem solving teaching strategies were used to teach the topics to SSII students. The exercise lasted for six (6) weeks.

### **1.8 Basic Assumptions**

The followings are the basic assumptions for the study.

1. The schools sampled are typical secondary schools in the zone with same facilities, staffing and same academic Calendar.
2. The topics for the study are topics treated at SSII, for the term and are appropriate for the level of students.

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

#### **2.1 Introduction**

This study investigated impact of two teaching strategies on attitude, retention and academic performance in ecology concepts among varied ability secondary school students in Zaria metropolis. In Chapter One, the research problems, the objectives of the study and the corresponding null hypotheses were briefly discussed. The focus of this chapter is to review the literature relevant to the study. The chapter is organized and presented under the following sub-headings:

- Historical Development of Science Education in Nigeria.
- Biology as a Science Subject.
- Instructional Strategies for Science Teaching.
- Lecture or Traditional Method of Science Teaching.
- Laboratory Teaching Strategy.
- Problem Solving Teaching Strategy.
- Students' Attitude and Academic Performance in Biology.
- Varied Ability and Academic Performance in Biology
- Retention of Learned Concepts in Biology.
- Gender and Academic Performance in Biology.
- Factors that Affect the Teaching of Biology.
- An overview of Similar Studies.
- Implications of Literature Reviewed on the Present Study.

## 2.2 Historical Development of Science in Nigeria

According to Uza (2014), science is the intellectual and practical activity which encompasses the physical and natural world through observation and experiment. Science (from Latin *Scientia* meaning knowledge) is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and Knowledge that can be rationally explained and reliably applied to everyday life. (Thompson, 2006).

Science education, is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community (Borich, 2004). The field of science education includes work in science content, science process (scientific Skills) some social science and some teaching pedagogy. The public image of science education may be one of the simple learning facts by rote science education.

According to Walker (2012) biology deals with many varieties of living organisms, it is a type of science concerned with the study of all living organisms including their structures, function, growth, origin of evolution, distribution and taxonomy. He defined biology as the large branch of science which focuses on the study of life. Sub-disciplines of biology are recognized on the basis of the scale at which organisms are studied and methods used to study them.

Other aspects of biology are:

Biochemistry which examines the rudimentary chemistry of life.

Microbiology studies the microorganisms and their function.

Molecular biology studies the complex interactions of systems of biological molecules,

Cellular biology examines the basic building block of all life i.e. (the cell) and

Ecology examines, how various organisms interact and associate with one another and with their environment.

Aworanti and Abimbola (2004) in their study revealed that the negative attitudes which students held about biology, affect their performance in topics such as genetics, evolution and other biology concepts. However, the work of Bichi (2010) revealed that a high achievement of biology concepts could be acquired through meaningful teaching and appropriate strategy. However, it is established from the studies that experimental work could have a strong motivating effect on the students because what is seen, touched and felt usually facilitates effective learning and retention (Bichi, 2010).

Krebs (1999) further defined biology experiment as a test of a hypothesis that suggests an explanation for a biological pattern or process. He accepted the distinction between measurable experiments, which involve collecting qualitative data on ecological units without applying an experimental treatment, and manipulative experiments, which involve assigning treatments and control to experimental units. Many ecologists however believe that experimental approach in ecology is essential not only for the advancement of theoretical and applied ecology, but also to produce credible, reliable and scientific data that will withstand legal scrutiny and guide management of contentious environmental issues (Krebs, 1999).

Ecology focuses on the structures and functions of the entire suite of microbes, plants and animals and their abiotic environment, thus this branch of biology also focuses on the energy and nutrient flow of an ecosystem. Most educators agree that scientific literacy is best achieved by learning science through laboratory and problem solving approaches. In these approaches, students acquire knowledge through procedures similar to those employed by scientists. This can be achieved by performing experiments which provide evidence to support or reject hypotheses regarding particular theory or theories (Cooper, 2004). The laboratory approach develops scientific literacy through its emphasis on learning systematic ways of evaluating scientific questions and by allowing students to

learn biological concepts through their own experimental experience. Analytically, literacy is measured by the degree to which students utilize the skills and scientific knowledge obtained through problem solving- based learning to evaluate practical application of science in daily life activities.

Ajaja,(2013) suggests that ecological experimentation should be widespread in secondary school biology curricula. Researchers argued that a good deal of valuable school laboratory work in biology is based on observation and description and that any difficulties students have in distinguishing between description and causal explanation may be less serious in biology than in the physical sciences. Thus, this line of reasoning, if widespread, among biological sciences, may widely be viewed as a science in which the experimentation has little place. However, it is the researcher's suggestion that the lack of laboratory work in secondary school ecology curricula is alarming for two reasons. Firstly, failure to use biology laboratory activities in secondary school curricula units which is the possibility for problem solving learning approach. Secondly such an omission may not be reflective of the practice of ecology as a science. Biology laboratory activities and experiments can be used frequently and successfully by biologists to answer both theoretical and applied questions (Ingrid, Scott and Lori 2016). Thus without the integration of biological laboratory works into secondary education, students will have limited exposure to how biologists actually practice their craft and may learn to perceive biology as an essential and non-experimental science with little practical and applicability. Such review would help explain why biology students often fail to grasp the connection between environmental issue and the science of ecology in biology. Ingrid, Scott and Lori (2016).

Advances in biochemistry, ecology, genetics, molecular biology and physiology have made biology a central focus in most human activities including problems on foods,

water, environmental pollution, health, ecosystem management and conservation (Evans and Vosniadu 2008). Biological literacy and problem solving skills are therefore relevant in view of the above global issues. However, to overcome such problems a disciplinary and interdisciplinary approach that focuses on the learner's activities and practical is required. Thus the biology teacher(s) are expected to select and use appropriate teaching strategies that would enhance student' performance during lesson presentation (Jegede and Inyang 1990., Taylor, 2009).

### **2.3 Biology as a Science Subject**

The term biology is coined from two Greek words- *Bios* meaning (life) and *Logos* meaning (study), biology can simply mean the study of life. Thus biology is the study of plant and animal as living things. Basically the two main branches of biology are Botany which is the study of plants and Zoology the study of animals (Taylor,1963)

The science of biology studies interaction between individual organism and their environments including interactions with both nonspecific and members of their species. Biology emerged in the 19<sup>th</sup> century much of its theoretical structure emerged in the twentieth century. Though biology includes a wide variety of sub-fields of ecology such as Medicine, Pharmacy which have so far been restricted to population community and biology. The term "ecology" was coined by the German zoologist Ernest Haeckes in 1866 to describe the economies of living forms. According to Taylor (2009) the theoretical practice of ecology consists of the construction of models of the interaction of living systems with their environment. These models are then tested in the laboratory and field. The field –work in biology consists of data collection that need not be inspired by any theory. Theory in ecology consists of the heuristics or principles used to construct models. Unlike evolutionary theory, ecology has no generally accepted global principles such as Mendel's and other rules of genetic inheritance. However, contemporary ecology

consists of some sub-disciplines including- population ecology, community ecology, conservation ecology, ecosystem (Shukla and Chandel, 2009).

Population biology focuses on the abundance and distribution of individual species and the factors that cause such distribution. Community biology deals with the members of species found at a given location and their interactions.

Biology is described as a science of life and plays a very vital role in the life of every human being, it is very vast with many divisions. The benefits of biology to mankind cannot be over emphasized. The knowledge explosion all over the world through the internet and worldwide web, in biology literacy has also expanded. Advances in fields of science such as biochemistry, microbiology, ecology, genetics, molecular biology and physiology have made biology a central focus in most human activities including problems on foods, water, environmental pollution, health management, ecosystem and conservation (Rosenzweig, 2005., Shukla and Chandel 2009). Apart from the inter-relatedness that exists among these branches, biology is closely related with other science subjects like agricultural science, geography, mathematics and physics. This implies that biology finds application in many specialized areas like medicine, pharmacy, food production and processing industries, biotechnology, genetic engineering, agriculture and horticulture, environmental protection (Osuafor and Okigbo 2013). Considering biology's many branches and vast applications in every field of human endeavor as mentioned above, its importance in a nation's economic development cannot be underestimated. Biological literacy and problem solving skills are therefore relevant in view of the above global issues. However, to overcome such problems a disciplinary and inter disciplinary approach that focus on the learners' activity skill is required. Thus the biology teacher(s) are expected to select and use appropriate teaching strategies during lesson presentation (Taylor, 2009)

## **2.4 Instructional Strategies for Science Teaching at the Secondary School Level**

There is a general argument that learning of science is more effective if the learner is directly involved in seeing and manipulating activities. Most practical work in biology is therefore regarded as psychomotor which involve manipulative skills and accuracy of data collection. In science education, teachers and their behavior in the classrooms are very important, Jakayinsa (2005) stated that “more than anything else, teaching methods affect the response of students and determine whether they are interested, motivated, assimilate and involved in the lessons in such a way as to engage on a meaningful learning”. His statement further emphasizes the key role of the teacher in the teaching-learning process and indicates possible roles of the teachers’ “instructional strategies” may play as a measure of teaching effectiveness (Bichi, 2008).

According to Obeka (2011), Karacop and Doymus (2013) effective and meaningful science teaching involves several activities both in the class and outside the classroom environment. Such activities include projecting demonstration, individualized learning, practical work, group discussion, visiting museums, zoo, botanical garden excursions, building models and other verbal and non-verbal activities. Thus in a classroom, there is no particular best method of teaching a subject.

However, poor teaching method was observed by Kasuko, (1995), Jakayinsa, (2005) and Abudllahi (2013) as one of the causes of students’ dismal performance in biology. Soyibo (2001) stated that the use of didactic method of teaching, which is teacher-centered, is the common mode classroom instruction in biology and except there is re-orientation and the use of method(s) that will involve students’ active participation, the present trend of poor performance in biology may continue. Our modern society is faster paced, globally networked, technologically oriented and requires workers who can solve problems and think critically. The Americans believed that poor performance in science, mathematics

and technology will certainly hamper their leading role in the global village. ADEA (2004) emphasizes that better learning achievements of students is ultimately determined in the classroom by motivated teachers who have the skills and resources to respond effectively to students' learning needs.

Atadoga and Onalapo (2008) pointed out that teaching methods and techniques have to be varied and mixed with real life situations. However, there are general rules which facilitate the selection of appropriate and adequate approaches of teaching or developing a science skill to students. These rules may equally apply to other non-science subjects hence they have been found to have instructional value for teaching and learning processes. Atadoga and Onalapo (2008) also stated that, in selecting methods, approach or strategy for science teaching, the teacher will have to consider the following:

- The pupils age.
- Previous knowledge as it relates to new topic.
- Topic to be taught.
- Behavioral objective (expected outcome).
- Time/period for the lesson.
- Size and available resources at the teacher's disposal.

They stated that, science teachers should not be dogmatic in their daily choices of teaching methods. Thus, the teachers should interchange or implore more than one method as many times as the need arises. The frequency with which the teacher changes his/her method (s) of teaching will depend on the concept, skill or attitude to be developed in the learner. However, variety of constructivist approaches to teaching science abound, such approaches include the strategies of concept mapping (Danmole and Adeoye, 2004), problem-solving (Akubuilu, 2004), computer based teaching (Child,

2009), conceptual Displays, simulations, games and role playing, role modeling, use of aids and resources (CAI and Integrated Video Media) (Alebiosu and Ifamuyiwa 2003).

Therefore, biology practical may be more desirable for the understanding, reinforcement and retention of basic theoretical facts than imaginative memory. Various studies also showed that students learn more from science lesson by doing rather than by mere observation (Ibe, 2013). The need to learn biology through an activity-oriented method has therefore been suggested locally and internationally. Although it is a slow and expensive method, it is more preferable. Biology techniques section of the practical biology is also an area where many skills such as manipulative knowledge and representation can be acquired.

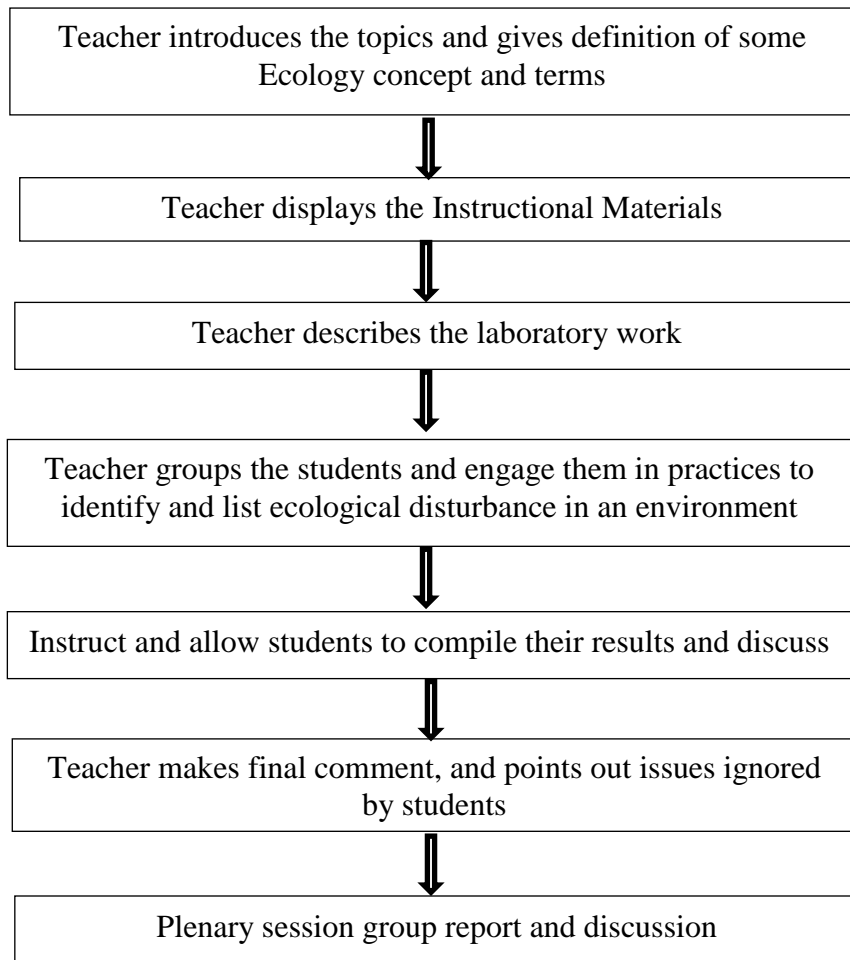
#### **2.4.1 Laboratory Teaching Strategy**

The use of Laboratory strategy in science teaching originated from the ideas of early scientists. The 17<sup>th</sup> century is very significant in this respect; this century was characterized as the century of “The scientific Revolution”. This is so because, it was in the 17th century that the experimental and laboratory method became widely employed tools of scientific investigation. Taylor (2009) claimed that “the idea of laboratory work in science begins to have influence in the society when scientists started basing their work on deliberately contrived experiments. According to him, Galileo Galilei (1564-1643) was the first to employ the modern scientific method in the fullness, in physics and astronomy. Galen’s writing on physiology contained examples of laboratory investigation, thus, current trends in curricula of various countries are endorsed to engage students in biology/science to use activity based and problem-solving approach in teaching/learning Taylor, (2009). This approach supports students’ natural interest in science; students are encouraged and engaged to make their own questions or “problems”, test hypotheses, gather and present information from various sources. In the contrast,

traditional learning involves memorization of facts, which often results in students' negative attitudes towards science and biology in particular; (Ingrid, Scott, and Lori 2016). The instructional aids governed by visual sense, hands-on-mind-on, among other ones include: books, pictures, maps, charts, films, models and practical demonstration. When properly used such visual aids result in more effective and meaningful learning than mere lecturing, (Ingrid, Scott, and Lori 2016). Obeka (2010) further stressed the importance of activity in learning. His believe is sub-stressed by a Chinese adage which says 'I hear and forget', I see and remember, I do I understand. In another study, Usman (2000) in his evaluation of biology teaching in secondary schools in Zaria, reported that the teaching and learning of biology has not been given considerable attention at the local level, hence there is inadequate use of local materials in science teaching. He stressed further that our local environment is very resourceful in materials for the teaching and learning of biology.

Ojediran, Oludipe and Ehindero (2014) investigated the impact of laboratory-based instructional intervention on the learning outcomes of low performing senior secondary students in Physics. The study adopted the pre-test and post-test control group quasi-experimental design. The results of the study indicated that there was significant difference in the achievement in Physics of low performing students exposed to laboratory-based instructional intervention (LBII) and those exposed to conventional teaching method (CTM). The study concludes that the use of laboratory based instructional intervention method of teaching should be embraced as a good asset to Physics Students and teachers in the senior secondary schools. Maikano (2007) also investigated the effects of Outdoor and Indoor laboratory experience on secondary school students' academic achievement and retention in ecology.

The traditional ideology of science teaching and learning has taken a dominant role. It represents the main approach to teaching in most curricula in the university, although some advanced skills and techniques in teaching, such as video, slides and multimedia are used now. Moreover, the increase in student numbers in universities and the rapid developments in science and scientific techniques have to be taken into account. This situation is creating a greater impetus for teaching reform to improve the quality of higher education. It is therefore necessary to introduce new strategies to modify traditional teaching and learning. The aim of this study therefore, is to determine the efficacy and impact of using Laboratory and problem solving strategies on attitude retention and academic performance in biology among Senior Secondary School Students of varied ability levels in Zaria educational zone Kaduna State. A Flowchart designed by the researcher to guide the teaching as shown below.



**Figure 2.1: Flowchart for Laboratory Strategy**  
**Source;Adopted from Bruner (1961)**

#### **2.4.2 Problem Solving Teaching Strategy**

The fast changes in science and technology in recent times have affected education systems. Students of today need to be able to adapt to a rapidly changing technological world (Şaşan, 2002). As a result of these fast changes, the education systems need to be modified. The education systems can activate the students to learn ways to enrich knowledge, to develop solutions for problems yet unknown and to enhance the skills of decision-making (İnceaka, Güven & Aydoğdu, 2010). Science education reformers have supported the idea that learners should be engaged in the excitement of science, they should be helped to discover the value of evidence-based reasoning and higher-order

cognitive skills and be taught to become innovative problem-solvers (Perkins & Wieman, 2008., Temel and Morgil, 2013). So, it is important for students to be prepared for the future by facing real problems in their learning environment and producing appropriate solutions to these problems (American Association for the Advancement of Science, 1993; Walker & Lofton, 2003).

Accordingly, Walker and Lofton (2003), also discovered that student using problem solving approach through computers had more understanding and more positive attitude towards biology and natural science than students who were educated by traditional style. Teaching science in both primary and post primary schools using problem solving approach aims at training students and develop their ability to solve problems they encounter in everyday life. Science presented in the form of the problem will provide motivation to students to learn science more deeply. Sanjaya (2007) and Agdas (2013) suggested that problem solving approach can develop student's ability to think critically and develop their ability to adjust to new knowledge.

The use of Problem solving strategy in field of ecology increased sharply in the second half of the twentieth century, growing from approximately 5% of field studies in the 1960s to 10% in the 1970s and over 30% in 1987. Problem-solving is the ability to identify and solve problems by applying appropriate skills systematically. Problem-solving approach is a process of activity where we take what we know to discover what we do not know. It involves overcoming obstacles by generating hypothesis, testing the predictions and arriving at satisfactory solutions. Problem-solving approach involves three basic functions, it is therefore evident that all organizations, national bodies and even individuals emphasized on the need for effective science teaching in Nigerian institutions and also the need for adequate supplies of materials and equipment needed to

undertake practical work that goes hand in hand with the science teaching, (Ihejirika and Onyenemezu 2012).

Adesoji (2008) investigated students' ability levels and effectiveness of problem-solving instructional strategy. He reported that there is disparity in the ability to perform specific tasks. In his word, he stressed that all aspects of Physics could be said to be problem-solving and students have varying ability when they are confronted with problems to solve. He also emphasized the view of Salami (2000) that problem-solving in Physics depends on students' cognitive ability level which differentiate between the high performing and low performing students in Physics in Nigerian secondary schools. Several studies within the Nigeria environment have, however, shown that learners are qualitatively different in their performance levels and in learning problems (Adesoji 2008). However, performance of low performing students has been found to be lowest while that of the high performing students was the highest (Adesoji, 2008). It has also been observed that problem-solving strategies were effective in teaching students of different performance level (Salami, 2000).

In Gagne's point of view, problem-solving involves combining previously learned rules into a new, never-before-used high-order rule (Gagne and Driscoll, 1988, Adeyegbe, 1993). However, Gagne identified five categories of learning which are verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. He suggested that different internal and external conditions are necessary for each type of learning. It can therefore be seen that problem-solving is one of the prerequisite for the overall development of a child in Gagne's perspectives of education. The overall development of a child is the inclusive function of education as in a balance curriculum (Gagne, 1970., Baltimore, 2008, Swanson, 2008; Yeung, 2006).

However, in general, these approaches and strategies of teaching are greatly neglected by teachers and their short-time effects are thought to be questionable. Bichi (2002) defines problem as that which arises when a living creature has a goal but does not know how his goal is to be reached or achieved. Mayer and Wittrock (2006) and Temel (2014) in their individual research described problem-solving as a cognitive processes directed at achieving a goal when no solution method is obvious to the problem solver. Kato and Kemii (2001) also defined problem-solving as application of knowledge and procedure to a problem situation. Problem-solving approach was also described by Mayer and Wittrock (2006) as the application of individually acquired set of skill to a situation which determine completely the method of solution this skill could be inform of holistic behavior as streamlined by Poyas 4 –stages model as follows

- Understanding the problem
- Formulating of Hypotheses
- Carrying out the plan
- Looking back

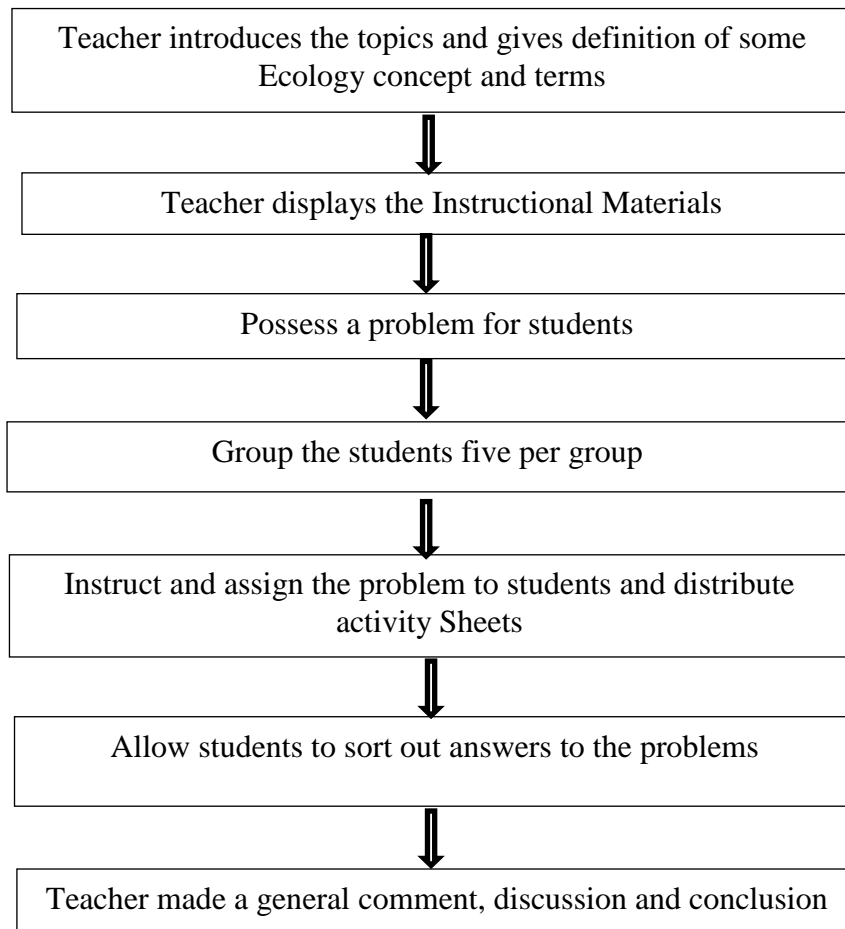
Problem solving should be a very real part of the curriculum, it presupposes that students can take on some of the responsibility for their own learning and can take personal action to solve problem, resolve conflicts, discuss alternatives and focus on thinking as a vital element of the curriculum. It provides students with opportunities to use their newly acquired knowledge in meaningful, real-life activities and assists them in working at higher levels of thinking. Students can use drawings to help them work at a problem from many different perspectives.

- Understanding the problem: It is important that students understand the nature of a problem and its related goals
- Describe any barriers: students need to be aware of any barriers or constraints that may be preventing them from achieving their goals.

- Identify various solutions: After the nature and parameters of a problem are understood, students will need to select one or more appropriate strategies to help resolve the problem. Students need to understand that no single strategy will work for all problems.
- Create visual images: many problem solvers find it useful to create “mind pictures” of a problem and its potential solutions prior to working on the problem.
- Guesstimate: Give students opportunities to engage in some trial and error approaches to problem solving.
- Create a table: A table in an orderly arrangement of data. When students have opportunity to design and create tables of information, they begin to understand that they can group and organize most data relative to a problem.
- Use manipulative: By moving objects around on a table, students can develop patterns and organize elements of a problem into recognizable and visually satisfying components.
- Work backward: it’s frequently helpful for students to take the data presented at the end of a problem and use a series of computations to arrive at the data presented at the beginning of the problem.
- Evaluate the results: it is vitally important that students have multiple opportunities to assess their own problem-solving skills and the solution they generate from using those skills. Frequently, students are dependent upon teachers to evaluate their performance in a classroom.

To this end the researcher having gone through quite a number of studies available both in federal and state government schools including universities, libraries, have found that not much work has been done particularly on the use of Laboratory and problem-solving strategies in teaching ecology in biology subjects, more especially in Zaria

educational zone. The following Problem-solving Flowchart guided the teaching in experimental group 2.



**Figure 2.2: Flowchart of problem-solving strategies**  
Source; Adopted from Bruner (1961)

### 2.4.3 Lecture Method

Lecture method of teaching in its many forms is the most commonly used method of transferring knowledge or impacting information to learners. However, eighty (80%) of the scientific information or principles that pupils (learners) receive from their teachers come through the lecture methods as it leads to an easy coverage of the school syllabus of a large class size in a single period. Lecture method, as it is traditional of ideals, concepts, generalization and facts, the objective of this method is to stuff the students with information. The teacher does much of the activity in form of talking, while the learners

are either passive or slightly involved. There are however, serious questions regarding the effectiveness of the lecture approach.

Lawson (2001) pointed out that, although the lecture method is used extensively in education, academic staff often are not trained in using this method in giving effective lectures. Ameh and Dantani (2012) have pointed out that despite the thirty years' existence of learning style theories, most teachers still dispense information using lecture methods without regards to students learning abilities. The lecture method of teaching is theoretical, extremely didactic and teacher-centered instead of being practical or student/activity-based. Lectures are usually and generally described from the instructor's point of view, where the student's need for interaction with the teacher is not addressed. Thus, lack of interaction (teacher-student relationship) is considered as one of the major limitations of the lecture method as described by (Maryland, 2012 and Yeung, 2006). McCoy (2005) and Obeka (2010), in their individual research observe that lecturing is frequently a one-way process unaccompanied by discussion, questioning or immediate practice, which makes it poor teaching method, boring and does not inculcate meaningful learning.

According to Abdulraheem (2012), the amount of material remembered by students immediately after a lecture is comparatively low, ranging from a maximum of 39.6% to as little as 5% in most cases. He also reported that a number of studies aimed at comparing lecture method with other teaching methods have been carried out and shown that 'lecture' is not particularly effective in achieving a desired cognitive objective (i.e. ability to apply such basic facts and principles, comprehending, analyzing, interpreting, synthesize) or in achieving affective and psychomotor objectives. Arisi (2002) in a related study on the effects of instructional methods and cognitive style on students' academic achievement in Junior Secondary School Social Studies examined three

methods, Advanced Organizer (ADO) Problem-Solving Inquiry (PSI) and Activity Discussion method (ADM), in the studies found that all the three had positive significant effects when compared to lecture method. Conventional lecture method is thus, a “one-way traffic” type of classroom interaction in which the teacher talks and writes notes on the board while the students listen and copy down notes. Students’ participations are minimal and they are not given the opportunity to give a feedback to the teacher. This method has been reported not supporting academic performance of low performing students, Njoku (2002).

However, no specific method has been set aside for the teaching of biology. Teaching methods such as inquiry, demonstration, guided discussion and use of audio-visual materials have been recommended for the teaching of science in schools. (Macdowell, 2012; Rogus 2005; Adedoyin 2007; New Secondary School Curriculum 2008). There is however the need to understand that different topics in science demand different approaches to the teaching. Therefore, the teacher should be conversant with the use of variety of teaching methods. Conventional Teaching Method is a “one-way traffic” type of classroom interaction in which the teacher talks and writes notes on the board while the students listen and copy down notes. Students’ participations are minimal and they are not given the opportunity to give a feedback to the teacher. This method has been reported not supporting academic achievement of low performing students.

In this present study therefore, Laboratory and problem-solving teaching strategies were used to determine if the result would be similar or different with that of Baja and Asim (2000) when compared the effects on students’ retention academic performance, and attitude towards biology.

Several other methods of teaching have been employed by teachers in biology ranging from:

- Project method
- Demonstration method
- Individualized learning
- Discovery (Guided and unguided inquiry method)
- Discussion Method
- Investigative method and Field trip method

#### **2.4.4 Factors that Affect the Teaching of Biology**

The significant position of teaching biology in secondary schools and colleges in our contemporary society cannot be overemphasized. Research has shown that biology enjoys more patronage by students than the other science subjects such as physics, chemistry etc. (Battle and Lewis 2002., Thomas, 2002 and Anyanwu, 2012). It has been reported however, that the failure rate in biology is highest compared to the other science subjects. Anyanwu (2012) is of the view that poor results in biology might be due to indiscriminate patronage by students, both the serious and unserious ones and also the fact that the subject is prerequisite to professions such as Pharmacy, Medicine, Agriculture, Biological Sciences, Micro-biology, etc. (Aganga, 2005) reported that there is no subject that is in greater need of constant re-evaluation than the science of biology.

The following sub-headings noted are some of the problems associated directly or indirectly with the teaching and learning of biology:

- Lack of Improvised and instructional materials
- Lack of qualified and experienced teachers.
- Lack of interest on the part of students.
- Inadequate laboratory equipment.
- Improper teaching methods.
- Lack of guidance and counseling.

- Attitude of parents towards their children's choice of careers.

Improvisation is the act of using alternative materials and resources to facilitate instruction wherever there is lack or shortage of first hand teaching aids. Improvisation according to Adamu (2003) is expected to help, though in varying degrees in the following aspects of learning; The major setback in the teaching and learning of biology is lack of instructional materials especially laboratory equipment. Essential textbooks are also lacking in the libraries thereby making the job of teaching and learning of the subject difficult. Learning science requires constant practice in the laboratory and reading within and without. In a situation where this is not possible due to lack of relevant materials, students are greatly disadvantaged. The inability of practical materials in particular often compels the teacher to resort to lecture method of teaching negating (opposing) the demonstration and student participation approach. (Kalu and Ndokwo, 2006) suggested the use of locally made materials in place of foreign sophisticated ones. According to them, this will go a long way to stimulating, motivating and developing students' interest in the teaching and learning of science especially biology.

Obeka, (2010) reported that instructional materials/teaching aids have profound influence in teaching and learning. Notwithstanding, a vast number of teachers' underscore this glaring fact. He concluded by saying that any teacher who is concerned about his public's/student's development is bound to give thought to issues that will enhance teaching and learning. To him teacher's job largely consists of communication experience to the child, which he does by sound and sight. Teaching aids such as tape recorders encourage active intelligent participation of the child and facilitate learning and listening skills.

The historical background of improvisation is dated back to 1946 after the Second World War (UNDP, 2005). This idea arose as alternative source to conventional materials

for instruction in schools as an aid to countries affected by the War. Any successful effort in teaching and learning of biology must see improvisation as a necessary tool. In other words, there must be appropriate use of instructional materials whether improvisation or real ones in order to aid meaningful teaching and learning of the subject especially at the secondary school level. Teaching biology demands practical lessons which help to give the students first-hand experience as they learn by doing. Hence, improvisation of materials, aids specially film, models and photographic survey research has peak in the biological sciences, Ahmed (2011).

According to Volkmann and Abel (2003), to assess the effectiveness of teaching and learning using improvised materials, certain variables are taken into consideration which includes: the teacher, the learner, and the learning environment. Thus, any improvised instructional materials that fail to satisfy the intended use will create confusion rather than understanding. Again, if stakeholders in the teaching and learning i.e the teacher, the learner and the laboratory staff are given adequate orientation, regarding the way forward in improvisation, greater achievements would be recorded in the study of science of biology.

Kalu, (2005) stressed that a professionally qualified biology teacher is one who has acquired the required skills and knowledge needed to teach the subject, such teachers include the NCE, B.Sc.Ed, M.Ed, Bsc/PGDE. Akale (2000), found a significant difference in the performance ofSS1 students taught by professionally trained teachers and the unprofessional ones,in his study, he observed that the quality of teaching depends on the training and qualification of the teacher. It is therefore not surprising that the Federal Government of Nigeria established under decree 3 of 2013 the National Policy on Education (NPE) had made recommendations on the full development of teacher education and teacher training institute.

Chiappetta and Koballa (2002) and Alhassan (2006) observed that the colleges of education are better suited than the university for the training of teachers particularly those that will function at the pre-primary and post primary levels of education. According to Yusuf and Balogun (2011), it is worthwhile to assess the performance of students as schools are responding to NCE as the minimum qualification for teaching especially in primary schools. This is so because low quality trained teachers will have serious consequences on teaching including poor performance of students.

It is believed that no matter how good and efficient the aims and objectives of an educational program may be the achievement of any program is mostly determined by the teacher (Inyan and Mahmond 2004). Ajaja and Eravwoke (2012) observed that the success of biology teaching depends to a large extent upon the quality, quantity and the devotion of biology teachers at different levels of education. Inyan and Mahmond (2004) and Macdowell (2012) in their separate works on survey of science teaching in Nigeria stated that the present ineffective teaching of science is limited by the employment of inexperienced and untrained caliber of teachers who do not remain in one school long enough to provide the needed continuity on science program. In his opinion, the problems facing the teaching of science is not just that of employing inexperienced and untrained teachers; but also indiscriminate transfer of teachers from one school to another as well as mass exodus of trained teachers from their profession to more attractive and rewarding careers. He also reported that enough graduates abound in Nigeria but science educators among them are scanty. Thus the few available ones are being overworked. In another view Kalu and Ndokwo (2006), opined that the problems of biology teaching in Nigeria should be addressed especially such areas as the syllabus, teaching methods, teaching aids including relevant literature and evaluation methods. Lawal, (2011) attributed the high failure rate in biology to a number of factors such as lack of qualified teachers, inadequate

learning facilities, inappropriate use of teaching and learning methods, over populated classes and over loaded curriculum.

Abdulazeez (2006) stated that the causes of poor performance in secondary school students in biology include the following:

- Low quality teaching
- Poor staffing conditions
- Administration of incapable students.

Also Rogus (2005) and Yusuf (2010) reported that science teaching is still suffering from numerous constraints such as lack of adequate teaching facilities, lack of trained science teachers, inadequate funds to purchase and maintain infrastructural facilities, overcrowded classrooms etc. Biology, like other sciences has been plagued by the problem of poor performance in recent times. Along the line, Adedoyin (2007) asserts that since the 1960s, Nigeria students' performance in biology have remained consistently poor, with biology having the highest enrolment and poorest results. Anyanwu (2012) examined SS1 biology syllabus and found that students have difficulties in learning some concepts. The findings of Maduabum (2004) and Alhassan (2006) showed that biology teachers in secondary schools perceived a good number of topics in the SSCE level biology syllabus difficult to teach. Olarewaju and Balogun (2005) and also Alhassan (2006), identified genetics as one of the difficult aspects in secondary school biology. It is documented that students have difficulties in learning ecology (Aiyedun, 2000; Poewell and Trowbridge, 2008 Adeniyi, 2009; Balani, 2010).

Although many factors may account for student's poor performance in biology, one of such factors might be student's difficulties in learning some concepts in secondary school certificate biology. Majority of students who sought to study biology do so in the assumption that it is relatively easier than other science subjects and perhaps the only

science subject to select after running away from physics and chemistry (Adedoyin, 2007). However, such students are usually disappointed in the end, particularly when they equally approach the study with least commitment as they do in the Arts subjects. In his findings, Ali, (2008) reported that learning and understanding of biology and science in general is likely to be more effective if learners are actively involved in first hand manipulative experience during laboratory activities. They confirmed the belief of developmental psychologists like Kennedy (2000), and Schuman (2008) that active manipulation of concepts and objects is important in teenage students. The study emphasized the central position of manipulation of concrete objects in science and this is an important learning strategy.

Sharehu (2010) found out that shortage of finance to purchase necessary laboratory equipment is one of the factors affecting the new National Policy on Education (NPE) and some subjects, especially biology in secondary schools. For better teaching and learning of biology, there must be a well-planned program, well equipped and furnished laboratories for valid outcome. Thus, Bichi (2002) confirmed that the whole work of science is centered on problem solving. A well planned laboratory work affords convenient learning processes of careful observation, accurate calculations and logical conclusion. This convenient learning can only be possible in the presence of the operational materials. Ofeegbu, (2007) in his findings on availability of biology equipment's has this to say. "All the secondary schools studied did not have enough equipment, visual aid or chemicals either by way of varieties or quantity.

Also, Akubilo (2004) and Agwilo (2007) discovered that out of 75 essential items prescribed by WAEC as part of laboratory facilities, the highest quality available in any of the schools he studied was 24 which give 32% score. While some schools had no apparatus at all. He therefore concluded that facilities in schools were inadequate on the

80 essential chemicals recommended, it was found that 15 (18.78%) was the highest quantity met in any school. And the question of inadequacy was found not to be limited to only experimental manipulated items, the studies also showed that infrastructure were inadequate in the laboratories (Marzano, 2011, Osuafor and Okigbo 2013). The issue of non-availability of materials becomes more touching when it is recalled that student can only be oriented to handle what is available without which effective instruction cannot take place.

It can then be concluded from the statement that instructional aids and laboratory facilities can affect the performance of students in science and biology subjects in particular. Students need to develop objective and critical thinking towards science by asking questions and using enquiry methods of solving problems through laboratory work (Sanjaya 2007). This shows that the unavailability of good and well equipped laboratory for effective teaching and learning of science, may lead to poor performance of students in science particularly in biology. According to Otagburuagu (2012), laboratory facilities are of paramount importance as far as biology teaching is concerned because they:

- Bring about meaningful, interesting and permanent learning experience;
- Provide means of extending experience by seeking to provide first-hand information;
- Also provide the real facts of what is to be learnt especially when they are effectively used during experimental and practical work.
- Odenbaugh (2005) and Otagburuagu (2012) in their individual reports on the facilities for science teaching in Nigeria, said financial difficulties faced by secondary school act as hindrance in the procurement of facilities and equipment for teaching science especially biology.

Uchenna (2013) observed that in schools today, many students perceive biology as difficult because of lack of center illustrations and meaningful interaction with biology materials and equipment, it has been observed that a concrete effort by the teacher to present learning materials to the students and permitting them to manipulate things will help to reduce failure rate in biology subject.

Family background is a collective terminology comprising of social class/status, economic status, family size, family structure, parents' educational level, occupation and other factors pertaining to family life. Thus, the family has the potential to influence a child's academic achievement. This is because it is the first environment of the child, and the initial experience that sharpen the child's values, aspirations, emotions, interest and attitudes are offered by the parents/family (Hofstein, Novon, Kipnsi, and VeNaaman 2005., Krashen, 2005., Henes, 2008). Similarly, Obasi (1999) observed that mere making sure that the children are prepared for school in the morning is important for the children's successful achievement at school. The important of this, lies on the fact that it awakens the consciousness of biology teacher to the fact that students come from different family background and therefore have different upbringing.

## **2.5 Students' Attitude and Academic Performance in Biology**

The word 'attitude' has been variously defined by many authors. Ahmed (2011) defined attitude as the predisposition to react positively or negatively towards object, ideas, institution or people. By predisposition it means the state of readiness to respond in some preferential manner towards a specific object, event or idea. Thus, if students hold positive attitudes towards a particular course or subject e.g. geometry, it is relatively easy to lead them towards desirable objectives (high geometry achievement). Chen and Howard (2010) defined attitude as relatively endeavoring tendency to respond to

somebody or something in a way that reflects a positive or a negative evaluation of that person or thing.

The term 'attitude' refers to a hypothetical construct, namely a predisposition to evaluate some object in a favorable or unfavorable manner (Olaewaju and Balogun 2011). This predisposition cannot be directly observed and is inferred from individual's response to the attitude or object, which can run from overt behavior to covert responses. Moor, (2006) posited that attitudes logically are hypothetical constructs (i.e. they are inferred, but not objectively observable). They are manifested in conscious experience, verbal reports, overt behavior, and physiological indicators. Elijah, Lynn and Jason (2015) stressed that the concept of attitude arises from attempts to account for observed regularities in the behavior of individual persons. Thus, attitude can be positive, favorable, neutral, negative or unfavorable, one's inner experiences are evidence of one's own attitude. Therefore, if students experience some difficulties in learning geometry, they will manifest unfavorable attitudes towards the subject. Favorable and positive attitude of students towards geometry is facilitated by good and suitable instructional approach hence it will yield high level of performance and retention of the concept, (Elijah, Lynn and Jason 2015). Bature, (2005) and Bilgin (2009) in their individual studies observed that major determining factors for attitude formation are the individual wants, information on group affiliation and personality. He further asserted that the importance of attitude arises from the fact that it has strong influence upon behavior and kinds of satisfaction and values the individual chooses. He believed that method of instruction influences attitude of students towards learning in the classroom. Sambo (2008) argued that the measurement of attitude is a complex matter and cannot be observed directly, but can be inferred from the way individual student reacts to a particular stimulus or situation.

Arigbabu and Mji (2004) also attempted to analyze attitude of student towards mathematics in their study by using mean scores. He said, 'if mean score lies between 0.00 and 1.5, it shows negative attitude, while if the mean scores lies between 1.50 and 5.0, it shows positive attitude'. His study revealed that students' attitude towards mathematics is believed to affect their performance either negatively or positively. He went further to say that attitude determines readiness or reluctance of students to embrace any new idea. It also facilitates or hinders students' desire to learn or acquire new idea or techniques. Wikipedia 2014 defined attitude as a way of thinking a posture of the body feeling informal self-confidence, self-esteem or hostile behavior of a person or individual. White (2009) and Balani (2010) reported that attitude is a critical factor in learning and stated that attitude is the basis for motivation in learning. Adegoke, (2011) argued that learners bring the attitude they acquire from home to the classroom and it has the capacity to facilitate or hinder learning. He then recommended that significant effort have to be made to develop and evaluate attitude shaping techniques for the benefit of the students in school. Much reference has been made to the teacher-related factor in attitude performance relationship.

Mukhejee (2012) stressed that the teacher has a major role to play in shaping the student's attitudes towards their teaching. Kalu (2005) and Anyanwu (2012) in their separate researches reported that the teacher's attitude and performance affect their students in science subjects. According to Alhassan (2006), research findings have intended to suggest that both intellectual and non-intellectual variables contribute significantly to the poor academic performance of students. Mukhejee (2012) observed that lack of study habit of students, lack of commitment, high rate of truancy, lack of contribution during lessons, inability to study, neglect of assignment, influence of peer group and pleasure seeking attitude contribute considerably to students' poor

performance. Attempts to identify the underlying causes of this trend for the most part involved quantitative analysis of student's enrolment rationales and their attitude to science (Alhassan, 2006 and Abdulrazak and Babikko 2012).

Students' attitudes toward science can be improved through non-formal learning which creates positive attitudes towards sciences, by encouraging learners to learn science and maximizing opportunities in society for scientific applications and biology is not left behind to this order (Salami, 2000., Adebajo, 2014 and Ahmed 2011). Thus, biologist and science researchers are concerned with the problem of how to improve the student's academic performance. In this study therefore laboratory and problem-solving strategies were used to see whether attitudes, retention and academic performance in biology students of varied abilities would improve among Senior Secondary School in Zaria Kaduna state.

Blair in Obeka (2009), has this to say, "to achieve is to accomplish or gain by effort or to do something successfully with an effort and skill". Alan, (2000), on the other hand maintained that academic achievement concerns mental health care. According to him, mental health has its basis, physical health, and intellectual skills which lead to satisfactory means of adjustment, social sensitivity and adequate self-concept. That is to say that academic performance of a child is based on the degree of intellectual stimulation that the child could receive from learning situation. Obeka, (2009) noted that teachers play vital and crucial role in the development of performance motive of the learner by providing a conducive environment for learning in and outside the class. He stated that in a classroom environment where the standards are too low, boredom, poor morale, idleness and noisy behavior leading to poor academic performance can set in. The relationship between gender and the academic performance of students has been discussed for decades. According to Eitle (2005), A gap between the achievement of boys

and girls has been found, with girls showing better performance than boys in certain instances (Chambers and Schreiber, 2004). Gender, ethnicity and father's occupation may be major contributors to student's academic performance (Mccoy, 2005).

## **2.6 Varied ability and Academic Performance in Biology**

Varied ability level is the level at which individual students can comprehend and be able to recall and remember learnt concept according to his or her cognitive (Lakpini and Atadoga 2012). Performance of every individual is not equal, there is a lot of variability and disparity. There are three levels of ability ie high, middle/average and low ability. A retention interval on the other hand is the time limit between a test of original learning and that of a retention test, thus knowledge retention is defined as the proportion of knowledge retained by an individual after a specific retention interval.

Lakpini, (2006) categorized the ability level of students as follows:

Top 25% =High ability

Middle 50% =average ability

Bottom 25 % = low ability.

In a search for the solution to underachievement, different ability levels of students have been identified as another major factor affecting the performance of students in biology. Alant, (2004)studied students' intellectual ability and discovered that students of varied ability levels performed differently depending on the type of method of instruction. Adesoji, (2008) opined that students are not the same especially when we consider the rate at which facts and principles in science are being assimilated. This implies that the rate at an individual performs his task differs. The ability level of students is a construct of its academic achievement. Salami (2000) discovered that students' performance depends on its cognitive ability. Studies have shown that learners are qualitatively different in their ability levels and in learning problems. Adesoji, (2002) ascertained that

method of instruction can improve the academic performance of students of low ability level. He also stated that problem-solving strategy were effective in teaching students of different ability levels. Okebukola, (1992) confirmed that the use of appropriate instructional strategies can influence the academic performance of low achieving students.

### **2.6.1 Retention of Learned Concepts in Biology**

Three main principles pertaining to knowledge retention have been identified

- i. Knowledge retention between 75-89% of its original level after a relatively short period of time.
- ii. Retention rate decreases over time as a finding of the length of retention interval in a relatively linear manner.
- iii. All performers regardless of their individual levels of achievement have similar knowledge retention rates.

Retention is generally affected by two variables

- Duration of study session
- Temporal distribution of study time across the session

Retention of material and knowledge is the primary goal of every teacher, but in today's school, it is common for a student to learn a material copy note and forget the material soon after. Therefore, it is important to consider knowledge retention when evaluating learning strategies, however one such strategy is distributed learning also known as "spread practice; in this procedure, a total study time is held constant but is spread across multiple study sessions. For instance, if a student solves five-long division problems in one day and five others in one week, the study is thus distributed. Moreover, if same student solves all the ten (10) questions in the same day, it would be considered mass practice. However, at longer retention intervals, distributed practice procedures have

better retention than mass practice, this is termed “spacing effect. According to Arthur (2013), it is widely accepted that the longer the period of non- use of retained material, the greater the probability of decay.

Other factors, which affect the amount of skill decay includes:

- Task type
- Over learning

However, knowledge retention during learning can be enhanced and facilitated by the following:

- a. Using relevant teaching strategies
- b. Revising, Revisiting and exploring the materials taught.
- c. Increasing the number of testing trials during the learning process.
- d. Providing relevant and specified information to learners.

Current curricula trends of various countries are endorsed to engage students in biology science to use problem based/ experimental strategies in teaching. These strategies support students’ natural interest in science; students are engaged to make their own questions, test hypotheses, gather and present information from various sources. In contrast, traditional learning involves memorization of facts, which often results in students’ negative attitudes and poor retention towards science (Arthur, 2013). Thus, the researcher implores the use of laboratory and problem solving teaching to see if retention attitude and performance of learned concept in ecology would improve. Thus in traditional method, students’ logical understanding and curiosity cannot be supported and they cannot get opportunities to deal with nature. However, constructivist theory frames learning as an active continuous process whereby students construct meaning based on prior ideas and experiences, (Alan, 2000) through physically and mentally acting on objects. Constructivist theory models have been used to improve students’ motivation and

attitude toward science and biology in particular Boody Wastson and Aubusson (2003). Also, Mkpanang (2010) and Dulyemi, Olaginju and Olumide Hadson (2014) found out that students using visual aids e.g models, charts, computers etc had more positive attitude and retention towards biology and natural sciences than students who were educated by traditional style.

## **2.7 Gender and Academic Performance in Biology**

Gender issues have become the order of modern educational forum. The role of gender in science achievement test has resulted to studies over time by scholars. In Africa and Nigeria in particular, gender bias is still very prevalent (Arigbabu and Mji 2004). Nwosu (2004) in his study pointed out that “sex” roles are somewhat rigid in Africa and Nigeria in particular. Gender related issues have attracted the attention of many researchers in science education for male and female in secondary schools. Many studies have investigated the influence of gender on academic performance. The environment and the personal characteristics of learners play an important role in their academic success. The school personnel, members of the families and communities may provide help and support to students for the quality of their academic performance. This social assistance has a crucial role for the accomplishment of performance goals of students at school (Goddard, 2003). Besides the social structure, parents’ involvement in their child’s education increases the rate of academic success of their children (Fatokun and Odegboji, 2010., Nwona and Akogun 2015).

The relationship between gender and the academic performance of students has been discussed for decades (Eitle, 2005). A gap between the performance of boys and girls has been found, with girls showing better performance than boys in certain instances (Chambers and Schreiber, 2004). Gender, ethnicity, and father’s occupation are significant contributors to student achievement (McCoy, 2005., Fatokun and Odagboyi

2010). The performance of students is negatively correlated with the low Social Economic Status (SES) level of parents because it hinders the individual in gaining access to sources and resources of learning (Enoh, 2004; Erinosh, 2005., Fatokun and Odagboyi 2010 and Obochi, 2015). Shofolahan, (2009), observed that low SES level strongly affects the achievement of students, dragging them down to a lower level. This effect is most visible at the post-secondary level of education. Aiyedun, (2000), Barnard, (2004) and Fasiku, (2011) in their individual studies also stated that the economically disadvantaged parents are less able to afford the cost of education of their children at higher levels and consequently they do not work at their fullest potential.

Gender is one of the factors interacting with performance, and studies involving science and gender factors have been unresolved (Nwona and Akogun 2015). Gender issues; both on the part of the teachers and the students; have been documented to affect performance and some other learning outcomes (Aiyedun, 2000 and Erinosh, 2005). Gender gap in science education is an impediment to advancement in science and technology according to (Alebiosu and Ifamunyiwa 2003). Danmole and Adeoye (2004) reported that there is no gender difference in the students' achievement in ecology when exposed to concept mapping method. Contrarily, some researchers found that male students have a higher achievement than female students (Novak and Mosunda, 2000., Poewell and Trowbridge 2008), while the opposite is observed i.e. female students perform better than male students (Bilgin, 2009). Research reports are not explicit on the effect of gender on achievement. Zember and Blume (2011) reported that most studies show that girls perform better than boys in schools and observed in a study that girls, though enter Turkish universities with low grades, but upon their entry, outperform their male counterparts (Ceren, Ozlem, Semra and Sungar 2001). Njoku, (2012) Adu and Sheyin (2013) and Amedu (2015) in their individual studies reported no significant

difference in the mean score performance of boys and girlstaught with different instructional methods. This agrees with Uduosoro (2011) who found no significantdifferent between the performance of boys and girls in chemistry and mathemetics.

Mari (2002)investigated gender related differences in acquisition of formal reasoning: pedagogic implication of teaching Chemistry using process-based approach. The findings showed that the initial gap between the male and female subjects in formal reasoning ability was bridged in all the Schemata (Conservation, Control of variables, proportional reasoning, probability reasoning, and combinatorial reasoning) except in correlation reasoning. This is due to the fact that the process-based instruction tends to have stimulated higher reasoning gained in the female subjects than the male subjects. He recommended therefore, the need to use science process-based instruction in the early years in secondary school as a means to reduce, if not totally eliminate, the male/female negative attitude towards biology, Lagoke, Jegede and Oyebanje (2007).

Abduraheem, (2012) worked on gender differences and academic achievement in integrated science in Junior Secondary Schools. He confirmed that males performed better than females and affirmed that males demonstrated significantly more positive attitudes towards science than females. Owuamanam and Babatunde (2007) also noted that females exhibit more positive attitudes towards Biology and males towards Physics. They noted that the girls tend to go for courses that do not require more energy and brain tasking such as home making while boys looked for jobs in management, engineering, banking and other brain-tasking professions. In a research carried out in London, Claire (2005) observed that girls excluded or self-excluded from formal education were rampant among African girls than White girls.

In another research carried out in London, Claire (2005) highlighted the high number of black girls being excluded from school and also looked at the way language is used in education. Both ethnicity and social class are factors which combined and interacting with gender and are seen as having a direct negative effect on achievement and performance of students. Okebukola (2004) and Abdulraheem (2012) noted that gender inequalities are interwoven with social class, ethnicity, sexuality and disability and these are other factors identified as influencing performance.

Adebanjo (2014) linked academic achievement with patterns of behavior. He noted that there are signs of boys being vulnerable to becoming disaffected. He explained further that boys tend to be less careful about rules and more indifferent to being reprimanded. Njoku (2002) determined the effects of mixed-sex and single-sex grouping strategies in co-educational classrooms on girls' acquisition of Physics process skills. The results showed that girls in single-sex group scored significantly higher in Physics process skills than girls in mixed-sex group. The differences in achievement may have originated from the differential opportunity to engage in learning tasks. Njoku, (2002), Lagoke, Jegede and Oyebanjo, (2007) noted that it is possible for boys in the mixed-sex group to deny the girls chance of participating in most of the activities during teaching and learning process because the boys always claim to be superior to the girls and as a result of this, they normally dominate the group and this could lead to a better performance of the boys than the girls in the group.

Head, Kane and Cogna (2002) revealed that boys are also more likely to be referred to Behavioral Support Services. Younger, Warrington, Gray, Rudduck, McLellan, Bearne, Kershner and Bricheno (2005) cautioned by pointing out that there are many boys who continue to do well in school and only few of them become affected. Of particular interest is the fact that girls, to a large percentage, avoid physical science subjects when

choice is offered. Studies indicated that girls who are more satisfied with school life and their school-related attitudes are more positive than those of boys (Head, Kane and Cogna 2002 and Younger *etal*2005). They explained further that the intellectual potential of girls is an untapped labour resource for science and technology. Average levels of attainment for boys are lower than those of girls at all stages and across almost all areas of the curriculum (Croxford, 2000). A similar picture can be observed in England and Wales (Younger *et al* 2005).(Anyanwu 2012) examined the biology syllabus and found out that students have difficulties in learning some concepts. The findings of Maduabum (2004), shows that biology teachers in secondary schools perceived a number of topics in the biology syllabus as difficult to teach. Maduabum (2004) identified genetics as one of the difficult aspects in secondary school biology. It is also documented that students have difficulties in learning ecology. Although many other factors may account for students' poor performance in biology. Bomide (2009) observed that students had difficulties in coping with certain concepts and topics in biology due to their cognitive complexity. This study therefore investigates the impact of laboratory and problem-solving strategies to see if the attitude, academic performance and retention of SSII biology students of varied ability levels would improve.

## **2.8 Overview of Similar Studies**

A number of studies have been carried out on the impact of instructional strategies on students' performance and learning outcome.

Adu and Sheyin (2013) conducted a study to investigate the Effects of activity-based Instructional Strategy on academic achievement of pre-service teachers in ecology at Ilorin, Kwara State, Nigeria. A quasi –experimental design which involved pre-test, post-test and control groups, consisting of the experimental group that was exposed to Computer-Based Instruction and the control group that received conventional/traditional

teaching method. 230 NCE Biology students both male and female were sampled from the population of all students in Nigerian Colleges of Education. Data were collected by using Achievement Test in Ecology (ATE), after six weeks of treatments, data were collected and analyzed using ANOVA. The hypothesis was tested, the result showed that there was significant effect of treatment on the achievement of students taught with Instructional Aids  $F(1,229) = 138.255, p < 0.05$  and those taught with lecture method. And there was no significant main effect of gender on the students' post-test academic achievement scores ( $F(1,229) = 209$ ). There was no significant interaction effect of treatment and gender on students' academic achievement in ecology at the post test level ( $F(1,229) = .234$ ). The present study is similar in terms of topic (ecology) and academic performance, but added attitude, retention and varied ability levels. While the former worked with NCE students the present study sampled SSS2 students in Zaria metropolis. Therefore, the studies are different in aspect of instructional aids, level and location.

Ahmed (2011) examined the relationship between attitudes towards biology courses and students' biology achievement in Isfahan. A total of 185 grade 12 (age 17-18 years) students in Isfahan answered to a 30-item questionnaire provided by authors based on Simpson Troost Attitude Questionnaire-Revised (STAQ-R) inventory developed by Owen 2008, to assess adolescent commitment and achievement in science. The results showed that among attitude towards science dimensions, only "biology is fun for me", have meaningful and positive relation with students' achievement in biology. Also there was no significant difference between girls and boys in attitude towards biology, although girls had better achievement in biology in comparison with boys. The present study is similar to this study in terms of gender and attitude of students towards biology. But different in terms of methods and locations.

Ojediran, Oludipe and Ehindero (2014), investigated the impact of laboratory-based instructional intervention on the learning outcomes of low performing senior secondary students in Physics in Ile-Ife, Oshun State, Nigeria. The study adopted the pre-test and post-test control group quasi-experimental design. The treatments were at two levels (LBII and CTM). A total number of 194 SSS II students participated in the study. Physics Achievement Test (PAT) was the main instrument used to collect data from students. The data collected were analyzed using descriptive statistics and t-test, using SPSS 15.00 statistical packages at 0.05 level of significance. The results of this study indicated that there was significant difference in the achievement in Physics of low performing students exposed to laboratory-based instructional intervention (LBII) and those exposed to conventional teaching method (CTM). The study concludes that the use of laboratory based instructional intervention method of teaching should be embraced as a good asset to Physics Students and teachers in the senior secondary schools. The study is similar to the present study in terms of method and both used SS2 Students, but, different in subject and location.

Osuafor and Okigbo (2013) carried out a study to investigate the effect of laboratory and discovery instructional strategies on the academic achievement of SS1 biology students in Akwa Anambra State, Nigeria. The research design was quasi experimental that employed a pre-test, post-test non-randomized equivalent groups. A total of 67 biology students found in two intact classes in two randomly selected schools were used for the study. The instrument used was Biology Achievement Test (BAT) which was validated and used for the data collection. The instrument had a reliability coefficient of 0.86. Data collected were analyzed using 'Mean and ANOVA', result obtained showed that there is a significant difference between the achievement of students taught with laboratory instructional method and those taught with traditional method. The

present study samples SS2 students using Laboratory and Problem solving strategy to motivate and stimulate learning. Both works are however similar in terms of subject, but the present study added attitude and retention of ability levels of SSSII in Zaria Kaduna State.

Obochi, (2016) investigated the effect of age and gender on attitude, academic performance and retention` on Senior Secondary (SSII) Biology students in Zaria Kaduna State. The sample size used comprises of 120 students [60 males and 60 females] selected at random from four Senior Secondary Schools. The instrument used for data collection was Students age and academic performance questionnaire(SAAPQ). The result obtained was analysed using frequency tables, simple percentage and ANOVA which was tested at 0.05 level of significance with Pearson Moment Correlation coefficient(PMCC). The results of the study indicate that there is a significant difference between age, gender and academic performance of students in Biology. There is a significant difference in the mean score of students' attitude and retention ability of those older in age with those younger in age taught with different teaching method. Students between the ages of 12-16 perform better than those between 19 years and above. The researcher recommended among others that teachers should use different methods in teaching biology subject. The older ones should be giving opportunity and encourage to ask and answer questions in the class. Learner centered approach should be used more often to encourage students' participation in class, effective use of science laboratory should be encouraged to improve performance of biology students.

Ezeudu and Okeke (2013) investigated the effects of simulation and problem-solving on students' academic achievement of SSII Chemistry students in Enugu State, Nigeria. The design of the study was quasi-experiment with a sample of 159 SSS2 students (80 males and 79 females). The results showed that simulation increases

students' achievement in chemistry more than traditional method. The study is similar to the present study in that the population is both SS2, but different from the present in terms of subject and location.

Obeka (2010) conducted a study on effects of problem-solving and demonstration methods on achievement and retention among SS1 and 2 students in Geography. 225 students were sampled for the study. Geography Achievement and Retention Tests (GART) were the instrument used for data collection. ANCOVA was used for the statistical analysis. The result of the study showed that there was no significant difference in the academic performance between inquiry, problem solving and demonstration teaching methods. The study used problem solving and demonstration methods in Geography while the present study implored laboratory and problem solving strategies in teaching biology. Beside, in the present study, attitude, retention of ability levels and gender were added. The study used ANCOVA to analysis the data while the present study, ANOVA, ANCOVA, and Kruskal wallis were used.

Lakpini (2006) investigated the effect of Conceptual Change in Instructional Strategy, using Powerful Ideas in Physical Science (PIPS) instructional model on achievement, retention and attitude of secondary school students with varied abilities in Zaria Kaduna State. One hundred and twenty (120) students, sixty (60) from each school were drawn from two senior secondary schools in kaduna State. High, average and low ability levels were determined using their continuous assessments scores and pre-test scores. Top 25% were ranked the high, middle 50% were the average while the lower or bottom 25% were the low ability group. Genetics Achievement Test (GAT), Biology Attitude Questionnaire (BAQ) and Conceptual Change Instructional Package (CCIP) were used for data collection. Five hypotheses were formulated at  $P < 0.05$ , from the result of the study, it was reported that the experimental group taught using PIPS

performed better than the control group among the ability levels. She recommended among others that Conceptual Change Strategy should be incorporated in teacher training program at secondary school levels.

Afolabi and Akinbobola (2009) investigated the effects of constructivist problem based learning technique on the academic achievement of physics students with low ability levels in Nigerian secondary schools. Quasi experimental design involving pre-test, post-test and control group was adopted for the study. A purposive sampling technique was used to select 2 schools out of 40 co-educational secondary schools in Taraba State. 105 senior secondary school II physics students were used for the study. Physics Achievement Test (PAT) and Physics Ability Level Test (PALT) were used to collect data. The Kuder- Richardson coefficient of internal consistency for PAT and PALT were 0.72 and 0.76 respectively. Three Hypotheses were tested at  $p < 0.05$  level of significance using t-test analysis. The result of the finding showed that the physics students with low ability level taught with problem based learning technique performed significantly better than those taught with conventional teaching method. Also, generally students taught with problem based learning technique performed better than those taught with conventional lecture method. There was no significant gender difference in the performance of male and female students taught with problem based technique. It is therefore recommended that problem based learning technique should be used to teach various concepts in physics in secondary schools. The work of Afolabi and Akinbobola involved only one strategy and was carried out among low ability SSI physics students in Taraba State, while the present study used two instructional strategies and was carried out among biology students of varied ability levels in Zaria Kaduna State.

Ajaja (2013) investigated the effect of 5E learning cycle and cooperative learning groups and compare with those taught using concept mapping and lecture methods with

the intention of identifying which one among them could be suitable for teaching biology in Ibadan Oyo State. To guide the study, four research questions were raised and tested at 0.05 level of significance. The design of the study was pre-test, post-test, delayed post-test, quasi experimental repeated measures design was used. The population samples of the study consisted of four mixed secondary schools with 259, SS2 students and eight Biology teachers. The major findings of the study include: significant effect of the four instructional methods on achievement and retention; students in the 5E learning cycle and cooperative learning groups significantly outscored those in the concept mapping and lecture groups on performance and retention tests; students in concept mapping outscored those in lecture method group both on immediate achievement and retention tests; students in 5E learning cycle and cooperative learning groups did not significantly differ on performance and retention tests; males and females in all the four groups did not significantly differ on the performance tests; and a non-significant interaction effect between sex and method of instruction on performance. It was concluded that the adoption of either 5E learning cycle or cooperative learning strategies may be appropriate for the teaching and learning of biology. The study is similar to the present study in terms of population i.e. SS2 and subject. The former was carried out in Ibadan while the present study was in Zaria Kaduna State.

Ibe, (2013) observed that the performances of the students in the Researcher-Made Biology Test (RMBT) using the expository method and guided- inquiry were compared. Furthermore, the interests of the two groups of students in Biology were compared. A purposive sample of 84 senior secondary school two (SSS II) students was drawn from two intact classes in a co-educational secondary school in Imo State. Two instruments were used for the study namely Biology Achievement Test (BAT) and Biology Interest Scale (BIS). The reliability of BAT was established at 0.78 through the use of Kuder-

Richardson (K-R 20) statistic. The reliability of Biology Interest Scale (BIS) was calculated through the use of Cronbach Alpha statistic and the coefficient of 0.91 obtained. The research questions were answered using Means and Standard deviations while the hypotheses were tested using Analysis of Co-variance (ANCOVA). Major findings of the study include: Teaching methods have statistically significant effect on students' performances in Biology. Students taught with guided-inquiry teaching method out-performed students taught with expository teaching method in Biology. The female students out-performed the males in the RMBT. The female students have higher interest levels in the RMBT than the males. The researcher recommended among other things that Biology teachers and Science teachers in general should take into consideration these teaching methods when presenting Biology and science materials to the students in the classroom.

Bichi (2002) investigated the effects of problem-solving instructional strategy and enriched biology curriculum in secondary schools in Zaria, Kaduna State. The researcher used experimental design and sample size of 156 SSII students. Research questions and Null hypothesis were analyzed using t-test at 0.05 level of significant. Biology Achievement Test (BAT) was used as an instrument for the data collected. The researcher used t-test as statistical tool at  $P < 0.05$ . His result revealed that there was significant difference in the academic achievement of students exposed to problem-solving with enriched curriculum and those exposed to the conventional method. Thus, this study investigated the impact of problem-solving teaching strategy on attitude, academic performance and retention among SSII biology student with varied abilities.

Odegboji,(2015) examined the effect of gender on the achievement of students in biology using the Jigsaw method in Akwanga, Benue State Nigeria. The sample was made up of 87 students of SS1 in a secondary school. The study utilized an intact class

comprising of 39 males and 49 females. The Biology Achievement Test (BAT) was constructed from past WAEC questions. A pretest and posttest were used and the results were collated by gender. A t- test analysis showed that there was no significant difference between the mean scores of boys and girls. The class was taught, topics in microorganisms for 12 weeks. At the end of the 12 weeks, the BAT was administered as posttest. The results were analyzed using the t-test at 0.05 level of significance. The results showed that there was a significant difference between the mean scores in favor of the males. This showed that the males gained more from the jigsaw method compared with the females. It was recommended that in order to get the best out of instruction, various methods, or a combination of them must be employed.

Seyhan,(2015), conducted a study to compare the effects of problem-solving applications (PSASL) and a research-oriented teaching method in science laboratory. 98 prospective science teachers, who were composed of 50 prospective teachers that had participated in problem-solving applications and 48 prospective teachers who were taught within a more researcher-oriented teaching method in science laboratories. A pre-test–post-test control group design was used. In the study, data were obtained using the “Problem Solving Inventory (PSI), “Science Process Skills Test (SPST)” and “Test of Logical Thinking (TOLT).” After the PSASL, five prospective teachers were selected among the experimental group and were interviewed using the fully structured interview form about the “PSASL” and the process it involves. Interviews were used to augment the quantitative data. According to the results obtained within the scope of the study, it can be observed that the effect of PSASL on the perception levels of problem solving skills, scientific process skills and logical thinking skills of prospective teachers is more effective than the more researcher-oriented teaching method application. In addition, the results obtained from interviews with prospective teachers’ ideas in the experimental

group about PSASL were parallel with the past test results. The present study implored the use of laboratory strategy to see if the attitude, academic performance and retention of SSII biology students with varied abilities in Zaria zone would improve.

Isiaka and Charles (2013) investigated the effect of cooperative, competitive and individualistic instructional strategies on the performance of high, medium and low academic achievers using video instructional package. A total of 120 SSII mathematics students were randomly assigned into cooperative, competitive, individualized and conventional teaching strategies. Students from each group were stratified into high, medium and low achievers. Video Instructional Package (VIP) on mathematics and Geometry Achievement Test (GAT) were used as treatment and test instruments, respectively. ANOVA and Scheffe test were used for data analysis. The results of the finding indicated that there was significant difference in the performance of the three groups in favor of cooperative learning strategy. Students' achievement levels had significant influence on their performance in competitive and individualized instructional strategies. Therefore, the present study implored the use of laboratory and problem-solving teaching strategies to see if the attitude and academic performance and retention of SSII students with varied ability in Zaria Educational Zone would improve.

## **2.9 Implications of Literature Reviewed for the Present Study**

This study has reviewed some related literature on the previous works done to the problems which are being faced in the teaching and learning of particularly ecology concepts in biology. It has also looked at conceptual framework of the study, effects of other teaching methods, and academic performance in the teaching and learning of biology and the effects of the teaching strategies on the students' retention of ecology concept among students of varied abilities. The major factor is the failure of the most

science teachers to use appropriate teaching strategies or methods which can enhance student's confidence and academic performance in science.

Many research works such as (Eitle, 2005., Oko, 2011., Egbunonu and Ugbaja 2011), aimed at comparing lecture method and other teaching methods have been carried out and shown that lecture method was not particularly effective in achieving higher cognitive objectives or in achieving affective and psychomotor objectives. From the literature reviewed, activity-based teaching methods such as guided inquiry, discovery, problem-solving among others, may facilitate and enhance both academic performance and self-efficacy of students. Teaching and learning of science/biology via laboratory and problem solving strategies may not only enable students grasp scientific information but also develop fundamental understanding and ability to conduct scientific investigation and inquiry.

So far, most of the works done using laboratory and problem-solving instructional strategies to boost academic performance and retention ability on students were mainly in physics, chemistry and some social sciences in other parts of the country, (Temel and Morgil 2012., Temel and Morgil 2013 and Temel 2014) worked on problem-solving application in chemistry, through cooperative grouping versus individual problem-solving, while Michael (2007) worked on experimental and inquiry- based approach of biology students in Australia but did not compare it with lecture method. The present study is carried out in northern part of Nigeria; therefore, it is different from the above authors in terms of subject and location. The studies of Uchenna (2013), Osuafor and Okigbo (2013) and others were carried out in different science subjects in secondary schools in the eastern part of Nigeria. The present study is different from Osuafor and Okigbo in terms of location, topic, subject, level and methods of teaching.

Bichi (2002) compared the effectiveness of problem-solving method and lecture method in promoting students' academic performance in evolution concepts and found that problem-solving is more effective than lecture method. Olubumi (1991) compared the effectiveness of laboratory approach and lecture method on cognitive achievement of Integrated Science students. The literature reviewed so far shows that laboratory, problem-solving, performance and attitude are practicable in Nigerian schools. This implies that the present study is in line with the reviewed literatures. Some of the researches carried out showed positive relationship between students' academic performance and the teaching strategy while some showed negative correlation. Therefore, this study intends to determine whether laboratory and problem-solving strategies would enhance attitude, academic performance and retention among varied ability SSII, students in ecology concept of biology in Zaria educational zone Kaduna state Nigeria.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Introduction**

This study investigates effects of laboratory and problem-solving instructional strategies on attitude, retention and academic performance of varied ability senior secondary school students towards ecology in Zaria, Kaduna State, Nigeria. The focus of this chapter is to outline the methodology used in conducting the study. The chapter is therefore presented under the following subheadings:

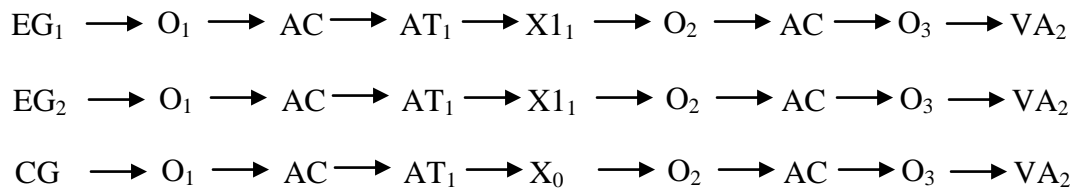
- Research Design
- Population of the Study
- Sample and Sampling Procedure
- Instrumentation
- Item Specification
- Selection of Topics to be Taught
- Validation and Reliability of the Instruments
- Pilot Testing of the Instruments
- Item Analysis of the Instrument
- Administration of Treatment
- Data Collection Procedure.
- Procedure for Data Analysis.

#### **3.2 Research Design**

In this study, the researcher employs a quasi-experimental design using pretest and post-test group design in which three intact classes are involved and assigned to three different treatments. The experimental groups EG<sub>1</sub> and EG<sub>2</sub> received six weeks' ecology

lessons using Laboratory and Problem solving strategies while the control group was taught same topics using traditional lecture method. Pre-test  $O_1$  was used to determine the equivalence of the three groups before the start of the experiment, while the post-test  $O_2$  was used to find out whether or not the laboratory and problem-solving teaching strategies have impact on retention, performance and attitude of the students.

The design is illustrated as follows:



**Fig. 3.1: Research Design Illustrated**

**Key:**

- EG<sub>1</sub> - Experimental group 1
- EG<sub>2</sub> - Experimental group 2
- CG - Control group
- O<sub>1</sub> - Pre test
- O<sub>2</sub> - Post test
- O<sub>3</sub> - Post-post test
- X<sub>0</sub> - No treatment (Lecture method)
- X<sub>1</sub> - Treatment (Laboratory)
- X<sub>2</sub> - Problem-solving
- AC - Academic Performance
- AT - Attitude
- VA - Varied ability

The design is suitable for this study because of the advantages stated by James (2000) and Sambo (2005) which is summarized as:

- The superiority of instructional strategy over the others can easily be tested.
- It gives indication of concept attainment and understanding gained by students after they have been exposed to a particular teaching method.
- The pre-test scores give indication as to whether the group (2 experimental and 1 control groups) differ significantly in the concepts they hold before instructions are given.
- It allows for the determination of retention ability of ecology concept taught.

### **3.3 Population of the Study**

The targeted population for the study comprises all the SS2 Biology students of public Secondary Schools in Zaria Educational Zone. The reason for using SS2 students was due to the fact that they are the stable group in senior secondary, they had covered syllabus for SS1 and currently undergoing SS2 syllabus. The SS3 students are excluded because they are engaged in their Senior Secondary School Certificate Examination (SSCE) at the time of the study while SSI have just entered into senior class and are new to biology topics.

However, there are twenty (20) government owned secondary schools in Zaria. Out of the 20 schools six (6) are co-education (mix) while fourteen (14) are singlesexed schools, six (6) single male, seven (7) single female and one (1) male and female schools. The total number of students in the population is 1600 made up of 791 males and 809 female students. The age range is between 15-21 years and mostly Hausa speaking. The choice for choosing government owned schools is due to the fact that they have common socio-economic background, admission procedure, staffing and promotion policy, availability of teaching materials and teacher discipline. Simple randomize technique in

balloting method was employed to select the three (3) co-education schools used for the study (two experimental and one control). Only three schools were used due to financial and time constrain. The details of the population are presented in Table 3.1.

**Table 3.1: Population of the Study**

S/N	Name of School	Type	No. of student		Total
			Boys	Girls	
1	GSS Alhudahuda	Male	100	-	100
2	GSS Aminu	Co-education	40	42	82
3	GSS Barawa	Male	70	-	70
4	GSS Basawa	Male	55	-	55
5	GSS ChinditBarrack	Male and female	60	50	110
6	GDSS Commercial	Co-education	48	30	78
7	GSS Chikaji	Male	52	-	52
8	GDSS D/Bauchi	Female	-	105	105
9	GSS Fadiya T/Wada	Female	-	68	68
10	GSS Guyabawa	Female		140	140
11	GSS Gwangila	Co-education	59	41	100
12	GSS KofaDoka	Male	80	-	80
13	GGSS Kofa Gaya	Female	50	-	50
14	GSS KofanJatau	Male	50		50
15	GSS Magajia	Co-education	41	38	79
16	GSS Muchia	Co-education	43	32	75
17	GSS Pada	Female	-	52	52
18	GDSS Samaru	Female	-	106	106
19	GSS Tudun Juku	Co-education	43	40	83
20	GGSS Zaria	Female		65	65
Total			791	809	1600

**Source: Zaria Educational Board (2014)**

### 3.4 Sample and Sampling Techniques

From the population, the co-educational schools were sampled in order to cater for the gender variable involved in the study. Three out of the six co-educational schools in the population were selected by using simple random techniques by balloting system. The three co-educational schools used in the study consists of 113 males and 72 female given a total number of 185 students. The sample size of 185 is in line with the Central Limit Theory of Tuckman (1975) which stated that in a research of this kind the sample size must cover 10-15% of the total population.

Details of sample selected for the study is presented in Table 3.2.

A class was randomly selected from the three co-educational schools using simple random sampling techniques by balloting system. In the exercise, the class selected were subjected to pretest using Ecology Performance Test (EPT) after which their scores were subjected to Analysis of Variance (ANOVA) at  $P = 0.05$  to determine the schools that are not significantly difference in their ability levels. However, from the result of the exercise, GSS Aminu Road and GSS Tudun/Jukun were the experimental groups while GSS Magajiya was the control group.

**Table 3.2: Sampled Schools for the Study**

S/N	School	Group	Sample of Students		Total
			Male	Female	
1	GSS Tudun Jukun	Experimental Group (I)	38	22	60
2	GSS Aminu	Experimental Group (II)	45	30	75
3	GSS Magajiya	Control	30	20	50
	Total		113	72	185

Source: State Ministry of Education (2014).

### 3.5 Instrumentation

For this research work, the following instruments were used:

- (i) Ecology Performance Test (EPT).
- (ii) Student Attitude Questionnaire (SAQ).

#### 3.5.1 Ecology Performance Test (EPT)

The (EPT) is an instruments developed by the researcher, it is an objective test which consists of 50 objective test items using content on ecology to determine the academic performance of SSII students of varied abilities in biology. It was also used to determine students' retention ability. The instrument was developed using test blue print adopted from bloom's taxonomy of cognitive educational objectives which are knowledge, comprehension, application, synthesis, analysis and evaluation. The EPT was used at 3 levels, Viz:

- (1) Pretest, to determine group equivalence
- (2) as Post-test to determine achievement and
- (3) as Post-post test to determine retention ability of students.

### 3.5.2 Student Attitude Questionnaire (SAQ)

Student Attitude Questionnaire (SAQ) developed by the researcher was used. The questionnaire comprises of 20 items to reflect on overall attitude of students towards biology. The Students Attitude Questionnaire (SAQ) was based on Likert 5-point rating scale, which are Strongly Agreed (SA), Agreed (A), Strongly Disagreed (SD), Disagreed (D), Undecided (UD) respectively. The responses and their points are as follows:

- Strongly agree (5)
- Agree - (4)
- Disagree - (3)
- Strongly disagree - (2)
- Undecided - (1)

**Table 3.4: Table of Specification/Test Blueprint for (Ecology Performance Table)**

Content	Wg%	Kn 30	Comp 20	Ap 20	An 10	Sy 10	Ev 10	Total 100
Ecological Succession	25	5	4	2	1	1	2	15
Population Size	25	5	3	2	1	1	2	14
Food Shortage	20	1	2	1	1	1	1	7
Overcrowding	15	1	2	0	1	1	1	6
Pop Studies/Bal in Nat.	15	2	2	1	1	1	1	8
Total	100	14	13	6	5	5	7	50

**Source: Adapted from Bloom (1956)**

Table 3.4 indicates item specification of Ecology concepts to be taught and the allocations based on Bloom Taxonomy of Cognitive Domain.

Key: Wg% is the weight assigned to the topics Kn = Knowledge, Comp. = Comprehension Ap = Application, An = Analysis, Sy = Synthesis and Ev = Evaluation.

### **3.5.3 Selection of Topics for the Study**

In carrying out the study, the following sub-topics were selected for teaching from ecology topic according to SSII syllabus.

- Ecological Succession
- Population Size/estimate
- Food shortage
- Overcrowdings
- Population Study/Balance in nature

The researcher checked the WAEC/SSCE result of students in some previous years (that is, 2009, 2010, 2011, 2012, 2013,2014, 2015 and 2016) and discovered that most students performed poorly in biology topics and such the above topics are SS2 contents as at the time of this research.

### **3.5.4 Validation of the Instruments**

Validity of a test refers to the degree to which the test measures what it is supposed to measure. To this point, content validity was affirmed by three Senior lecturers with Ph.D from Department of Biological Science and Department of Science Education, Ahmadu Bello University, Zaria. Also, two senior biology teachers with 15 years teaching experience in secondary schools and with minimum qualification of Masters' degree validated the same instrument. (Appendix I and III).

The lecturers and the teachers from the two institutions were asked to examine and assess all the items of the instrument paying particular attention to the following.

- i. the content validity of the instrument i.e whether the test confirm to the subject specification and objective of the study.
- ii. Whether the questions are clear, precise and free from ambiguity.

- iii. Whether the questions match the ability of the students.
- iv. language component of the instrument, appropriateness of the items in terms of reading difficulty level for the groups that are meant for and clarity of statements in the instrument.
- v. The experts made constructive criticisms in the area of language and content of (EPT) instrument. The corrections were made leading to the final selection of the items and the corresponding marking scheme. (See Appendices, I, II and III)

The experts made constructive criticisms in the area of language level and content of (EPT) instrument. The corrections were made leading to the final selection of the items and the marking scheme as presented in (Appendix I and II). In the case of Ecology Performance Test (EPT), initially, there were 55 questions but after validation only 50 were retained. Some questions were reframed example questions 10, 12 and 14 were corrected as follows:

Q. 10 In an ecosystem the organism which change light energy into stored chemical energy is called.

- a. Consumer
- b. Decomposer
- c. Producer
- d. Carnivore
- e. Achiever

Q.12 A dry indehiscent fruit containing one seed and possessing a hairy pappus is described as:

- a. A nut
- b. A drupe
- c. A cypela

d. A follicle

e. Kannel

Q. 14 Identify from the following a nitrifying bacteria

a. Nitrobacter

b. Rhizobium

c. Azotobacter

d. Nitrosomonas

e. Pest

For Students Attitude Questionnaire (SAQ) 20 questions were constructed and 4 of the questions were corrected in terms of language and all were retained.

### **3.6 Pilot Testing of the Instrument**

The instruments for the study i.e. Ecology Performance Test (EPT) and Students Attitude Questionnaire (SAQ) were pilot tested using thirty (30) SSII students from GSS Commercial College Zaria whose school were not involved in the main study, but were equivalent group for the study from Sabon Gari Zone. The materials designed for the pilot testing comprised of two instruments Ecology Performance Test (EPT) which consists fifty (50) structured questions with A-E options and twenty (20) Student Attitude Questionnaire (SAQ) were used. The result for the item analyzes is shown in (Appendix VIII).

The pilot testing was done to:

- (i) find out the characteristics of EPT through item analysis.
- (ii) determine the appropriate length of time required for the test.
- (iii) determine the appropriateness of the workings of the EPT and SAQ items.
- (iv) to find out the reliability of both EPT and SAQ in the study.

### **3.6.1 Reliability of the Instruments**

Reliability of a test is the degree to which a test on repeated measurement yields almost the same result as when administered to subjects of similar characteristic (Bichi, 2002). To determine the reliability of the instrument (EPT), test-retest method using the same instrument. The test was administered to SSII Biology students in Zaria Educational Zone, Kaduna State which is not part of the sample. The instrument was administered twice with the interval of two weeks as proposed by Tuckman (1975). Pearson Product-Moment Coefficient Statistics was employed for analysis. The reliability coefficient of Ecology Performance Test (EPT) was found to be  $r = 0.79$ , which indicates that the reliability of the instrument is high and can be used for data collection in this study.

In the case of Student Attitude Questionnaire (SAQ), the questionnaire comprised of 20 items. The researcher administered the test to same group of students in GSS Commercial College. Split-half method involving odd and even number items were used. Spearman Rank Order Correlation was employed, the result of rho obtained was determine to be 0.81 indicating strong positive relation (Appendix VIII) Thus, SAQ is reliable for the study.

### **3.6.2 Item Analysis**

The pilot test provided data for the item analysis. The data collected were analyzed to determine the indices of difficulty and discrimination of each of the 50 items. (Appendix VII and VIII).

#### **3.6.2.1 Facility Index (F.I) of (EPT)**

The Facility index of an item in a test as defined by Inyanand Mahmmond (2004) is the percentage of all students who responded correctly to the items. Item difficulty index can vary from 0.00 to 1.00, and 1.00 indicates that everyone answered correctly while

0.00 means no one answered correctly. In computing the difficulty index for each item in the test, the following steps are involved:

- Rank-order of the scores on the test from highest to lowest.
- Identification of the high scoring group and the low scoring group. The top scoring 1/3 of the students and the lowest scoring 1/3 students were selected.
- The percentage of the high scoring 1/3 and low scoring 1/3 of the total test items was calculated.
- Computation of the item difficulty index by adding the percentage of those that got the item correct in the high scoring and low scoring group and then divide by 2 as in the following formula

$$F = \frac{R_u + R_L}{N} \times 100$$

Where:

F = Facility Index

R<sub>U</sub> = Is the number among the high 27 percent of the respondents who scored the items correctly.

R<sub>L</sub> = Is the number among the lower 27 percent of the respondents who scored the item correctly.

N = Is the total number of respondents in each of the upper and lower groups i.e students that are involved in the analysis. Lawal (2009) and Adamu (2014) recommended facility indices between 0.30 -0.70 as appropriate/acceptable for achievement test. For this study, items which fall between the range of 0.30 – 0.70 was selected. A difficulty index of 0.75% and above is regarded as easy in items of difficulty level, while the index of 0.25% or less, is regard as hard in terms of difficulty level. In Ecology Performance Test (EPT) test items with difficulty index which falls between the range of 0.25% -0.75% are retained which is in accordance with Lawal (2009) and Adamu (2014).

### 3.6.2.2 Discrimination Index (DI) of (EPT)

The discrimination index of a test item is used to identify high and low achieving students. It is used to separate or sort out high and low ranking students in a test as reported in the pilot testing. According to Ibrahim (2012), the discrimination index of a test item is the ability to separate and rank any student in a test. Items showing little or no difficulty or items that show a percentage of success in favor of the poor group should either be eliminated or re-examined and such items should be reworded or rescored. Lawal, (2009), and Ibrahim, (2012) recommended 0.30 and 0.80 discrimination indices for selecting good items for achievement test. For this study, items with discrimination indices between 0.30 and 0.70 were selected and those with very low indices were discarded or rejected while some were reconstructed and finally selected (Appendix VII). The discrimination indices (DI) is determined by the formula given by (Olorukooba, 2001) as presented below. Thus, the Ecology Performance Test (EPT) was calculated using the formula.

$$D = \frac{R_U + R_L}{\frac{1}{2} N} \times 100$$

Where:

D = Discrimination Index.

$R_U$  = The number among the Upper 27% of the respondents who scored the items correctly.

$R_L$  = The number among the Lower 27% of the respondents who score the items correctly.

N = Total number of respondents in each of the upper and lower group.

According to James (2000) and Lawal (2009), items with discrimination index which range from 0.30 to 0.49 are moderately positive and those above 0.70 are highly positive. However, the magnitude of discrimination indices which range from 0.30 – 0.70

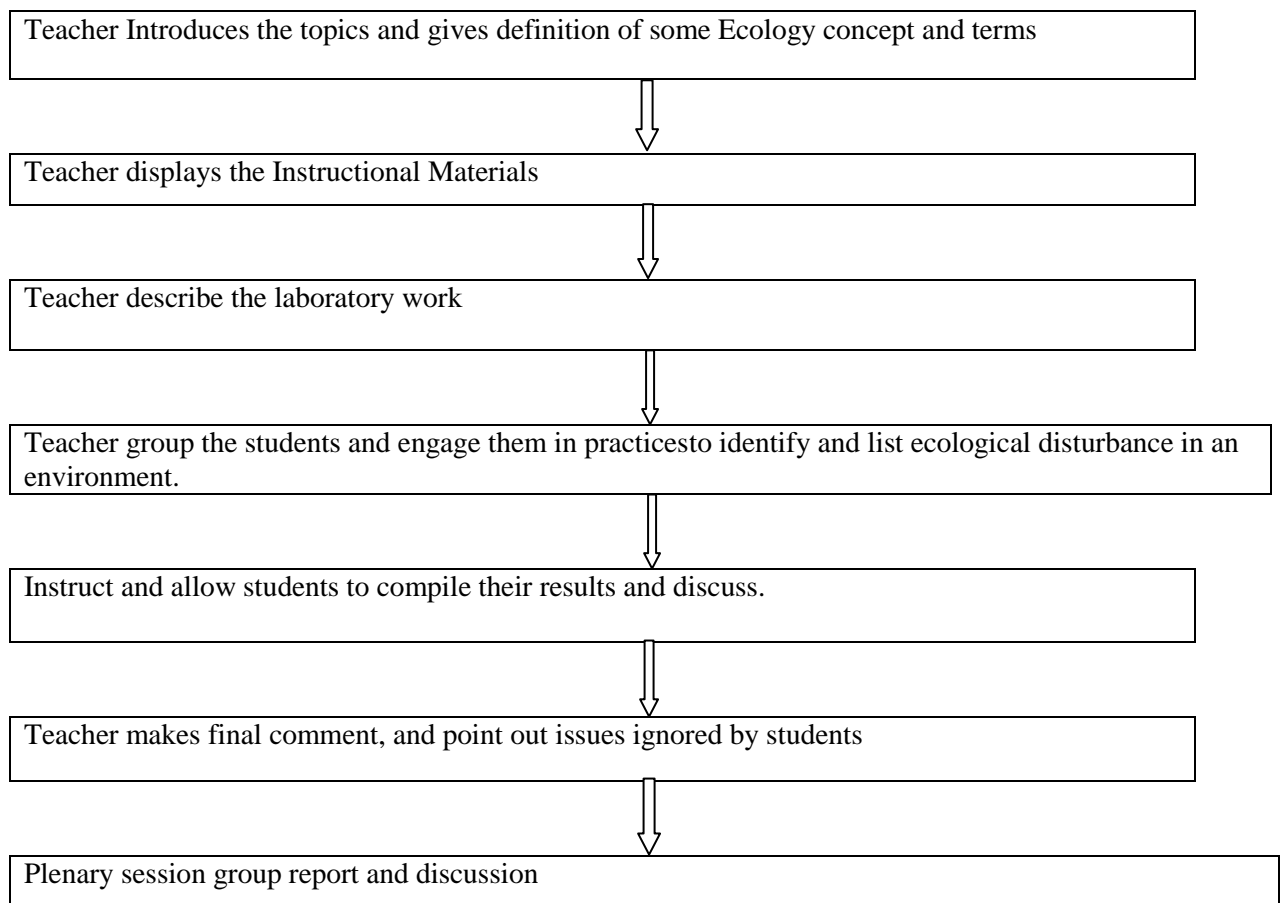
are used in accordance with Lawal, (2009). The Facility indices and discrimination indices calculated from the initial tests which did not fall within the theoretically acceptable range suitable for use were rejected. Thus, the instrument was reduced from 0.30 – 0.70 which was finally used for the study. The discrimination index was calculated using the formula stated by (James, 2000 and Lawal, 2009) (Appendix VIII).

### **3.6.3 Administration of Treatment**

Both the experimental (EG1 and EG2) and the control groups of varied ability levels were exposed to teaching for a period of six (6) weeks for 90 minutes per lesson per week. The three groups were taught by the researcher in order to give them equal chance and to avoid any bias and dichotomy in the focus of the study and as well to minimize intervening variable.

The experimental groups were taught using laboratory and problem-solving strategies respectively while the control group were taught using lecture method. In the experimental classes, the students were assigned to work in groups of (5) students per group in order to carry out the activities in accordance with the lesson plan. The control group on the other hand were not given the opportunity to carry out activity or practical.

Meanwhile three lesson plans for each topic two for experimental groups (Appendix IV) and the other for control group (Appendix VI) were prepared for each of the topics selected for six weeks. Thus, eighteen (18) lesson notes were prepared altogether for the study.



**Figure 3.2: Flowchart for Laboratory Strategy**  
**Source; Adapted from Bruner (1961)**

Laboratory chart for Experimental group one was taken in the following steps.

Step 1: Teacher introduces the topic and gives definitions of some ecology terms students will come across. The objective of this step is to make students familiar with some terms in ecology.

Step 2: Teacher displays the instructional materials and explains what happens around the ecological areas. The objective of this is to enable students observe materials that can be used to study ecology in the laboratory.

Step 3: Teacher describes the laboratory work and the procedures.

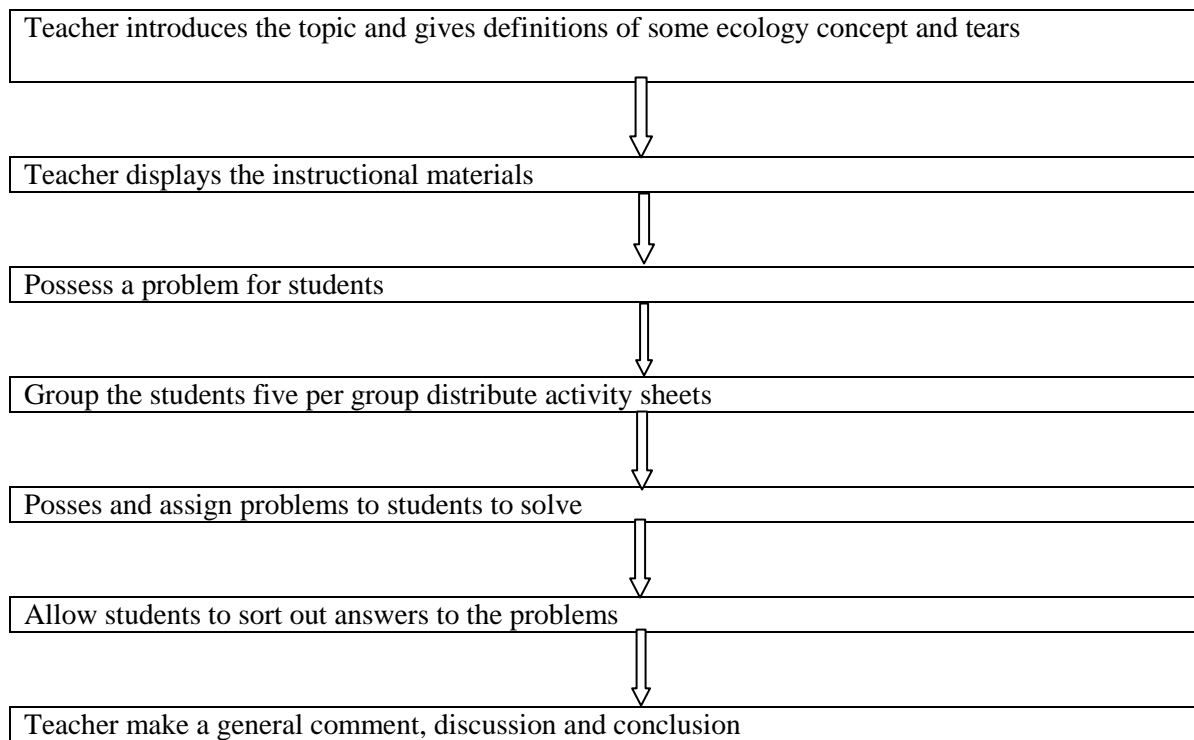
Step 4: Students were grouped into five per group and allowed to have discussion within themselves. The objectives of this step is to make students get interacted with each other

by listen to the view of their colleagues, the contributions opinion and ensure full participation. Students will be allowed to work for 20minutes.

Step 5: Teacher guides, direct and instruct students on what to do and at the end allow them to compile their work and result in a sheet.

Step 6: Students would submit the group report, comments are made by the teacher who once more explained certain issues and points students may not get right.

Step 7: Teacher concludes by bringing the whole groups together and arrive at a common solution. The objectives of this is to avoid bias and misunderstanding of ideas about the topic taught.



**Figure 3.3: Flowchart of Problem-solving strategy**

**Source; Adapted from Bruner (1961)**

**Flowchart for Problem Solving Strategy has the following steps**

Step 1: Teacher introduces the topic by posing a problem to students’ vis questioning. The objectives of this is to make students have a critical thinking and reasoning.

Step 2: Teacher displays the instructional materials with a kind of contradictions to allow students sort out the answers. The aim is to make students find solutions to the problem by themselves.

Step 3: Teacher makes students work in groupsof five, with problem-solving activity sheets, teacher establishes a context for the problem. This is to assist the students to acquire some manipulative skills via science process, and encourage team work.(Appendix IX, diagram I)

Step 4: Teacher allow students to sort out answers to their problem, within the groups, teacher compares the results and reports of the students and makes corrections where necessary.

Step 5: Teacher poses new problem base on their results. The objectives of this step is to make sure the students understand the concept of the work.

Step 6: Teacher concludes the lesson by making comments, contribution and evaluating the students by asking them questions based on the topic taught.

### **3.6.4 Control Group Lecture Method**

The control group were taught the same ecology concepts by the researcher by using the traditional lecture method which involves verbal presentation of the ideas about the topics. During the lesson the students in the group listen and take notes as the teaching progresses. Lesson plan for the group is presented in (Appendix VI)

### **3.7 Data Collection Procedure**

At the end of the treatment, the students in both groups (that is, experimental and control) were tested by the administration of the test instrument (EPT) as post-test which lasted for (1.15) hours based on the pre-test duration. The computed test scripts were collected and marked based on the marking scheme requirement. The scores of the two groups were subjected to statistical analysis.

### **3.8 Procedure for Data Analysis**

The data collected for this study were analyzed at  $P \leq 0.05$ , using descriptive statistics in form of mean scores and standard deviation to answer the research questions and inferential statistics of ANOVA, t-test and ANCOVA to test the null hypotheses.

$H_{01}$ : There is no significant difference in the mean scores performance of varied ability students taught ecology using laboratory and problem-solving teaching strategies and their counterparts taught with lecture method.

The  $H_{01}$ , was tested using Analyses of Variance (ANOVA).

H<sub>02</sub>: There is no significant difference in the mean attitude score of biology students taught ecology using laboratory and problem-solving teaching strategies and those taught using lecture methods.

The hypothesis was tested using Kruskal-Wallis test.

H<sub>03</sub>: There is no significant difference in the mean retention score among varied ability students taught ecology using laboratory and problem solving strategies and those taught using lecture methods.

The null hypothesis was tested using Analyses of Covariance (ANCOVA).

H<sub>04</sub>: There is no significant difference between the mean scores of male and female students taught ecology concept using laboratory teaching strategy and those taught using lecture methods.

This hypothesis was tested using ANCOVA.

H<sub>05</sub>: There is no significant difference between the mean scores of male and female students taught ecology using problem-solving teaching strategy and those taught with lecture method.

The hypothesis was tested using ANCOVA.

## **CHAPTER FOUR**

### **DATA ANALYSIS, RESULTS AND DISCUSSION**

#### **4.1 Introduction**

This study investigated impact of two teaching strategies on attitude, retention and academic performance in ecology among varied ability secondary school students in Zaria metropolis Nigeria. The data generated from the study were analyzed using the Statistical Package for Social Science (SPSS) and the level of significance adopted for rejecting or retaining the stated hypotheses was  $p \leq 0.05$ . This chapter was presented under the following subheadings.

- Data Analysis and Presentation of Result.
- Answering the Research Questions.
- Testing the Null Hypotheses.
- Findings
- Discussion of Findings

#### **4.2 Data Analysis and Presentation of Results**

The data collected for the purpose of this study were analyzed based on the research questions and hypotheses formulated. Thus, the following data were generated.

- Pretest data generated via Ecology Performance Test (EPT) to establish group equivalence before the experiment.
- Posttest data generated via Ecology Performance Test (EPT) to establish academic performance after treatment.
- Post-post test data generated via Ecology Performance Test (EPT) to measure retention of learned concepts.

- Students' attitude data generated via Students' Attitude Questionnaire (SAQ) to measure their attitude towards ecology concept before and after treatment.

### 4.3 Answering Research Questions and Testing the null hypotheses

#### Research Question 1

Are there differences in the mean academic performance scores of students in the high, middle and low ability level taught ecology using laboratory, problem-solving teaching strategies and their counterparts taught using lecture method?

To answer research question one, Post-test data generated via EPT were subjected to descriptive statistics to calculate mean and standard deviation. Summary of the analysis are shown in Table 4.1.

**Table 4.1: Means and Standard Deviation of Post-test Scores of Varied Ability Students for E1, E2 and Control Groups**

Ability Levels	Treatment	Mean	Std. Error	Mean Difference
Low	Laboratory	12.30	0.24	1.32
	Problem solving	13.62	0.32	
	Laboratory	12.30	0.24	0.67
	Control	11.63	0.35	
	Problem solving	13.62	0.32	1.99
	Control	11.63	0.35	
Middle	Laboratory	12.77	0.27	1.5
	Problem solving	15.50	0.25	
	Laboratory	12.77	0.27	1.23
	Control	14.00	0.57	
	Problem solving	15.50	0.25	2.73
	Control	14.00	0.57	
High	Laboratory	17.34	0.54	1.80
	Problem solving	19.14	0.49	
	Laboratory	17.34	0.54	0.64
	Control	16.76	1.11	
	Problem solving	19.14	0.49	2.38
	Control	16.76	1.11	

Table 4.1 revealed that among the low ability levels the mean difference between laboratory, problem solving and lecture is ( $\bar{X}$ = 1.32,0.67 and 1.99) respectively in favour of problem solving strategy. The Table also showed that students performed better in problem-solving approach in all the three levels of varied ability (high, medium and low). It is observed in the Table that students with high ability obtained the highest mean score among the three ability levels. From the Table, it is also observed that the low ability students performed better in problem-solving approach (13.62) compared to low ability students in Laboratory (12.30) and control (11.63) groups.

To find out how significant the difference in the groups was, the data were subjected to 2-Way Analysis of Covariate (ANCOVA).

### **Testing Hypothesis One**

There is no significant difference in the mean academic performance scores of students in the high, middle and low ability level taught ecology using laboratory and problem-solving strategies and those taught using lecture methods.

To test  $H_{01}$ , the Post-test scores of the Experimental Group 1, Exp. Group 2 and Control Groups were subjected to Analysis of Covariance (ANCOVA). Summary of the analysis are shown in Table 4.2

**Table 4.2: Summary of 2-Way Analysis of Covariance (ANCOVA) of Students' Performance in Ecology by Treatment (laboratory, problem-solving and Lecture) with Varied Ability Levels**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2065.48 <sup>a</sup>	9	229.50	101.96	.000	.84
Intercept	875.07	1	875.07	388.77	.000	.69
Pre-test	379.75	1	379.75	168.71	.000	.49
<b>Main Effects</b>						
Treatment	124.93	2	62.46	27.75	.000	.24
Varied ability	206.93	2	103.47	45.97	.000	.34
<b>2-Way Interaction Effects</b>						
Variedability	7.82	4	1.96	.87	.48	.02
Level*Treatment						
Error	393.90	175	2.25			
Total	38106.00	185				
Corrected Total	2459.38	184				

Table 4.2 shows the summary of Analysis of Covariance (ANCOVA) of Students' Performance in ecology by Treatment (laboratory, problem-solving) and (Control) and Varied ability levels. The results in the Table revealed that the effect of treatment on students' performance in ecology is statistically significant,  $F_{(2,175)} = 27.75$ ,  $p < 0.05$ . Consequently, the null hypothesis which states that there is no significant difference in the mean scores of students of varied abilities taught Ecology using laboratory and problem-solving strategies and those taught using lecture methods is therefore rejected. This implies that treatment has a significant main effect on the students' performance in ecology ie ( $F_{(2,175)} = .87$ ,  $p\text{-value} = .48$  ( $p > 0.05$ )). In order to determine which group differs significantly among the three methods, Bonferroni Post-hoc analysis was done and the results were presented in Tables 4.3.

**Table 4.3: Post-Hoc Analysis: Pairwise Comparison of Students' Performance in Ecology by Treatment (Laboratory, Problem-Solving and Lecture)**

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
<b>Laboratory</b>	Problem solving	-2.17*	.30	.000	-2.89	-1.45
	Control	-.44	.47	1.000	-1.57	.70
<b>Problem solving</b>	Laboratory	2.17*	.30	.000	1.45	2.89
	Control	1.74*	.47	.001	.61	2.86
<b>Control</b>	Laboratory	.44	.47	1.000	-.70	1.57
	Problem solving	-1.74*	.47	.001	-2.86	-.61

The result in Table 4.3 which shows the Post-hoc analysis, revealed that the p-values of .000 and .001 for problem-solving strategy against laboratory and control groups were less than .005. This is an indication that significant difference exists in the academic mean scores of students taught using Laboratory, Problem-Solving and Control group, in favour of problem-solving strategy. Table 4.3 also revealed that there is no significant difference in the performance of students taught ecology using laboratory teaching strategy and lecture method (control group).

### **Research Question 2**

Are there differences in attitude of students in the high, middle and low ability levels taught ecology using laboratory and those taught same concept using problem-solving teaching strategies?

To answer this research question, data generated from Students Attitude Questionnaire were subjected to Mean and Standard Deviation Statistics. Summary of the Analysis are shown in Table 4.4 and 4.5.

**Table 4.4: Mean and Standard Error of Attitude of Students Taught Ecology Using Laboratory, Problem-Solving Teaching Strategies and Lecture method**

Variability_Level	Treatment	Mean	Std. Error	Mean diff.
Low	Laboratory	77.87	0.37	0.40
	Problem solving	77.47	0.38	
Middle	Laboratory	78.14	0.30	1.23
	Problem solving	76.90	0.28	
High	Laboratory	78.39	0.54	0.50
	Problem solving	77.89	0.49	

Table 4.4 shows the Means and Standard Error of Attitude of students taught Ecology using laboratory and Problem Solving Teaching Strategies. The table revealed that differences exist among the two teaching methods. Table 4.4 also showed the comparison of attitude of varied ability students taught Ecology using laboratory and problem-solving strategies. The table revealed that students showed more attitude in Laboratory group than those in problem-solving group in all the three levels of varied ability with mean differences of 0.40, 1.23 and 0.50 respectively. However, in order to determine whether the difference is significant, Kruskal-Wallis test was carried out and the result is presented in Tables 4.5.

### Testing Null Hypothesis Two

There is no significant difference in the mean attitude scores in high, middle and low ability biology students taught ecology using laboratory and problem-solving teaching strategies and those taught using lecture methods.

To test H02, the Post-test Scores of Exp. 1, 2 and Control groups were subjected to Kruskal Wallis Test as shown in Table 4.5

**Table 4.5: Kruskal-Wallis Test on Students' Attitude**

Variable	Group	N	$\bar{X}$ rank	Df	H-cal	P	Remark
	Laboratory	60	115.57				.
<b>Attitude</b>	Problem-solving	75	83.45	2	15.90	0.000	Sig
	Lecture method	50	80.24				

Significant at  $P \leq 0.05$

In the result presented in Table 4.5, Kruskal-Wallis test revealed that there is statistically significant difference in the mean attitude scores ( $H\text{-cal} = 15.90$ ,  $P = .000$ ) of students taught ecology using laboratory strategy (mean rank = 115.57), problem-solving teaching strategies (mean rank = 83.45) and those taught using lecture methods (mean rank = 80.24). Since the P-value is less than .05, the null hypothesis is therefore rejected. This implies that there is a significant difference in the attitude of students taught ecology using laboratory and problem-solving teaching strategies in favor of laboratory and those taught using lecture methods. A series of Mann-Whitney tests was conducted as a post-hoc analysis, and the results are presented in Table 4.6.s

**Table 4.6: Post-Hoc Analysis using Mann-Whitney Test**

<b>Group</b>	<b>N</b>	<b>Mean Rank</b>	<b>Sum of Ranks</b>	<b>Z</b>	<b>U-value</b>	<b>P</b>	<b>Decision</b>
<b>Laboratory</b>	60	81.31	4878.50	-3.539	1451.5	.000	Significant
<b>Problem-solving</b>	75	57.35	4301.50				
<b>Laboratory</b>	60	64.76	3885.50	-3.339	944.5	.001	Significant
<b>Control</b>	50	44.39	2219.50				
<b>Problem-solving</b>	75	64.10	4807.50	-.416	1792.5	.68	Not Significant
<b>Control</b>	50	61.35	3067.50				

### **Research Question 3**

Are there differences in the mean retention scores of high, middle and low ability level students, taught ecology using laboratory and problem-solving teaching strategies and their counterpart taught using lecture method?

To answer this research question, Post-test data of exp. Group 1 exp. Group 2 and the Control group were subjected to descriptive statistics. Means and Standard deviations were calculated and used to draw Table 4.7

**Table 4.7: Mean and Standard Error of Retention Ability of Students Taught Using Laboratory and Problem Solving and Lecture Teaching Strategies**

Group	N	Mean	Std. Error	Mean Difference
Laboratory	60	20.88		
Problem-solving	75	20.29	.38	.59
Laboratory	60	20.88		
Control	50	19.20	.58	1.68
Problem-solving	75	20.29		
Control	50	19.20	.56	1.09

Table 4.7 revealed that differences exist in the retention ability of students taught using laboratory strategy ( $\bar{X}$ = 20.88), problem solving strategies ( $\bar{X}$ = 20.29) and lecture method ( $\bar{X}$ = 19.20) with laboratory strategy having the highest score, while control had the lowest score. The Table also revealed that the mean difference between laboratory and problem solving strategies is ( $\bar{X}$ = 0.59) in favor of laboratory strategy, while the mean difference between laboratory and control group is ( $\bar{X}$ = 1.68) in favor of laboratory strategy. Also, the Table revealed that the mean difference between problem solving strategy and control group is ( $\bar{X}$ = 1.09) in favor of problem-solving. The Mean Performance of varied ability students in Exp. 1, 2 and Control were also calculated and the summary of the analysis are shown in Table 4.8

**Table 4.8: Mean Performance of Varied Ability Levels of students taught ecology Using Laboratory and Problem Solving strategies and Lecture Teaching method.**

Varied ability	Treatment	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
<b>Low</b>	Laboratory	17.91 <sup>a</sup>	.48	16.96	18.84
	Problem solving	18.13 <sup>a</sup>	.38	17.39	18.87
	Control	16.03 <sup>a</sup>	.31	15.41	16.65
<b>Middle</b>	Laboratory	21.53 <sup>a</sup>	.34	20.87	22.19
	Problem solving	19.99 <sup>a</sup>	.34	19.32	20.65
	Control	19.74 <sup>a</sup>	.71	18.34	21.14
<b>High</b>	Laboratory	23.21 <sup>a</sup>	.75	21.74	24.68
	Problem solving	22.76 <sup>a</sup>	.76	21.26	24.25
	Control	21.83 <sup>a</sup>	1.40	19.06	24.60

a. Covariates appearing in the model are evaluated at the following values: Post.

In the same vein, the three levels of students with varied ability was compared with their performance when taught ecology using laboratory teaching strategy, problem solving and those taught with lecture method. The results as shown in Table 4.8, indicated that students of Low varied ability performed better in problem solving group ( $\bar{X}$  = 18.13) than those in laboratory ( $\bar{X}$  = 17.90) and control group ( $\bar{X}$  = 16.03). In contrast, students of medium and high levels of varied ability performed better when taught ecology using laboratory teaching strategy than their counterpart taught ecology using problem-solving strategy and lecture method (control group).

To find out whether there is a significant difference in the groups, the data were subjected to a 2-Way Analysis of Covariate (ANCOVA).

### Testing Null Hypothesis Three

There is no significant difference in the mean retention scores of high, middle and low ability students taught ecology using laboratory and problem-solving strategies and those taught using lecture methods.

To test H03 to determine how significant the difference in the groups was, the data were subjected to a 2-Way Analysis of Covariate (ANCOVA) as shown in Table 4.9

**Table 4.9: Summary of 2-Way Analysis of Covariance (ANCOVA) of Students' Retention Ability in Ecology by Treatment (laboratory, problem-solving and Control) and Varied ability.**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3282.97 <sup>a</sup>	9	364.78	104.86	.000	.84
Intercept	370.79	1	370.79	106.59	.000	.38
Post-Test	332.10	1	332.10	95.72	.000	.35
Varied ability	223.72	2	111.86	32.16	.000	.27
Treatment	29.62	2	14.81	4.26	.016	.05
Varied ability * Treatment	28.13	4	7.03	2.02	.093	.04
Error	608.78	175	3.48			
Total	71975.00	185				
Corrected Total	3891.75	184				

Table 4.9 shows the summary of 2-Way Analysis of Covariance (ANCOVA) of Students' Retention Ability in Ecology by Treatment (laboratory, problem-solving and Control) of Varied abilities. The table revealed that the effect of treatment on students' Retention Ability in Ecology is statistically significant,  $F_{(2,175)} = 4.26$ ,  $p < 0.05$ . Thus the null hypothesis which states that there is no significant difference in the retention ability of students taught ecology using laboratory and problem solving strategies and those

taught using lecture methods is therefore rejected. This implies that treatment has a significant main effect on the students' retention ability in Ecology. The results also showed that treatment of students of varied ability and retention of concepts are statistically difference,  $F_{(2,175)} = 2.02$ ,  $p > 0.05$ . In order to determine which group differs significantly among the three methods, Bonferroni Post-hoc analysis was done and the results were presented in Tables 4.10.

**Table 4.10: Bonferroni Post-Hoc Analysis: Pairwise Comparison of Students' Retention Ability in Ecology by Treatment (Laboratory, Problem-Solving and Control)**

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
Laboratory	Problem solving	.59	.38	.377	-.34	1.51
	Control	1.68*	.58	.014	.27	3.09
Problem solving	Laboratory	-.59	.38	.377	-1.51	.34
	Control	1.09	.56	.164	-.27	2.45
Control	Laboratory	-1.68*	.58	.014	-3.09	-.27
	Problem solving	-1.09	.56	.164	-2.45	.27

Bonferroni Post-hoc analysis revealed that laboratory and lecture methods (control group) are significantly difference in their mean scores  $p = .014$  ( $p < .005$ ). This is due to the large number of mean score of students taught with laboratory method. The table also revealed that there is no significant difference in the performance of students taught ecology using laboratory teaching strategy and problem solving strategy,  $p = .38$  ( $p < .005$ ). Problem-solving shows no significant difference to control group,  $p = .16$  ( $p > .005$ ).

#### **Research Question 4**

What are the differences in the mean academic performance of male and female students taught ecology using laboratory and lecture method?

To answer this research question, the Post-test Scores of Exp. Group 1 and the Control Group were sorted out according to Gender and subjected to descriptive statistics. Means and Standard Deviation(SD) were computed/calculated. Summary of the analysis is shown in Table 4.11

**Table 4.11: Means and Standard Deviations of Post-test Scores of Male and Female Students Taught Ecology Using Laboratory and Lecture methods**

<b>Treatment</b>	<b>Gender</b>	<b>Mean</b>	<b>Std. Error</b>	<b>Mean difference</b>
<b>Laboratory</b>	Male	13.26 <sup>a</sup>	.38	.69
	Female	12.57 <sup>a</sup>	.34	
<b>Lecture method</b>	Male	12.58 <sup>a</sup>	.42	.10
	Female	12.68 <sup>a</sup>	.37	

Result in Table 4.11 shows that differences exist in the mean scores of male and female students when taught using laboratory teaching strategy, problem solving and those taught with lecture method. The difference between male and female in laboratory group is .69 in favour of male students. (The Table also revealed that female students performed better than male in problem-solving and control group with differences of .91 and .10 respectively). In order to determine whether the difference is statistically significant or is just by chance, a 2-Way Analysis of Covariance (ANCOVA) was used to calculate the difference. The summary of the analysis is shown in table 4.12.

### Testing Null Hypothesis Four

There is no significant difference in the mean academic performance scores of male and female students taught ecology concepts using laboratory teaching strategy and those taught using lecture methods.

To test H04, a 2-Way Analysis of Covariance (ANCOVA) of the Mean Scores of male and female students in Exp. 1 and Control groups were calculated and the summary of the analysis is presented in Table 4.12

**Table 4.12: 2-Way Analysis of Covariance (ANCOVA) of Means Scores of Male and Female Students' Taught Ecology Using Laboratory Strategy and Lecture method**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1781.78 <sup>a</sup>	6	296.96	78.01	.000	.72
Intercept	666.02	1	666.02	174.96	.000	.50
PreTest	1601.52	1	1601.52	420.71	.000	.70
Treatment	324.52	2	162.26	42.62	.000	.32
Gender	.51	1	.51	.13	.716	.00
Treatment * Gender	20.89	2	10.44	2.74	.067	.03
Error	677.60	178	3.81			
Total	38106.00	185				
Corrected Total	2459.38	184				

Result in Table 4.12 shows the summary of Analysis of Covariance (ANCOVA) of male and female students' Performance in Ecology by Treatment (laboratory) and Control. The Table revealed that academic performance according to gender is not statistically significant,  $F_{(1,178)} = .13$ ,  $p > 0.05$ . Thus, a 2-Way ANCOVA showed that gender and treatments are not statistically significant. Therefore, the null hypothesis is thus retained. This implies that gender does not significantly influence academic performance of students when taught ecology using laboratory or lecture method.



### Research Question 5

What are the differences in the mean academic performance scores of male and female students taught ecology using problem-solving teaching strategy and those taught using lecture method?

To answer this research question, the Post-test scores of Exp. Group 2 and the Control Group were sorted out according to gender and subjected to descriptive statistics. Means and Standard Deviation (SD) were computed/calculated. Summary of the analyses are presented in Tables 4.13 and 4.14.

**Table 4.13: Means and Standard Deviation of Post-Test Scores of Male and Female Students Taught Ecology Using Problem-Solving Strategy and Lecture Methods.**

Treatment	Gender	Mean	Std. Error	Mean difference
Problem-solving	Male	14.81 <sup>a</sup>	.31	.89
	Female	15.50 <sup>a</sup>	.32	
Control (lecture)	Male	12.35 <sup>a</sup>	.41	.07
	Female	12.42 <sup>a</sup>	.36	

**Table 4.14: Means and Standard Deviation of Post-Test Scores of Male and Female Students of Varied Ability Levels Taught Ecology Using Problem-Solving and Lecture Method**

Varied ability_Level	Gender	Mean	Std. Error	Mean diff	95% Confidence Interval	
					Lower Bound	Upper Bound
Low	Male	12.363 <sup>a</sup>	.296	.453	11.777	12.949
	Female	12.816 <sup>a</sup>	.264		12.293	13.339
Middle	Male	15.166 <sup>a</sup>	.342	.112	14.489	15.842
	Female	15.054 <sup>a</sup>	.358		14.345	15.763
High	Male	17.919 <sup>a</sup>	.666	2.358	16.599	19.238
	Female	20.277 <sup>a</sup>	.719		18.854	21.701

Result in Table 4.13 shows that differences exist in the mean scores of male and female students taught ecology using problem-solving strategy and those taught using lecture methods. The difference between male and female in problem-solving group is .89 in favour of female students. The table also revealed that female students performed better than male in control group with mean difference of .07. Table 4.14 also indicated that female students in low and high level of varied ability had higher mean score than male with the mean differences of .45 and 2.36 respectively. While male students in medium varied ability had a mean slightly greater than female with the mean difference of 0.12.

#### Testing Null Hypothesis Five

There is no significant difference in the mean academic performance scores of male and female students taught ecology concept using problem-solving teaching strategy and those taught using lecture methods.

To test  $H_0$  in order to determine whether gender is statistically significant, a 2-Way Analysis of Covariance (ANCOVA) was conducted as shown in Table 4.15

**Table 4.15: 2-Way Analysis of Covariance (ANCOVA) Mean Scores of Students' Taught Ecology Using Problem-Solving Strategy and Lecture Method.**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	1218.55 <sup>a</sup>	4	304.64	84.41	.000	.74	
Intercept	585.60	1	585.60	162.26	.000	.58	
Pre-test	1063.20	1	1063.20	294.59	.000	.71	
Treatment	239.26	1	239.26	66.29	.000	.36	
Gender	6.54	1	6.54	1.81	.181	.02	
Treatment * Gender	5.01	1	5.01	1.39	.241	.01	
Error	433.10	120	3.61				
Total	26517.00	125					
Corrected Total	1651.65	124					

Result in Table 4.15 shows the summary of Analysis of Covariance (ANCOVA) of male and female students' Performance in Ecology after Treatment in experimental group two (problem-solving), (Control group). The Table revealed that gender is not statistically significant,  $F_{(1,120)} = 1.81, p > 0.05$ . Also, a 2-Way ANCOVA showed that gender and treatments are not statistically significant,  $F_{(1,120)} = 1.39, p > 0.05$ . Therefore, the null hypothesis which stated that there is no significant difference in the mean scores of academic performance of male and female students taught ecology using problem-solving teaching strategy and those exposed to lecture method is therefore retained. This implies that gender does not significantly influence the academic performance of students when taught ecology using problem-solving strategy or lecture method (Control group).

#### **4.4 Findings**

The following are the findings after the statistical analysis of the data collected in the course of this study.

1. There is a significant difference in the mean scores of students of varied ability taught biology using laboratory and problem-solving strategies and those taught using lecture methods. The observed difference is in favor of experimental treatment one and two (laboratory and problem-solving). The finding answered the stated research question one.
2. There is a significant difference in the attitude of biology students of varied ability taught ecology using laboratory and problem-solving teaching strategies and those taught using lecture methods. The positive effect in attitude is in favor of laboratory and problem-solving strategies. The question thus answered the stated research question two.
3. There is significant difference in the retention of concepts among students of varied ability taught ecology using laboratory and problem-solving strategies and

those exposed to lecture methods. As indicated in the mean scores, the treatments had positive effects on the three levels of the abilities (high, middle and low). But the difference is in favor of experimental group two (problem-solving strategy). The finding answered and rejected the research question three.

4. There is no significant difference in the mean scores of male and female students taught ecology using laboratory strategy and their counterpart taught using lecture methods. As indicated by the mean scores, neither the males nor the females performed significantly better than the other. This is to say that gender has no role or influence on the academic performance of the groups. The finding thus answered and retained the research question four.
5. There is no significant difference in the mean scores of male and female students taught ecology using problem-solving strategy and those exposed to lecture methods. As indicated in the mean scores, neither the males nor the females performed significantly better than the other in the two groups. This implies that sex does not determine academic performance of students. This finding answered and retained the stated research question five.

#### **4.5 Discussion of the Findings**

This study investigated the impact of laboratory and problem-solving strategies on attitude performance and retention among varied ability SSII students in Zaria Educational Zone of Kaduna State, Nigeria. The data collected were analyzed using Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) at  $P < 0.05$  level of significance.

Research question one was stated to identify the difference in the mean score academic performance of students with varied ability taught ecology using laboratory and problem-solving strategies and their counterparts taught the same concepts using lecture

method. The result of testing hypothesis one Table 4.1 shows that there is a significant difference in the mean scores of performances of varied ability students taught ecology using laboratory and problem-solving teaching strategies compared with their counterparts taught with lecture method. The table revealed that the mean difference between laboratory and problem-solving strategies is ( $X= 1.32$ ) in favor of problem-solving strategy, while the mean difference between laboratory and control group is ( $X=0.67$ ) in favor of laboratory strategy, therefore hypothesis one which stated no significant difference in the methods was rejected. Thus, the finding is in agreement with the study conducted by Afolabi and Akinbobola (2009) who recorded a significant difference among SSII physics students with low ability level taught using problem-based learning technique when compared with those taught with conventional lecture method. The finding is also in line with the work of Osuafor and Okigbo (2013) who reported a significant difference in achievement of SSI students taught biology with different instructional strategies and also that of Ojediran, Oludipe and Ehindero (2014) who also reported that there was significant difference in the achievement in physics of low performing students exposed to laboratory based instructional intervention (LBII) when compared with those exposed to conventional teaching method (CTM).

The result is also in line with that of Adu and Sheyin (2013), who reported that there was a significant effect on the achievement of students taught with instructional strategy, compare with those taught with lecture method.

Table 4.2 shows the ANCOVA of students' performance in ecology by treatments and varied ability levels. The result of the analysis indicates that the effect of treatments on students' performance in ecology is statistically significant,  $F_{2,18} = 27.75$ , where  $p < 0.05$ . Consequently, the null hypothesis which states that there is no significant difference in the mean scores of students of varied ability taught ecology using laboratory and

problem-solving strategies and those taught using lecture method is therefore rejected. This implies that treatment has a significant main effect on the students' performance in ecology. The table also revealed the value of varied ability levels of students as  $F(2,18 = .87, p\text{-value} = .48 (p > 0.05)$ . To determine which group differs significantly among the three methods, Bonferroni Post hoc analysis was done as shown in Table 4.3 and the result revealed that the p-values of .000 and .001 for problem-solving against laboratory and control were less than 0.005. This shows that significant difference exists in academic mean scores of students who receive the two treatments and lecture method in favor of problem-solving strategy. The result also indicates no significant difference in the performance of students in experimental group one (laboratory) strategy and those in control group (lecture method). The findings of this study are in accordance with Bichi, (2002) who investigated the effects of problem-solving strategy and enriched biology curriculum on senior secondary school students in Zaria. His result revealed that there was significant difference in the mean scores of students exposed to problem-solving when compared with those taught with conventional method. The present study is also in agreement with the findings of Obeka, (2010), Ajaja, (2013); Ibe, (2013) and Seyhan, (2015) who worked with different instructional strategies (i.e. laboratory, problem-solving, inquiry, demonstration and discovery) in their individual studies and reported that problem-solving and laboratory strategies have positive effect on academic performance of students when compared with lecture method.

Table 4.4 shows the Mean and Standard Error of Attitude of students taught Ecology using laboratory and problem-solving strategies and control group. The table revealed that differences existed among the two teaching strategies and lecture method. The difference in the mean scores of attitude of students taught ecology using the two strategies and those taught same concept using lecture method are 6.01, 5.07 and

0.94 respectively in favor of problem-solving strategy. Also the mean difference which exists between laboratory strategy and control method was found to be 5.07. However, to determine whether the differences are significant and which of the groups differ significantly, Kruskal-Wallis test was carried out. Thus, Table 4.5, (Kruskal-Wallis Test) revealed that there is statistically significant difference in the mean attitude scores ( $H\text{-cal} = 15.90$ ,  $P = 0.000$ ) of students taught ecology using laboratory strategy (mean rank = 115.57), problem-solving strategy (mean rank = 83.45) and those taught same concept using lecture method (mean rank = 80.24). Since the P-value is less than .05, the null hypothesis is therefore rejected. This implies that there is a significant difference in the attitude of students taught ecology using laboratory and problem-solving strategies (i.e. experimental groups) over those taught using lecture methods (control group). The result was further subjected to a series of Mann-Whitney tests as a post-hoc analysis.

Table 4.6 shows a significant effect when using the two strategies, the significant difference in attitude observed among the groups was likely due to using specimen and instructional materials where students could see, feel and touch in laboratory and problem-solving strategies on the experimental groups. If the treatments have no effects, the three groups are expected to perform equally the same since they were both pretested and found to be equivalent. The find of this study agrees with that of Ahmad, (2011), who reported a significant difference in attitude among students when examined the relationship between attitudes towards biology courses and students' biology achievement. The finding also confirms that of Ibe, (2013) who observed significant effects in attitude among students taught with guided-inquiry when compared with those exposed the lecture method. The finding of this study is also in line with result of Obochi, (2016) which recorded a significant effect in the mean scores of students' attitude when

investigates the effect of age and gender on attitude and academic performance of SSII biology students in Zaria.

The results presented in Table 4.7 indicated that there was a significant difference in the retention strength of students taught using laboratory, problem-solving strategies and lecture method with laboratory strategy having the highest scores, while control group had the lowest scores. The table also revealed that the mean difference between the three groups is very high among the experimental 1 group (laboratory) followed by experimental 2 group (problem-solving) and lowest in control group. The finding confirms the work of Osuafor and Okigbo (2013) who conducted similar study in Akwa Anambra State, and observed that laboratory based instructional method improved the performance of SSII biology students. The result is in agreement with that of Ojediran, Oludipe and Ehindero (2014), who also conducted a similar study in physics in Oshun State and reported that laboratory strategy improved the performance and retention of students in physics. The finding of this study is also in line with the work done by Bichi, (2003) which stated a significant difference in retention and performance in evolution concepts among student taught with problem-solving strategy when compared with those exposed to traditional lecture method. In the same vein, the three levels of students of varied ability were compared with their performance when taught ecology using laboratory teaching strategy, problem-solving and those exposed to lecture method.

The result presented in Table 4.8 shows varied ability levels, the result indicated that students with low ability performed better and retain more concept when taught with problem-solving strategy than those taught with laboratory and lecture method. In the contrast, students with medium and high abilities performed better when taught ecology using laboratory strategy (i.e. experimental group 1) than their counterpart taught the same concept using problem-solving (i.e. experimental group 2) and lecture method

(control group). To find out how significant the difference in the group was, the data were subjected to a 2- Way Analysis of Covariate (ANCOVA).

Results of the analysis as presented in Table 4.9, revealed that the effect of treatment on students' 'retention ability' in ecology is statistically significant. This implies that treatment has a significant main effect on the students' retention ability in ecology. The finding of this study confirms that of Lakpini (2006) which reported that using PIPS and CCIS Model to teach genetics concepts improved the academic performance and retention of low ability SSII students in Zaria. The finding also supports those of Ezeudu and Okeke (2013) and Ojediran, Oludipe and Ehindero (2014) who observed increase in academic performance of low performing students when taught with different simulation and laboratory-based instructional models in chemistry and physics respectively. To confirm the retention rate among the varied ability of the various groups, Bonferroni Post-hoc analysis was conducted as indicated in Table 4.10 and the result revealed that laboratory strategy and lecture method are significantly difference in their mean scores  $p = .014$  ( $p < .005$ ). The table also revealed that there is no significant difference in the retention of concepts among students of varied abilities taught ecology using laboratory and problem-solving strategies.

The result presented in Table 4.11 shows that difference exist in the mean scores of male and female students taught using laboratory, problem-solving teaching strategies and those exposed to lecture method. Thus the difference between male and female students in laboratory group is .69 in favor of male students. The table also revealed that female students performed better than male in problem-solving and control groups, with difference of .91 and .10 respectively. In order to determine whether gender is statistically significant or the difference is just by chance, a 2-Way analysis of covariance (ANCOVA) was conducted as shown in Table 4.12.

The results from Table 4.12 indicates that gender and treatments are not statistically significant, thus the treatments are gender friendly hence gender does not influence the understanding of students in the experimental and control groups. Therefore, the null hypothesis is retained. The finding of this study is however in accordance with those of Mari, (2002), Njoku, (2012) Adu and Sheyin (2013) and Amedu, (2015) which in their individual studies reported no significant difference in the mean scores of male and female students taught with different instructional methods. The finding of this study is not in line with that of Abduraheem, (2012) who worked on gender differences and academic achievement in integrated science in Junior Secondary Schools. He confirmed that males performed better than females and affirmed that males demonstrated significantly more positive attitudes towards science than females. Owuamanam and Babatunde (2007) also noted that females exhibit more positive attitudes towards Biology and males towards Physics. The result of this study is however different from that of Ibe, (2013) who reported that female students out-performed the males in RMBT when taught biology using guided-inquiry method.

## **CHAPTER FIVE**

### **5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Introduction**

This study investigated the impact of two teaching strategies laboratory and problem-solving on attitude, retention and academic performance among varied ability Secondary school biology students Zaria, Kaduna State Nigeria. In this chapter the summary of the findings from the study are presented, while the conclusion and recommendations are highlighted under the following subheadings.

- Summary
- Major Findings
- Conclusions
- Contributions to Knowledge
- Recommendations
- Limitations of the Study
- Suggestions for Further Study.

#### **5.2 Summary of the study**

The study investigated the Impact of Laboratory and Problem-solving Strategies on attitude, performance and retention in biology among varied ability Secondary schoolbiology students in Zaria, Kaduna StateNigeria. The subjects for the study were SSII students of Government owned Co-educational Schools. Simple random technique involving balloting method was employed in selecting the sample. Five research questions were stated and five null hypotheses were formulated and tested using t-test statistics. Relevant literatures related to the study were reviewed and these provided insight to already existing problem. The research design was a quasi-experimental design

using pretest and post-test group in which three intact classes were involved and assigned to three different treatments. The three groups ie two experimental EG1, EG2 and one Control group received six weeks' ecology lessons.

Two instruments were developed for the study. (i) A 20 items of Student Attitude Questionnaire (SAQ) using the Likert Scale was used (ii) Ecology Performance Test (EPT) which contained 50 items of multiple choice questions were also used by the researcher. The two instruments were validated, the facility and discrimination indices of the performance test were determined. These instruments were used for data collection. A pre and post-test design was used for the study using three groups, i.e. two experimental and one control. Laboratory and Problem-solving Strategies were used in teaching the experimental groups, while the control group was taught using lecture method. The top 25% were ranked the high, middle 50% were the average while lower or bottom 25% were low ability group. The intact classes of the three schools were used so as to cater for the issue of gender. Five research questions and five null hypothesis were formulated and tested at 0.05 level of significance. The data collected were analyzed using t-test and Kruskal Wallis statistics to determine the significant difference of the three groups, at  $P < 0.05$ .

The findings of the study showed among others that laboratory strategy had significant effects on the attitude and academic performance of the students of varied abilities. Low ability students that were taught ecology using problem-solving strategy improved in their performance and retained the learnt concept more than those taught using lecture method. Neither male nor female in the two experimental groups performed significantly better than the other in biology after treatment. Based on the findings of the study, it is recommended that laboratory and problem-solving strategies should be used to teach ecology at secondary school level.

### 5.3 Major Findings

The following are the major findings after analyzing the data collected for the study:

- There is a significant difference in the mean scores of students of varied ability taught biology using laboratory and problem-solving strategies and those taught using lecture methods. The observed difference was in favor of experimental group one and two (i.e. laboratory and problem-solving strategies).
- There is a significant difference in the change of attitude of biology students of varied ability taught ecology using laboratory and problem-solving teaching strategies and those taught using lecture methods. The positive effect in attitude was in favor of laboratory and problem-solving strategies.
- There is a significant difference in the retention of ecology concepts among students of varied ability levels taught ecology using laboratory and problem-solving strategies and those exposed to lecture methods. As indicated in the mean scores, the treatments had positive effects on the three levels of the abilities. But the difference was in favor of experimental group two (problem-solving strategy).
- There is no significant difference in the mean scores of male and female students taught ecology using laboratory strategy. As indicated by the mean scores, neither the males nor the females performed significantly better than the other. The treatment was thus gender friendly.
- There is no significant difference in the mean scores of male and female students taught ecology using problem-solving strategy. As indicated in the mean scores, neither the males nor the females performed significantly better than the other. This implies that problem-solving teaching strategy is gender friendly with regards to academic achievement.

## 5.4 Conclusions

Based on the findings of the study, the following conclusions were made

- i. laboratory and problem-solving teaching strategies have the potentials of enhancing and improving the academic performance of students in biology subject of SSII level. This could be due to the fact that students were involved and exposed more to realities of life and tend to work as scientist and acquire knowledge by themselves which the teacher only correct their impressions hence they participated fully in the class unlike in lecture method of teaching, where the students remained passive.
- ii. The attitude of the students of varied ability in the experimental groups i.e. laboratory and problem-solving improved unlike their counterpart in control group. Thus, Problem-solving strategy removes the teacher as a dictator and sole owner of knowledge which renders student passive, rather students are actively involved in the process of learning which is not so in conventional lecture method.
- iii. Students in the experimental groups had better retention of the concept taught when using the two treatments hence they remember quickly what they see than what they hear in lecture method.
- iv. Since neither the male nor the female in the experimental groups performed significantly better than the other in Ecology Performance Test (EPT), it means that gender has no influence on the students' academic performance thus, the instructional strategies are gender friendly and this is an indication that hopefully the gab in biology performance in schools is bridged.
- v. In a nutshell, the findings of this study indicate that activity based learning is better than teacher centered learning in promoting attitude, performance and

retention of learned concept of biology subject among SSII students of varied abilities.

## **5.5 Contributions to Knowledge**

The significant position of teaching biology in secondary schools and colleges in our contemporary society can hardly be overemphasized. Researches have shown that biology enjoys more attention by students than other science subjects such as physics, chemistry etc. It has been reported however, that the failure rate in biology is highest compared to the other science subjects. The poor results in biology might be due to the indiscriminate enrolment by students, both the serious and unserious ones and also the fact that the subject is prerequisite to professions such as Pharmacy, Medicine, Agriculture, Biochemistry, Micro-biology. Aganga, (2005) reported that there is no science subject that is in greater need of constant re-evaluation than the science of biology.

1. The adapted and modified models and flowcharts used in the experimental groups 1 and 2 (laboratory and problem-solving strategies) have bridged the gap which exist among the students about biology as abstract and difficult subject to understand.
2. The strategies were also used to improve students' academic performance, increase and enhance retention of students and especially those with low ability levels.
3. The strategies also promote empowerment and self-reliance and significantly elevates the self-confidence of the learner which cannot be obtained by using conventional method.

4. The findings of this study have also added information to the existing literature on ecology concepts and classroom practices as regards to teaching and students' performance.

## **5.6 Recommendations**

Based on the findings of this study, the following recommendations are made:

1. The use of laboratory and problem-solving teaching strategies should be encouraged among secondary school Biology teachers by Ministry of education and other education agencies.
2. Government agencies such as Federal and State Ministry of Education and other Stakeholders in educational sector should provide adequate and relevant instructional materials for effective utilization of laboratory teaching strategy to enhance meaningful learning among senior secondary school students of varied abilities.
3. Curriculum planners such as Nigerian Educational Research and Development Council (NERDC), West African Examination Council (WAEC) and Ministry of Education should incorporate and emphasis on the importance of using laboratory and problem-solving teaching strategies to facilitate student centered activity learning.
4. Teachers of senior secondary schools should ensure provision of equal opportunities for both male and female students in the classroom and during practical, hence interactions with one another may enhance their understanding.
5. School Administrators in secondary schools should assist in provision of instructional materials either by a way of standard or improvising to facilitate an effective use of activity-based learning such as laboratory and problem-solving teaching strategies to enhance meaningful learning.

6. Biology teachers in secondary schools should be encouraged and sponsored by ministry of education, schools and even Parent Teachers' Association of such schools for training and retraining through attending seminars, conferences and workshops on regular basis so as to acquaint them with new trends and innovations in science teaching.
7. Effective use of Laboratory and problem-solving strategies by biology teachers of senior secondary schools can provide students with low performance in biology the opportunity to participate in the activities and maximize individual potentials in learning the subjects.
8. Laboratory and Problem-solving strategies should be adopted in schools, used in teaching Biology concepts and mostly ecology topics especially at secondary school level, these will allow students interaction and encourages higher order thinking among them.
9. Biology students in SS level should be given the opportunities and guided on how to handle and manipulate some of the biology materials, tools and equipment in the laboratories

### **5.7 Limitations of the Study**

The study has the following limitations:

- i. the study was meant for only SSII students of Government owned Schools in Zaria Educational zone. The results and conclusions were restricted to the population from which the sample was drawn. The findings may be different or otherwise if the samples were larger or if the whole secondary schools in Zaria or Kaduna State were used.
- ii. many of the students could not easily comprehend with English language until much more explanations were made.

- iii. Time allocation for biology subject is too short and thus posed a big challenge for the researcher.
- iv. lack of infrastructure (chairs and desks) for the students in the schools was also a shortcoming since only few were available at the time of this study.

### **5.8 Suggestions for Further Studies**

This study can be furthered in the following,

1. similar study can be carried out in other secondary schools outside Zaria zone so that the validity and scope of generalization made in this study can be extended.
2. the study investigated impact of laboratory and problem-solving teaching strategies on attitude and academic performance in ecology. Thus, there is the need to try the strategies on other disciplines such as Chemistry, Geography, Agriculture and other secondary school subjects to see what the result will be.
3. the strategies used in this study could be used in other higher institution of learning i.e. Polytechnics, Colleges of Education or even Universities.

## REFERENCES

- Abdul Razak, N and Babikkoi, A. (2012). Integrating the Broadcast Media in Teaching Strategies of learning ESL in Malaysia. *Journal of Education and practice*, 3(7), 36-39.
- Abdulahi, J.S. (2013). *Teaching Methods*. Zaria: Ahmadu Bello University Press.
- Abdulraheem, B.O. (2012). Gender Differences and Academic Achievement and Retention in Social Studies among Junior Secondary schools in Ekiti State. *European Journal of Educational Studies* 4(1), 155.
- Adamu, K.A. (2003). Towards Enhancing Better Performance in School Examinations: Giwa *Journal of Education*; 2: 56-66.
- Adamu, G. J. (2014) Effect of Problem-solving Instructional Strategy on Self Efficacy, Creativity and Academic Achievement in Genetics Among NCE students PhD Thesis ABU, Zaria.
- Adebanjo, A.A. (2014) Attitude and Gender difference in the Utilization of computers among Undergraduates. *Nigerian Journal of Computer Literacy*, 5(1), 170-184.
- Adedoyin, T.S. (2007). Curriculum Development. Newsletter, No. I. Science Education: A Course for Senior Secondary Schools.
- ADEA (2004) The Quest for Quality Learning from African Experience, *Proceedings of the IDEA Biennial meeting. Grand Bale Mauritius*
- Adegoke, B.A. (2011). Effect of Multimedia Instruction on Senior Secondary School Stents Achievement in Physics. *European Journal of Education Study* 3, 537-540.
- Adeniyi, B.O. (2009). *Teaching Biology Science Creativity*: Ibadan University Press Ltd. Ibadan.
- Adesoji, F. A. (2002) Modern strategies in the teaching of integrated science, in S.O Ayodele (Ed.), *Teaching strategies for Nigerian Secondary schools*. Ibadan: Power House Press publishers p.205-212.
- Adesoji, F.A. (2008). Students Ability Levels and Effectiveness of Problem—Solving Instructional Strategy. *Journal of Social Physics*, 17, 5-8.
- Adeyegbe, G. O. (1993) The Senior Secondary Schools, Science Curricular and Candidate's Performance: *An Appraisal of the first cycle operation. Journal of Science Teachers Association of Nigeria*, 28 (1&2), 1 – 6, 3 – 12.
- Adeyemo, A.O. (2005). *Principle of Education and Practice of Education*. Ado-Ekiti: Omolayo Standard Press and Bookshops Nig. Ltd.
- Adu, D. O. and Sheyin, A. O. (2013) Impact of Computer-Based Instruction on Pre-Service Teachers' Achievement in Ecology. *Society for Information Technology and Teacher Education New Orleans, Louisiana United States*.
- Afolabi, F. and Akinbobola, A. O. (2009) Constructivist Problem-Based Learning Technique and the Academic Achievement of Physics Students with low Ability level in Nigerian Secondary Schools. *Eurasian Journal of Physics and Chemistry Education* 1(1) 45-51.

- Aganga, A.A. (2005) Understanding the Nature of Science. A Comparative Study of Different Groups of Student and Science Teacher in Oyo State. *Obudum Journal of Education Studies* 4(1):13-186.
- Agdas, S. (2013). Effects of problem based learning on development of Critical Thinking Skills and dispositions in Engineering PhD thesis, University of Florida.
- Agwilo, J.B. (2007). The Conception of Integrated Science by pre-service Science Teachers *Journal of Science Teachers Association of Nigeria* 24<sup>th</sup> Annual Conference Proceedings.
- Ahmed, R.N. (2011) Attitude towards Biology and its effects on Students' Achievement. *International journal of biology*, 3, 4: ISN 1916-9671-ISSN 1916-969x.
- Aiyedun, J.O. (2000). Influence of Sex Difference of students on their Achievement in School Mathematics. *Journal of the Mathematics Association of Nigeria*. 25(1):9-113.
- Ajaja, O.P and Eravwoke Y.O (2012) Effect of 5E learning circle on student Achievement in Biology and Chemistry. *Cypriot Journals of Educational Sciences*. 7, (3), 244-265.
- Ajaja, P.O. (2013). Which Method Best Suit Biology Teaching? Lecture, Concept, Mapping Co-operative Learning or learning Cycle? *Electronic Journal of science Education*, 17(1)
- Akale, S.A. (2000) Biological Science and Teacher Education: Ibadan: Heinemann Educational Books Nig Ltd.
- Akubuilu, D.U (2004). The effect of problem solving instructional strategies on students Achievement and retention in biology with respect to location in Enugu State. *Journal of Science Teachers Association of Nigeria*, 24(112), 94-100.
- Alan, C.I. (2000). Constructivism: Science Education's Grand Unifying Theory. *The clearing Huasa*, 74(1):9-12.
- Alant, B. (2004). Researching problems in introductory physics: Towards a new understanding of familiarity. *African Journal of Research in Mathematics, Science and Technology Education*, 8 29-40.
- Alebiosu, K.A. and Ifamuyiwa, A.S. (2003): Empowering teachers for sustainable development through ICT. Institute of Education O.A.U. Ago-Iwoye.
- Alhassan, N. (2006) Identification of Difficult topics in Senior Secondary School Certificate Biology Syllabus and their Effective on Performance in final Examination. Unpublished Research Project ABU, Zaria.
- Ali, A. (2008). *Conducting Research in Education and Social Sciences*. Nigeria Tashiwa Networks.
- Amedu, O. I (2015) The Effect of Gender on the Achievement of Students in Biology Using the Jigsaw Method. *Journal of Education and Practice*. 6, (17).
- Ameh, P.O. and Dantani, Y.S. (2012). Effects of lecture and demonstration method on the academic Achievement of students in chemistry in Nasarawa L.G.A of kano State. *International Journal of modern social Science* 1(1).
- American Association for Advancement of Science (AAAS), (1993). Benchmarks for Science Literacy. New York Oxford University press.

- Anyanwu, J. (2012) Act Based Learning Handbook Buck Institute for Education. Ojo printing Press. Ibadan.
- Anyanwu, R.I., Obochi, M.U. and Isah, A.Y.(2015), Comparison of Biology Teachers Commitment to teaching in Sabon-gari Local Government Area, Kaduna State. *Journal of Science Technology and Education*, Abubakar Tafawa Balewa University, Bauchi State, Nigeria. 3(3), 76-86
- Arigbabu, A.A. and Mji, A. (2004). Is Gender a factor in Mathematics performance among Nigerian Pre-Science Teachers? *Sex Role*, 51(11 and 12) 749-758.
- Arisi, R. O. (2002) Effects of Teaching Methods on the Learning Process Amongst Social Studies with vary learning characteristics. PhD. Thesis, Delta State University, Abraka.
- Arthur, L. (2013). Step in Manpower Development. Hearst newspapers. Hearst Communication Inc. Houston Chronicle. Texas
- Atadoga, M.M and Onaolapo, M.A. (2008). *A Handbook of Science Teaching Method*. Vol. 1. 38-57 S/Gari Zaria. Shola Press.
- Bajah, S.T. and Asim, A.E. (2000). Constructivism and Science Learning. Experimental Evidence in a Nigeria Setting. *A Journal of the World Councilor Curriculum and instruction Nigerian Chapter*, 3 (1), 106-113.
- Balani, I.B. (2010). Thinking Ahead for an Appropriate Science Curriculum for Nigerian Senior Secondary Schools. Bunnmi Press. Lagos.
- Baltimore, S. (2008). *Inside Education Light for all Baltimore sun*. Maryland News. Calvet Street, Baltimore.
- Barnard, W. M (2004). Parent involvement in elementary school and educational attainment. *Children and youth Services Review*, 26, 39- 62.
- Battle, J. and Lewis, M. (2002). The increasing signify <http://gradworks.umi.com/3372318.pdf>.cance of class: The relative effects of race and Socioeconomic status on academic achievement. *Journal of Poverty*, 6(2), 21-35.
- Bature, I. J. (2005) Students Perceived Difficulties in SSCE Mathematics Syllabus in some selected Secondary Schools in Plateau State. *Journal of Educational Studies* 13 (1) 110-115.
- Bichi, S. S. (2002). Effects of Problem-solving Method on Secondary School Students. Achievement in Evolution. *Journal of Vocational and Technical Education*, JOVETED 4(1) 98-105
- Bichi, S. S. (2003) Effects of Gender on Academic Achievement in Evolution Concepts Among Secondary School Students Using Problem-solving Instructional Strategy, in Zaria. *Journal of Studies in Education* 3 (1) 133-138.
- Bichi, S.S. (2008). Resources for Science, Technology and Mathematics Education in Nigeria in the 21<sup>st</sup> Century. *Journal of Educational Research and Development*, 3(1), 168-178.
- Bilgin, I. (2009). The Effects of Guided Inquiry Instruction Incorporating a Co-operative Learning Approach on University Students' Achievement of Acid and Base Concepts and Attitude towards Guided Inquiry Instruction. *Scientific Research and Essay*, 4(10), 1038-1040.

- Biological Science Curriculum Study (2005). *Doing Science: The Process of Scientific Inquiry*, <http://Science.Education.nil.gov/supplements/nih6/inquiry/others/copyright>.
- Blevins, B.M. (2009). Effects of socioeconomic status on academic performance in Missouri public Schools.
- Bloom, B.S. (1956). *Taxonomy of Educational Objectives: Classification of Educational Goals. Handbook: Cognitive Domain*. New York: David Mckak co.
- Bomide, O. (2009). *Attitudes of teaching in Teaching Biology Science Creativity*: Ibadan University Press Ltd. Ibadan.
- Boody, N., Wastson, K. Aubusson, P. (2003). A Trial of the Five Es. A Referent Model for Constructivist Teaching and Learning *Research in Science Education*, 33,27-42
- Borich, G.D. (2004). *Effective Teaching Method, Fifth Edition*. New jersey: Merrill, Prentice Hell.
- Bruner, J. (1961). *Acts of Learning and Discovery* Harvard Educational Review 31, 21-33  
Cambridge, MA: Harvard University Press.
- Bruner, J. (1996). *The Culture of Education*. Cambridge, MA: Harvard University Press.
- Campbell, B., Kauduna, L., Allie., Buffler, A. and Lubben, F. (2000). The Communication of Laboratory investigation by University Entrance. *Journal of Research in Science Teaching*. 37 (8), 839-853.
- Ceren, T. Ozlem, S. Ozkan, I. Semra, A. and Sungar, S. (2001) Biology concept perceived as difficult by Turkish High school students, Hacehepe “*Universitesi Egitimfakultesi Dergisi* 21: 145-150.
- Chambers, E. A. and Schreiber, J. B. (2004). Girls’ academic achievement: Varying associations of Extracurricular activities. *Gender and Education*, 16(3), 327-346.
- Chen, C and Howard, B. (2010). Effect of live simulation on middle school student’s attitude and learning toward science. *Journal of educational technology and society* 13(1), 133-139.
- Chiappetta, E.L. and T.R. Koballa (2002). *Science Instruction in the Middle and Secondary Schools*. Merril Preface Hall.
- Childs, P. (2009). Improving Chemical Education Turning Research into Effective Practice. *Chem. Edu. Res. Pract.* 10,189-203.
- Claire, H. (2005). *Gender in Education 3-19-A Fresh approach*, London Association of Teachers and Lecturer pdf <http://www.att.org.uk>.
- Cooper, G.J. (2004). *The science of the Struggle for Existence; on the Foundations of Ecology*. New York; Cambridge University Press.
- Croxford, L. (2000) *Gender and National Curricular: Shifting agendas in the UK and Europe*, London Routledge.
- Danmole, B.T. and Femi Adeoye, K.O. (2004). Effect of concept mapping Technique on Senior Secondary School Students’ Achievement and Retention of Ecology concepts. *Journal of Science Teachers Association of Nigeria*, 39, No (1and2) 32-38.

- Dewey, J. (1993). *How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process*. Lexinton; MADC Health and Company.
- Duliyemi, A. N., Olaginju, A.M. and Olumide. J. (2014). Effects of Computer Simulation Package, Gender and Parental Education On Nigerian Secondary School Students' Attitude Towards Biology 21<sup>st</sup>centuary, Academic forum conference proceedings. Harvard.
- Egbunonu, R. Ugbaja, R. (2011). An Analysis of Students' Performance in Biology, 2000-2005 *Proceeding of the 52<sup>nd</sup> Annual Conference of Science Teachers Association of Nigeria STAN*. 17(3) 235-250.
- Eitle, T. M. (2005). Do Gender and Race Matter? Explaining the Relationship Between Sports Participation and Achievement. *Sociological spectrum*, 25(2), 177-195.
- Elijah, B.C, Lynn, M.I Jason, R.W. (2015) Boosting Students' Attitude and Knowledge About Sets Them Up for Collage Success. *The American Biology Teachers*, 77(2) 113-118.
- Enoh O.A. (2004). Education schooling and Global Change. A Lead Paper Presented on the Occasion of the 5<sup>th</sup> National Conference of school education, Federal College of Education, Zaria Kaduna State, 6<sup>th</sup> July, 2010.
- Erinosho, Y.E. (2005). Women and Science, 36<sup>th</sup>Inagurae Lecture- Olabisi Onabanjo Ago-Iwoye, 1-37
- Evans, E.M, and Vosniadu, S. (2008). Biology: A Developmental Analysis. *International handbook of Research on conceptual change* (pp. 263-294)
- Ezeudu, F.O and Okeke, P.E (2013). Effect of Simulation On Students' Achievement in Senior Secondary School Chemistry in Enugu East Local Government. Area of Enugu state. *Nigeria journal of educational practice*, 4(20).
- Fasiku, A.M 2011. Gender Influence on Social Study Teacher's Sensitivity Environmental Education in JuniorSecondary School in Ekiti State. *Educational Focus* 3(1) 9-14
- Fatokun, K.V.F & Odagboyi I.A (2010) Gender Disparity and Parental Influence On Secondary School Achievement in Nasarawa State, Nigeria. *Journal of Research in National Development*. [Http://Www.Transcampus.Org](http://Www.Transcampus.Org)
- Federal Republic of Nigeria (2005). *Nigeria Constitution*, Abuja: Federal Government Printer.
- Federal Ministry of Education (2009). *National Policy on Education*. Abuja NERDC.
- Federal Ministry of Education (2013). *National Policy on Education 6<sup>th</sup> Edition* Government Press, Yaba, Lagos: Nigeria.
- Federal Republic of Nigeria. (2013). *Minimum Standard for NCE Teachers 4<sup>th</sup> Edition* National Commission for colleges of Education Garki Abuja: Nigeria.
- Fosnot, C.T. (1996). *Constructivism: Theory, Perspective and Practice*. New York: Teacher College Press.
- Goddard, R.D. (2003). Relational Networks, Social Trust, And Norms: A Social Capital Perspective On Students' Chances of Academic success. *Educational Evaluations & Policy Analysis*, 25, 59-74

- Gagne, R. M. (1970) Learning Requirement for Enquiry, Reading in Science Education. New York, Macmillan Company.
- Gagne, R. M. and Driscoll, J. C. (1988) Learning Requirement for Laboratory, Reading in Science Education. New York, MacMillan Company.
- .Gungor, S. H. (2014) The investigation of the perception of problem solving skills by prospective science teachers in the Science Laboratory, *Eurasian Journal of Physics and Chemistry Education* 6(2), 142-161.
- Gungor, S. H., and Morgil, I. (2015). Inquiry based experiment application in the chemistry laboratory. *Journal of Science Education*, 16(2), 15-57.
- Head, G., Kane, J. and Cogna, N. (2002). An evaluation of behavior support in secondary schools in south Lanarkshire, Glasgow. University of Glasgow Scotland.
- Henes, B. (2008). The Exploration of Socioeconomic Status and Student Achievement at Beverly Elementary School. *Un published thesis*. Merietta Collage.
- Hofstein, A. and Lunette, V.N. (2004). The Laboratory in Science Education: Foundations for the Twenty- First century. *Science Education*, 88, 28-54.
- Hofstein, A., Novon, O., Kipnis M. and VeNaaman, M. (2005). Developing Students Ability to Ask Better Questions Resulting from Inquiry-Type Chemistry Laboratories. *Journal of Research in Science Teaching*, 142(7), 791-806.
- Ibe, H.N.(2004). Effect of Guided Inquiry Demonstration and Conventional Method of Teaching Science Process Skills among Senior Secondary School Students. An Unpublished M.Ed. Thesis Department of Science Education University of Nigeria, Nsukka.
- Ibe, H.N. (2013). Effects of Guided-Inquiry and Expository teaching methods on Senior Secondary School Students performance in Biology in Imo State. *Journal of Education Research and Behavioral Sciences* vol. 2(4) pp.051-057.
- Ibrahim, A. I. (2012) Core Subject for Primary School Teachers. A paper presented at a training on Improving Teaching, Organized by Gombe State University Consultancy Services, Gombe, Nigeria.
- Ige, T.A. (2001). Problem Solving: A Viable Tool for Teaching Ecology concepts. 39<sup>th</sup> Annual Conference Proceeding of Science Teachers' Association of Nigeria (STAN).
- Ihejirika, J.C. and Onyenemezu, E.C. (2012). Adult Education and Development of Manpower Resources in Nigeria. *Journal of Social Science and Humanities*. 3:3.
- .Inceaka, A. E., Guven, E. and Aydogdu, M. (2010). Effect of Problem Solving method on Science Process Skills and academic achievement. *Journal of Turkish Science Education*, 7(4) 13-25.
- Ingrid, W., Jenifer, D., Scott, P. and Lori, S., (2016) Hands - on Activities for teaching Biology to high School or Middle School Students. University of Pennsylvania.
- Inyan, N.E.U. and Mahmond, J.T. (2004) Science Education Research Trends in Nigeria. *Journal of the Science Teacher Association of Nigeria*. 39(1 and 2) 61-65.
- Isiaka, A.G., Moses. J, and Charles, O. O. (2013) Effectiveness of Video-based Cooperative learning strategy on high, medium and low academic achievers.

- Jakayinsa, A.A. (2005). *Fundamental of Instructional Methods*. Olives Production Ltd Kwara.
- Jegade, O.J. and Inyang, N. (1990). Gender Difference and Academic Achievement in Integrated Science among Junior Secondary School Students. "A Nigerian Study". *International Reviews of Education*, 36(3), 364-368.
- James, T. (2000). Effect of combining reflective writing with Concept Mapping and Lecture method on Pre-Service N.C.E. Teachers Attitude Achievement in Biology. PhD Thesis, A.B.U., Zaria.
- Jenkins, J.P. (2013). Teacher data teams: Using The Problem solving process to maximize teacher efficacy, Walden University, College of Education.
- Justus, J. (2005). "Qualitative Scientific Modeling and Loop Analysis" Philosophy of Science, in Press.
- Kalu, U.U.andNdokwo, J.O. (2006) Student Participation in Biology Practical and its Effect on performance in SSCE in Zaria Nigeria. *A Journal of Teacher Education*. 12(1)152-155.
- Kalu, U. U. (2005) Qualification of teacher as a Precursor for Enhanced Student Achievement in practical biology in SSCE in Zaria, Nigeria. *Journal of Vocational and Technical Education* 4(1):60-68.
- Karacop, A & Doymus K. (2013) Effect of Jigsaw Cooperative Learning and Animation Techniques on Students Understanding of Chemical Bonding and their Conception of the Particulate Nature of Matter. *Journal of Science Education and Technology* 22(2)
- Kasuko, H. (1995). Teacher Centered and Children Centered Pedagogical Approaches in Education Ninety Fourth Year Book of the National Society for the Study of Education, 205-225.
- Kato, Y. and Kamii, C. (2001). Piaget's Constructivism and Childhood Education in Japan *Prospects* 302(2) 161-173.
- Kennedy, H. L. (2000) Society Cannot Continue to exclude Women from the field of Science and Mathematics. *Journal of Mark Education* 120 (3), 525.
- Krashen, S. (2005). The hard work hypothesis: Is doing your homework enough to overcome the effects of poverty? *Multicultural Education*. 12(4). 16-19.
- Krebs, C. J. (1999) Ecological Methodology. *Journal of Biological Education* (2002) 36(4) California, USA.
- Lagoke, A.B., Jegede, J.O. and Oyebanje, P.R. (2007). Towards the Elimination of Gender in Science Concepts Achievement Through the use of Environmental Analogs. *International Journal of Service Education*, 19(4), 365-382.
- Laird, B.K. (2014). The Effects of monitoring intensity on discretionary effort, honesty, and problem solving ability PhD Thesis, University of Memphis.
- Lakpini, M. A. (2006) Effect of PIPS and Conceptual Change instructional strategy on the achievement, retention and attitude of senior secondary school (SSiii) biology students with varied ability levels. PhD Thesis Ahmadu Bello University, Zaria.

- Lakpini, M. A. and Atadoga, M. M. (2012) Effect of Conceptual Change Strategy on Academic achievement, retention and attitude of Senior Secondary School (SSII) Biology of varied ability levels in Zaria, Kaduna Nigeria.
- Lawal, F. K. (2009) Effectiveness of Conceptual Change Instructional Strategy in Remediating Misconception in Genetics Concepts Among Senior Secondary School students in Kano State. PhD Thesis Faculty of Education A.B.U. Zaria.
- Lawal, F.K. (2011) Biology Teachers' Perception of the senior secondary biology curriculum and the need for reform. *Journal of Science Teachers Association of Nigeria*. 52, 205-209.
- Lawson, A.E. (2001). "Using the Learning Cycle to Teach Biology Concept and Reasoning Patterns. *Journal of Biological Education*, 35(4), 165-168.
- Macdowell, C.C. (2012). Problems Associated with the Study of Biology Science at the Senior Secondary Schools: Research Project Submitted to the Department of Education. A.B.U, Zaria.
- Maduabum, O. (2004). Problems Associated with the Study of Experimental Biological Science in Senior Secondary Schools: Research Project Submitted to the Department of Education. A.B.U, Zaria.
- Maikano, S. (2007) Effects of Outdoor and Indoor Laboratory Experience on Secondary School Students Academic Achievement and Retention in Ecology in Kaduna State. M.ed Thesis. Department of Education, A.B.U.Zaria.
- Mari, J. S. (2002). Gender Related Differences in Acquisition of Formal Reasoning Approach. *Journal of the Physics Teachers' Association of Nigeria*, 37, 76-81.
- Maryland, D. (2012). A Teacher Education Programmed for Teacher Transformation; The Online Bachelor of Education modestimuk11@hotmail.com.
- Marzano, R. (2011). *Enhanced Discovery Learning*. *Educational Psychology* 101(1)46-57.
- Mayer, R.E. and Wihrock, R.C. (2006) *Handbooks of Educational Psychology* (2<sup>nd</sup> PP.2887-304)
- McCoy, L.P. (2005). Effect of demographic and personal variables on achievement in eight grade algebra. *Journal of Educational Research*, 98 (3), 131-135.
- Michael, S.O. (1998). Restructuring US higher education: Analyzing models for academic program Review and discontinuation. *The review of higher Educational*, 21(4), 377-404.
- Michael, L. K. (2007) Oxford Dictionary of Sport Science and Medicine.
- Mkpanang, J. T. (2010) Effect of Computer-Assistant Instruction (CAI) with drill and practice on academic achievement of students in physics. *Nigeria Journal of Science and Education*, 8(1) 71-86.
- Moor, R. (2006) Class Attendance How Students' Attitude about attendance Relate to their Academic Performance in Introductory Science classes. *Research and Teaching in Development of Education*, 23 (1). 21-33
- Morgil, I., Gungor, S. H. and Secken, N. (2009). Investigating the Effects of Project-Oriented Chemistry Experiments on some Affective and Cognitive Field Components. *Journal of Turkish Physics Education*, 6, 108-114.

- Mukhejee, A. (2012). Evaluation of Nigeria Integrated Science Project. *Paper Presentation at the STAN National Workshop on the New Niger Integrated Science Project*Owerri.
- New Secondary School Curriculum (2008). Nigeria Educational Research and Development Council (NERDC).
- Njoku, Z.C. (2002). Enhancing Girls' Acquisition of Physics Process Skills in Co-educational Schools: An Experience with Sex Grouping for Practical Chemistry. *Journal of Physics Teachers' Association of Nigeria*, 37, 69-75.
- Novak, J.D. and Mosunda, D. (2000). A twelve-year longitudinal study of science concept learning. *An American Educational Research Journal* 28. 117-153
- Nwagbo, C.N. and Chukelu, O. (2011). Effect of Biology Practical Activities on Student's Process Skill Aquisition *Stannoline.org/journal/pdf/stan*
- Nwagbo, C.N. (2011). The Relative Efficacy of Guided Inquiry and Expository Methods on the Achievement in Biology of Students of Different levels of Scientific Literacy. *Journal of Science Teachers Association of Nigeria*, 36(1&2), 43-51.
- Nwona, H.A. and Akogun, N.A. (2015). Breaking Gender Barrier in Science, Technology and Mathematics Education. *Nigeria Journal of Research in Education*.36, 98-109.
- Nwosu, A. A. (2004) Gender and Acquisition of Science Process Skills among Secondary Schools. Implication for Science Teaching. *Proceeding of Science Teachers Association of Nigeria* Ibadan. Heinmann Educational Books 206 209.
- Obasi, A. O. (1999) Effect of Family and Socio-Economic background on Attitude and Performance of Sceondary School Stuent.
- Obeka, S. S. (2009) EPODEWALAD and Power of Simulation Games of Geographical and Environmental Education, Zaria A.B.U. press.
- Obeka, S.S. (2010). Effect of inquiry and Demonstration methods on students' Academic Achievement and Retention in some Environmental Educational Concept of Geography. *A Journal of Studies in Science and Mathematics*. UNN Press.
- Obeka, S.S. (2011). *Panacea of Science Education Research*. Ahmadu Bello University Press. A.B.U Zaria.
- Obochi, M. U. (2015) Prospects of Biology in Entrepreneurship Education for Sustainable Development in Africa. African Conference on Entrepreneurship Education for Sustainable Development in Africa. Faculty of Education, Ahmadu Bello University, Zaria.,930-933.
- Obochi, M.U. (2016) Effect of age and gender on learning ability, attitude, retention and academic performance of SSII biology students in Zaria educational zone Kaduna state Nigeria. *Nigerian Journal of Science and Educational Research*. 12(1) 213-217
- Odegboji, O.I. (2015) Effect of gender on the achievement of students in biology using Jigsaw method.
- Odenbaugh, J. (2005). "Ecology" in Sarkar, S. and Pfeifer, J Eds. *The Philosophy of Science an Encyclopedia* New York:

- Ofeegbu, J.S. (2007). *Learning Styles: A Review of Four Teaching Methods*. Abba Century Books Ltd.
- Ojediran, I.A., Oludipe, D.I., and Ehindero, O.I. (2014). Impact of Laboratory- Based Instructional Intervention on the Learning Outcomes of Low Performing Senior Secondary Students in physics. *Creative Education*, 5, 197-206.
- Okebukola, P. A O. (1992) Can good concept mappers be good problem-solvers? *Education Psychology*, 12(2): 113-129.
- Okebukola, P.A.O. (2004) Gender Equity in Science Classrooms. Paper Presentation at the UNESCO Conference, Pretoria USA.
- Oko, R.O. (2011). Towards Transforming Nigeria Universities for Quality Education. *New Understanding Racial-Ethnic Differences in Secondary School Science and Mathematics Achievement (Diary On Line Sun Nov. 13, 2011)*.
- Olarewaju, A.N.and Balogun, B.O. (2011) Attitudes and Teaching Methods of some Science teacher and Students Achievement. *JORIC* 2(i).
- Olubumi, O. C. (1991) The Effect of Laboratory and Lecture Teaching Methods on Cognitive Achievement in Integrated Science. *Journal of Research in Science Teaching*, 2 (81), 213 and 224.
- Olurunkooba, S. B. (2001) The Relative Effect of Cooperative Instructional Strategy and Traditional Methods of Teaching, on Performance of Senior Secondary School Chemistry Students. Ph.D. Thesis, Department of Science Education A.B.U. Zaria.
- Onyeizugbo, E. U. (2003) Effects of Gender, Age and Education on Assertiveness in Nigeria Sample. *Psychology of Women Quarterly*. 27 1-16.
- Otagburuagu, T. (2012) Literacy and the Nigerian Economy in the 21<sup>st</sup> Century Illusions.
- Osuafor and Okigbo (2013) Effect of laboratory and inquiry methods on academic achievement of SSII biology students in Akwa Anambra State, Nigeria. Ph.D Thesis.
- Owuamanam, O.T. and Babatunde, J.O. (2007). Gender Role Stereotypes and career choice of Secondary School students in Ekiti State. *Journal of Educational Focus* 1 (1): 103-110.
- Perkins K.K. and Wieman, C.E. (2008). Innovative teaching to promote Innovative thinking in *Education for Innovation: Implications for India, China and America* pp,181-210.
- Powell, J.C, and Trowbridge, L.W. (2008). *Teaching Secondary School strategies for developing scientific literacy*. U.S.A: Pearson Prentice Hall.
- Rogus, R. (2005). Project Technique and Science Curriculum Innovation in Nigeria. *Journal of Science Teachers Association of Nigeria (STAN)* Vol. 24 No. 1 & 2.
- Rosenzweig, M.L. (2005). "Applying Species Area Relationships to the Conservation of Species Diversity". *New Directions in the Geography of Nature*. Sunderland, MA Sinauer Associations, PP 329-343.
- Salami, I.O. (2000). Effect of Three Instructional Models of Students Teachers' Performance in Selected Teaching Skills. *Unpublished Ph.D. Thesis*, Ibadan: University of Ibadan.

- Samaras, H., Giouvanakis, T., Bousiou, D., Tarabanis, N. (2006). Towards a New Generation of Multimedia Learning Research. *Association of Advancement in Computer Education Journal*, 14(1), 3-30.
- Sambo, A. A., (2008) Research Methods in Education Ibadan, Stirilling Hordan Publishers (Nig) Limited.
- Sanjaya, S. (2007) Teaching My Students Problem Solving Approach.
- Sasan, H.H. (2002). Constructivist Learning. *Journal of Lifelong Education*, 74(75), 49-52.
- Schuman, N. (2008). Teaching Strategies of practical Biology and Students' Attitude to the Subject in some Secondary schools in Oyo state, M.Ed. thesis, University of Ibadan.
- Seyhan, H.G (2015) The Effects of Problem Solving Applications On the Development of Science Process Skills, Logical Thinking Skills and Perception On Problemability in the science Laboratory. *Asia-Pacific Forum on Science Learning and Teaching*, 16, (2)8, p.2.
- Sharehu, A.L. (2010). Education as the Child of the Society. *An Address Delivered at 5<sup>th</sup> National Conference of the School of Education Federal College of Education, Zaria, 6<sup>th</sup> July, 2010*
- ShoFolahan, F.O. (2009).The Effective of Socio-Economic Background and Teaching strategies on learning Outcomes in Integrated Science. Unpublished Ph.D Thesis. University of Ibadan.
- Shukla, R.S. and Chandel, P.S. (2009). *A Textbook on Plant Ecology Ethno Botany and Soil Science*. S. Hand and Company Ltd.
- Soyibo, K. (2001) Impact of Concept and Vee Mapping on three modes of class interaction on students' performance in genetics. *International Journal of Science Education.*, 33(2) 113-120.
- Swanson, C. (2008). Child-Centered Learning; Are We Going Too Far? In *Education Practical and Theory*, 5 Comments, Seneschal D. Ed.
- Taylor, F.S. (1963). *A Short History of Science and Scientific Thought*. New York w.w Norton
- Taylor, P.J. (2009). *Unruly complexity, Ecology Interpretation, Engagement* Chicago; University of Chicago Press.
- Temel, S. and Morgil, I. (2012) Problem-solving applications in Chemistry laboratory. Ankara University, *Journal of Faculty of Education Science* 45(2), 55-76.
- Temel, S. and Morgil, I. (2013). Problem solving applications in chemistry laboratory. *Pamukkale University Journal of Education Faculty*. 33(1), 39-52.
- Temel, S. (2014) The effect of problem-based learning on prospective teachers' Critical thinking dispositions and perceptions of problem-solving ability. *South African Journal of Education*, 34(1), 769-789.
- Thomas, A.A. (2002). Resource development and urbanization in Service of Education for National Development in Education in Contemporary Nigeria, Implication for National Development. *A Publication of school of education, Kogi State College of Education Ankpa*.

- Thompson, T. (2006). An Assessment of the Teaching of Integrated of Integrated Science in the Junior Secondary Schools.
- Tuckman, B.W. (1975). Measuring Educational Outcomes. Handout Base Huvawick, New York.
- Uchenna, M. N. (2013) Gender Issues in STEM Education. The way forward, Science Education, A Global Perspective, Next Generation Education Ltd Abuja.
- Uduosoro, U.J (2011). The Effect of Gender and Mathematics Ability on Academic Performance of Students in Chemistry. *Africa Research Review*
- United Nations Development Program UNDP (2005). *The human Development Report*. New. York Oxford University Press.
- Usman, (2000) The Relationship Between Students Performance in Practical Activities and their Academic Achievement in Integrated Science Using NISTEP Mode of Teaching. Ph.D. Thesis A.B.U. Zaria.
- Uza, D. V. (2014) Science and Technology: Key to our National Development. Retrieved from [http://www.commonwealhyhministers.com/special-reports/Science and Technology Key to our national development](http://www.commonwealhyhministers.com/special-reports/Science-and-Technology-Key-to-our-national-development) 15<sup>th</sup> May.
- Volkman, M.J. and Abel, S.K. (2003). Rethinking Laboratories Tools for Converting Cookbook Labs into Inquiry. *The Science Teachers*, 38-41.
- Walker, C. (2012). *Challenges of Secondary Teachers; Wake Forest University New release; Winston Salem North Carolina.*
- Walker, J.T. and Lofton, S.P. (2003). Effect of a Problem based learning curriculum on students' perceptions of Self- directed learning. *Issues in Educational Research*, 13(2), 71-100.
- White, W.N. (2009). Science, Society and Science Teaching Effectiveness in Nigeria. *Journal of Science Teachers Association of Nigeria* 21(1)
- Yeung, S.Y.S. (2006). Is Student-Centered Pedagogy Impossible in Hong Kong? The case of Inquiry in Classrooms. *Asia Pacific education Review*, 10(3): 377-385.
- Younger, M., Warrington, M., Gray, J., Rudduck, J., McLellan, R. Bearne, E., Kershner, R. and Bricheno, P. (2005). Raising Boys' Achievement. DFES Research Report, London.
- Yusuf, M.O. and Balogun, M.R. (2011). Student-Teachers' Competence and Attitude Towards Information and Communication Technology: A Case Study of a Nigerian University Contemporary Educational Technology, 2011, 2 910 18-36.
- Yusuf, S.D. (2010). Science teacher Education in Nigeria: Challenges for Quality Education for Sustainable Development. *Journal of Quality Education (JQE)* 1 (1) Isa Kaita College of Education Katsina; Nigeria.
- Zembar, L.B & Blume, L.B (2011). Gender and Academic Achievement [www.education.com/reference/article/Gender-to-academy-to-achievement](http://www.education.com/reference/article/Gender-to-academy-to-achievement).

**APPENDIX I:**  
**Ecology Performance Test**

**Time: 45 minutes**

**Instruction:** Read the following instruction carefully before you answer the questions.

1. Use HB pencil for the examination
2. Shade only one letter for each answer in the objective questions.

**SECTION A: Bio Data**

**Name of School:** -----

**Class:** -----

**Gender: Male** [  ]    **Female:** [  ]

**Age:**

**Section B:** Items of Ecology Performance Test

Answer the entire question on the question paper by circling the correct option for each question A – E

1. Example of carnivorous plants are
  - a. Bladder wort and sundew
  - b. Citrus & gwava
  - c. Lemon & pitchers plant
  - d. Mango & pawpaw plants
  - e. Lectus and cabbage
2. Saprophytic plants are
  - a. Mushroom, asperillus, mucor, fungi
  - b. Ringworm, rizoones, roots
  - c. Fern, liche, mould, wig
  - d. Water hycinte, mosses, mucor
  - e. Water plant and mould
3. In the marine food web, the source of energy to the producer come from
  - a. Sea waves
  - b. Sea water
  - c. Land
  - d. Air
  - e. Sun

4. A population is best describes as
  - a. A group of the same species of organisms living together.
  - b. A group of animals and plants living together
  - c. A group of insects and grasses
  - d. Different species of wild animals
  - e. Plant and animal in a group.
5. Possession of strong adhesive is a feature of animals living in/on
  - a. Sandy beaches
  - b. Rocky shores
  - c. Benthic zone
  - d. Desert
  - e. Pond zone
6. A stable self-sustaining environment produced by an interaction between the biotic and Abiotic components is best described as
  - a. A niche
  - b. A community
  - c. An ecosystem
  - d. A habitat
  - e. A relationship
7. Which of the following factors is not associated with aquatic habitats?
  - a. Salinity
  - b. Turbidity
  - c. Temperature
  - d. Edaphic
  - e. Measurement
8. Trees in savannah habitats usually have heavy thick bark which mainly
  - a. Reduces the rate of transpiration
  - b. Protect them from the scorching sun
  - c. Protect them from heavy winds
  - d. Resist bush fires
  - e. Prevent rain fall
9. Example of instruments used to measure the speed of a stream?
  - a. Simple float
  - b. Secchi disc
  - c. Quadrat frame
  - d. Rain guage
  - e. Tape
10. In an ecosystem the organism which change light energy into stored chemical energy is called.
  - a. Consumer
  - b. Decomposer
  - c. Producer
  - d. Carnivore
  - e. Achiever

11. Which of the following juices contains the enzyme ptyalin?
  - a. Gastric juice
  - b. pancreatic juice
  - c. Succus
  - d. Saliva
  - e. Mucor
12. A dry indehiscent fruit containing one seed and possessing a hairy pappus is described as
  - a. A nut
  - b. A drupe
  - c. A cypela
  - d. A follicle
  - e. Kannel
13. The thunder storm can be beneficial to plants because it
  - a. Kills the pest that attack crops
  - b. Destroys some of the major crops
  - c. Adds nitrates to the soil
  - d. Makes rain water available to plants
  - e. Remove decay organism from the soil
14. Identify from the following a nitrifying bacteria?
  - a. Nitrobacter
  - b. Rhizobium
  - c. Azotobacter
  - d. Nitrosomonas
  - e. Pest
15. State from the following reagents used for test for starch.
  - a. Million's reagent
  - b. Fewing's solution
  - c. Sudan III
  - d. Iodine solution
  - e. Methylate spirit
16. Identify one of the following as an autotrophic mode of nutrition.
  - a. Chemosynthesis
  - b. Saprophytism
  - c. Parasitism
  - d. Symbiosis
  - e. commensalism
17. Mention one of the following that is not a way of reducing air pollution.
  - a. Siting factories and power stations away from residential areas.
  - b. Building tall factory chimneys
  - c. Passing waste gases through filters and absorbers
  - d. Recycling tin cans bottles.
  - e. Change of ferlizer
18. Name one of the factors that is not associated with aquatic habitat.
  - a. Temperature
  - b. Light intensity
  - c. Turbidity
  - d. Wave action
  - e. Humidity

19. List the types of soil that had highest water retaining capacity?
  - a. Clay
  - b. Laterite
  - c. Loamy
  - d. Gravel
  - e. Sandy
20. Change in energy flow between organisms in a habitat can be represented by
  - a. Pyramid of biomass
  - b. Pyramid of number
  - c. Pyramid of energy
  - d. Food chain
  - e. Food web
21. One of the following processes is not involved in the carbon-cycle?
  - a. Burning
  - b. Decay
  - c. Transpiration
  - d. Respiration
  - e. Photosynthesis
22. Which of the following processes are involved in the water cycle?
  - a. Evaporation
  - b. Condensation and precipitation
  - c. Evaporation and transpiration
  - d. Precipitation and condensation
23. Water in the human body is derived from following sources except through
  - a. Drinking water
  - b. Food substances
  - c. Cytoplasm of worm-out cells
  - d. Respiratory activity
  - e. Absorption by the skin
24. Conservation of natural resources can be achieved by the following except
  - a. Creation of national parks
  - b. Formation of conservation societies and agencies
  - c. Establishment of game reserves
  - d. Deregulated harvesting
  - e. Making laws on conservation
25. Water rises most rapidly in
  - a. Sandy soil
  - b. Clay soil
  - c. Sandy-Loamy soil
  - d. Loamy soil
  - e. Humus soil
26. The process by which living organisms obtain and utilize materials from external environment for metabolic activities is known as
  - a. Respiration
  - b. Growth
  - c. Nutrition
  - d. Excretion
  - e. Digestion

27. The host parasite relationship is known as
  - a. Parasitology
  - b. Parasitolysis
  - c. Parasite
  - d. Parages
  - e. Parasitism
28. In which of the following do we have extracellular digestion?
  - a. Autotrophs
  - b. Spcotrophs
  - c. Hetrotrophs
  - d. Paratroph
  - e. None of the above
29. Parasites that can only survive and grow in living cells are described as
  - a. Facultative
  - b. Obligate
  - c. Biotrophic
  - d. Hecrotrophic
  - e. Endosite
30. One of the following is an example of facultative parasite
  - a. Bracket fungi
  - b. Mush room
  - c. Mucor
  - d. Fern
  - e. None of the above
31. The three main digestive enzymes being produced by fungal saprostromphs are
  - a. Carbohydrase, sucrose and lipase
  - b. Carbohydrase, lactose and secrase
  - c. Carbohydrase, pepsin and ferin
  - d. Carbohydrase, lactose and glucose
  - e. Carbohydrase, lipase and protease
32. In the symbiotic association between fungi and green algal, which of the following provides moisture (water) minerals salts and
  - a. Algal
  - b. Mosses
  - c. Lichers
  - d. Letose
  - e. Fungi
33. Which of the following pairs of enzymes is an example of proteases
  - a. Maltase and erepsin
  - b. Pepsin and lactase
  - c. Erepsin and pepsin
  - d. Ptypsin and pepsin
  - e. None of the above
34. In nitrogen cycle, decay bacteria act on dead-organisms and feaces to produce
  - a. Ammonia
  - b. Nitrites
  - c. Nitrates
  - d. Urea
  - e. All of the above

35. In nitrogen cycle, the role of nitrosamines is to convert ammonia into
- Nitrites
  - Chlorine
  - Nutrite
  - Glucose
  - None of the above
36. Name one of the following elements required in large amounts by plants.
- Molybdenum
  - Boron
  - Copper
  - Phosphorous
  - Sulphur
37. List one of the following substances that has the highest amount of energy in joules per unit weight.
- Carbohydrates
  - Proteins
  - Fats
  - Vitamins
  - Minerals and salt
38. Identify one of the following stimuli that is not perceived through the skin of Mammals?
- Pressure
  - Light
  - Heat
  - Pain
  - Cold
39. Only specially adapted micro-organisms are found in
- Salty water
  - Humid air
  - Moist soil
  - Mouth cavities
  - Nasal cavity
40. Name one of the following pairs of organisms that exist as colonies
- Obelia and Euglena
  - Pandorina and volvox
  - Chlamydomonas and amoeba
  - Hydra and spirogyra
  - Hydra and volvox
41. The wind vane instrument is used to measure
- Direction of the wind
  - Height of the wind
  - Depth of a river
  - Amount of rainfall
  - None of the above
42. Hygrometer is used to measure
- Pressure of an object
  - Temperature
  - Weight of organism

- d. Water intensity
  - e. Relative humidity
43. Barometer is an instrument used to measure
- a. Temperature
  - b. Pressure
  - c. Weight
  - d. Height
  - e. Relative humidity
44. The best soil for farming is
- a. Sandy soil
  - b. Clay soil
  - c. Loamy soil
  - d. Humus soil
  - e. All of the above
45. Which of the follow ecological factors are common to aquatic habitats
- a. Temperature
  - b. Rainfall
  - c. Light
  - d. All of the above
46. Sacchi disc is an ecological instrument used to measure
- a. Organisms that live in the soil water
  - b. Turbidity or transparency of water
  - c. Height and length of an object
  - d. Speed of water
  - e. All of the above
47. Colorimeter (PH indicator) is used to measure
- a. Salinity of water
  - b. Alkalinity and acidity of soil or solution
  - c. Light intensity of water
  - d. Temperature of objective
  - e. None of the above
48. Salinity of water means
- a. Hardness of water
  - b. Softness of hard water
  - c. Transparency of water
  - d. Saltiness or concentration of salt solution in water
  - e. None of the above
49. An ecological niche is referred to as
- a. A specific portion of a habitat which is occupied by a particular species or organisms
  - b. A special area for man
  - c. An environment of water animal
  - d. An area for crop protection
  - e. None of the above
50. Ecology is simply defined as
- a. The study of micro-organism
  - b. Study of plant in water
  - c. Study of plant and animals in relation to their environment
  - d. Non living organism
  - e. All of the above

## APPENDIX II

### Marking Scheme

1. A	11. D	21. C	31. E	41. A
2. A	12. C	22. A	32. E	42. E
3. E	13. C	23. E	33. C	43. B
4. A	14. A	24. B	34. A	44. C
5. C	15. D	25. A	35. A	45. D
6. C	16. A	26. C	36. A	46. B
7. D	17. D	27. E	37. C	47. B
8. A	18. E	28. B	38. B	48. D
9. A	19. A	29. B	39. D	49. A
10. C	20. C	30. A	40. B	50. C

### APPENDIX III

#### Student Attitude Questionnaire(SAQ)

**SCHOOL:**

**CLASS:**

**SEX:**

**SUBJECT:**

This instrument is a five point like type scale consisting of 20 statements about your attitude toward biology. For each statement, think about what and how feel, toward biology and ecology topic (s) how competent will you be to carry out any experiment in any of the related topics. They are not yes or no questions; they are just your feelings and perceptions about the subject or topic. For each of the topic below, indicate the degree to which you agree or disagree with the statement (s) and then tick one of the following options of your choice on the boxes provided.

The responses and their points are as follows:

Strongly agree - (5)

Agree - (4)

Disagree - (3)

Strongly disagree - (2)

Indicated - (1)

The above indicates that any positive response or option ticked earns the point that tally with it.

However, any negatively worded statements are scored by reversing the numeric value.

Key:

SA - Strongly agree

A - Agree

D - Disagree

SD - Strongly disagree UD - Undecided

S/N	STATEMENTS	SA	A	D	SD	UD
1	I like biology as a subject					
2	I enjoy biology class (s) at all times					
3	I like ecology topics when taught in the class					
4	In my school we do biology practical more than theory					
5	Topics in ecology are difficult to understand					
6	There is a biology laboratory in my school					
7	Materials for experiment (s)are available for use in the laboratory					
8	I participate fully during practical					
9	I score higher in biology subject more than any other subject					
10	We work in groups during practical class					
11	My teacher assigns individual work in every practical class					
12	I can easily understand biology through direct observation via practical and experiments.					
13	Practical classes are more interesting to attend than theory classes					
14	I can perform biology experiment on my own					
15	Ecology related questions in exams are easier to answer					
16	I can draw biology diagrams without much difficulty					
17	Biology materials and apparatus are difficult to handle					
18	We have enough time at least two periods for biology practical					
19	I want to do biology relate courses in my further studies (medicine, pharmacy, micro biology)					
20	I would not like to do biology after secondary school					

## APPENDIX IV

### Lesson Plan for Experimental Group(Laboratory)

WEEK ONE

Subject: Biology

Class: SS II

Sex: Mixed

Topic: Ecological succession

Time: 50 Minutes

**Behavioral objectives:** At the end of the lesson, the students should be able to;

- I. Define ecological succession
- ii. List the types of ecological succession
- iii Differentiate between the two types of succession.
- iv Explain ecological terms and identify succession processes in their environment.

**Previous knowledge:**

The students are familiar with basic Ecological Concepts, Ecosystem, and types (Decomposers, consumers, producers).

**Introduction:**

The teacher introduces the topic by asking the following questions and the student should indicate true or false.

Ecological succession is the process of vegetation change on a site over time?

The mechanisms that cause the group of species dominating a site to change over time are the same for all ecological communities.

Interactions between specie are important in ecological succession

Random events can change the ecological succession.

**Presentation:**

**Step I:**

Teacher defines ecological succession as a long term gradual or progressive series of changes occurring in the structures composition, variety or diversity and number of species in an area till, a stable or climax community is established.

**Step II:**

Teacher displays the instructional materials and described the laboratory work.

**Step III:**

Teacher groups the students 5 per group to list and identify the types of ecological disturbance in an environment.

**Step IV:**

Teacher describes Primary succession as that which starts on a base or virgin land surface which have not previously borne vegetation or tampered with. It usually starts with lower organisms and takes a longer time to reach a climax community. Examples of primary succession include ponds, vegetation in rocks, mangrove forest etc.

Factors which can give rise to primary succession are: Erosion, deposition of sand duress: -Volcanic ash, land-slides, Earthquakes, emergence of bare surface, thunderstorms, Hurricanes, Tornadoes, Extreme drought Mining or construction activities.

Secondary succession on the other hand starts on already colonial surface. It may start with fairly complex organisms and it takes a shorter period of time to reach a climax community. E.g. of secondary succession are found in abandoned farmland and grassland.

**Activity I:**

Teacher share student into five in a group. Each group member should list as many ecological disturbances as they can, in their school or home environment.

**Activity II:**

Students were asked to identify the plants found in the environment, and suggest how many years it has survived in the particular environment. In this activity, students analyze the production and utilization of organic molecules in ecosystems. Students construct food chain and a food web, which including producers, primary consumers, secondary consumers and decomposers.

Students learn how organic molecules move and are transformed in ecosystems as a result of the trophic relationships in food webs, photosynthesis, cellular respiration, and biosynthesis. This provides the basis for understanding carbon cycles and energy flow through ecosystems. In the final section, students use these concepts and quantitative reasoning to understand trophic level. Teacher calls each group of students to report on their findings.

**Conclusion:**

Teacher concluded the lesson by giving the students assignment to write short note to explain the following: -

Ecological disturbance

Ecological succession

Climax community

Competition

## Lesson Plan for Experimental Group (Laboratory)

WEEK TWO:

Subject: Biology

Class: SS 2

Sex: Mixed

Topic: Population size

Time: 50 minutes

### **Instructional materials:**

Pencils, meter, rule/stick, work sheet, textbook, chalkboard.

### **Behavioral objectives:**

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

Describe the Biosphere and its components

Describe an organism.

Identify the methods of estimating population size on population density to the development of a community (plant and animal community).

### **Previous knowledge:**

The students are familiar with:

Basic measuring, multiplication and division skills

Basic understanding of the Biosphere and Environments.

### **Introduction:**

Teacher introduces the topic by reviewing what the Biosphere is (i.e. Apart of the earth that includes living and non-living things).

Teacher explains the different types of environments and ecosystems such as tropical rainforests, deserts etc.

### **Presentation:**

#### **Step I:**

Teacher explains the terms population, population density. Bio domes (which contains both biotic and a biotic factors).

#### **Step II:**

Teacher displays various materials that can be used to estimate a population and also list the types and methods of estimating population such as (capture – mark – release – recapture method, quadrat method, removal method, direct counts, random sampling etc. Teacher further explain the method of estimating population size using the following instruments. Mark and recapture is a method commonly used in ecology to estimate an

animal population's size. A portion of the population is captured, marked, and released. Later, another portion is captured and the number of marked individuals within the sample is counted. Since the number of marked individuals within the second sample should be proportional to the number of marked individuals in the whole population, an estimate of the total population size can be obtained by dividing the number of marked individuals by the proportion of marked individuals in the second sample. The method is most useful when it is not practical to count all the individuals in the population. Other names for this method, or closely related methods, include; capture-recapture, capture-mark-recapture, mark-recapture, sight-re-sight, mark-release-recapture, multiple systems estimation, band recovery the Petersen method, and the Lincoln method

**Quadrat:** It is a frame structure made of wooden material which forms a square shape of a known area.

The size of a quadrat depends on the organisms to be studied e.g.  $0.25\text{m}^2$  for lichens,  $1\text{m}^2$  for plants in an open field,  $10\text{m}^2$  for trees in a wood area. Quadrat is particularly useful when studying a habitat supporting several species of plant.

Teacher also explains other method of estimating population size through.

Direct observation which involves direct counting of large mobile or slow moving organisms and plants.

**Removal method:** This method is suitable for estimating number of small organisms e.g. insects within a known area of grassland.

### **Activity I:**

Teacher divides the class into groups of five students each, assign one student to be the group leader (with the meter stick) and the other recorder (using the drawing/workbooks) the students calculate the population size of the classroom.

### **Activity II:**

The students make the following measurements and record them on their drawing/workbooks: -

Use a meter stick to measure the length and width of the classroom.

Multiply the length and width to get area of the classroom in square meters.

Count the number of individual student in the classroom.

Calculate how much space each person has by dividing the number of square meters in the classroom by the number of people. Space = Area (Length x width)

Number of people.

**Activity III:**

Students practice more population density problems by completing the worksheet table.

**Evaluation**

Teacher goes round the class during the activity, studies and observe the teams as they work.

**Conclusion**

Teacher concludes with a class discussion to review the worksheet, and discuss population density tends (e.g. How does the population density of the classroom affect the amount of resources (e.g. paper, chair, tape etc.)

**Assignment:**

The students to list the groups of living things that might be in the environment near where they live.

## Lesson Plan for Experimental Group (Laboratory)

### WEEK THREE

Subject: Biology

Class: SS2

Sex: Mixed

Topic: Food shortage

Time: 50 minutes

#### **Instructional materials:**

Charts and pictures showing various causes of food shortage such as bush burning, flood, poor storage facility etc.

#### **Behavioral: objectives:**

By the end of the lesson, the students should be able to:

Define food shortage

State at least 5 causes of food shortage.

Identify the effects of food shortage on the size of a population.

#### **Previous knowledge:**

The students have knowledge on population size of an area.

#### **Introduction**

The teacher introduces her lesson by asking the students some questions based on what was discussed during the last class and linking it to the present topic to be taught.

#### **Presentation:**

The teacher presents her lesson by;

##### **Step I:**

Definition of food shortage

Food shortage is when there is not enough food available for people to eat due to difficulties in food distribution as result of famine, drought hunger etc.

##### **Step II:**

Teacher lists the causes of food shortage as follows:

Overpopulation, Flood, Drought, Pests, Diseases, Bush burning, Poor harvest

Poor soil or infertility of the soil, Water, Poor storage facilities.

##### **Step III:**

Effects of food shortage on the size of a population.

Competition by species

Emigration

Decline in the rate of reproduction.

Scarcity of a particular food.

**Activity:**

Teacher displays some simple of healthy fruits and seeds and some weak and unhealthy ones, then asks students to identify and state reasons for difference in appearance of the fruits.

**Evaluation:**

The teacher evaluates her lesson by asking the students some questions which are: -

Define food shortage

Mention causes of food shortage on the size of a population

**Conclusion:**

The teacher concludes her lesson by summarizing all she has taught the students and the teacher gives the students assignment.

**Assignment:**

List and explain 10 effects of food shortage of the size of a population.

## Lesson Plan for Experimental Group (Laboratory)

### WEEK FOUR

Subject: Biology

Class: SS2

Sex: Mixed

Topic: Overcrowding

Time: 50 minutes

#### **Instructional materials:**

Charts on a card board paper showing various factors that may cause overcrowding.

#### **Behavioral objectives:**

By the end of the lesson, the students should be able to:

Define overcrowding

List at least 5 factors that may cause overcrowding.

Mention at least 5 effects of overcrowding

State various adaptations to avoid overcrowding

#### **Previous knowledge:**

The students have knowledge on food shortage and its effects

#### **Introduction**

The teacher introduces her lesson by asking the student. Some questions based on what was discussed during the last class and linking it to the present topic to be taught.

#### **Presentation:**

The teacher presents her lesson by

##### **Step I:**

Definition of overcrowding

Overcrowding is defined as a situation which occurs when a population in a given habitat increase beyond a point where the resources in the habitat such as space and food are not enough to support all the individuals in the population. In other words, overcrowding occurs where there is an increase in the population of a particular species beyond the caring capacity of that particular area. For instance, a space designed to accommodate only 10 rabbits can be said to be overcrowding if 20 or rabbits have to live in such place.

##### **Step II:**

Factors that may cause overcrowding

Increase in birth rate (Natality)

Increase in food supply  
Increase in death rate (Mortality)  
Immigration  
Lack of dispersal  
Inadequate space  
Absence of predators

**Step III:**

Effects of overcrowding  
The effects of overcrowding include: -  
Shortage of space  
Shortage of food  
Competition  
Anti-social behavior  
Spread of disease  
Preying on each other  
Death of organism

Teacher further explains each of the above points.

**Step IV:**

Adaptation to avoid overcrowding plants and animals have developed various means to avoid overcrowding such means and ways includes: -

Territorial behavior  
Dispersal of seeds and fruits  
Emigration  
Swimming  
Production of chemicals by plants  
Productions of canopies

Teacher explains each completely with notes

**Evaluation:**

The teacher evaluates her lesson by asking the students questions which are:-

Define overcrowding  
Mention 5 factors that may cause overcrowding  
List 5 effects of overcrowding  
What are the adaptations to avoid overcrowding?

**Conclusion:**

The teacher concludes her lesson by summarizing all she has taught the students and teacher gives them assignment.

**Assignment:**

List and explain 5 adaptive features undertaken by plants and animals to avoid overcrowding.

## Lesson Plan for Experimental Group (Laboratory)

### WEEK FIVE

Subject: Biology  
Class: SS2  
Sex: Mixed  
Topic: Population studies  
Duration: 50 minutes

#### **Instructional materials:**

An improvised quadrat and a tape

#### **Behavioral objectives:**

By the end of the lesson the students should be able to;  
define population  
explain the word habitat  
identify factors affecting population

#### **Previous knowledge:**

The students are familiar with the major Biomes of the world

#### **Introduction:**

The teacher introduces the lesson by asking them students questions based on their previous knowledge; List the major biomes of the world?

Tropical rainforest, savanna, desert, shrub, afro-alpines, swamp.

#### **Presentation:**

The teacher presents the lesson in the following steps;

##### **Step I:**

The teacher defines population as the total number of organisms of the same species living together in a given area at a particular time. The teacher went further to explain that in an ecosystem, the community is made up of many populations of different species.

##### **Step II:**

Teacher explains a habitat as a dwelling place of living organism. The teacher explains that in a population studies of a habitat, the following are studies;

Types of organisms, this involves the listing of various types of population that are found in a particular habitat it helps to determine the relationship that exist between various organisms e.g. plant and animal in a habitat.

Dominance: - Dominance refers to those species that exert greater influence or major controlling effect on the other members of the community dominance could be expressed in terms of their: -

Number

Occupation of largest portion of space

Possession of the largest biomass and

The largest contribution of energy flow in the habitat

i. Population size: - This refers to the total number of the same kind in a given area of habitat. A large population stands a better chance of surviving dangerous and unfavorable conditions such as fire, disease etc.

ii. Population density: - Population density is defined as the number of individual organisms' per unit area or volume of the habitat. Mathematically, population density.

Total population or population size

iii. Population frequency: - This refers to the number of times an organism occurs within a given area of habitat.

iv. Percentage cover: - This refers to the Area covered or occupied by given species in its habitat and it is expressed in percentage.

population growth rate: - This refers to the net result of the influence of natality (birth rate) and mortality (death rate) of organism in a given habitat.

### **Step III:**

The teacher identifies factors affecting population as;

Natality (birth rate): This refers to the rate of given birth to new organisms. This generally, be it plant or animal leads to increase in population.

Mortality (death rate): This refers to the rate at which organisms die in a habitat. Mortality generally leads to a decrease in population.

Immigration (dispersal): This is the movement of organisms from different habitats into a new habitat. This tends to increase the population of the new area.

Emigration: - This is the movement of organisms out of habitat due either scarcity of food or unfavorable conditions this however, reduces the population of a habitat.

Availability of food: The availability of food in a given habitat tends to increase the population of that habitat.

Seasonal climate changes: - Unfavorable climate change may result in the decrease of a population.

Breeding period: - Most organisms move out of a habitat during breeding period thereby reducing the population of that habitat.

Natural disasters: - Natural disasters like fire, drought flood earthquake etc. may lead to decrease in population as many organisms may die or move out of that habitat to a new area.

**Activity:** students were asked to list places and areas in their community where natural disasters have taken place.

**Evaluation:**

The teacher evaluates the lesson by asking the students questions such as:

What is population

What are the things to study in a population?

List 5 factors affecting population

**Conclusion:**

The teacher concludes the lesson by giving the students the summary of the note and assignment to:

Describe how population studies can be conducted in a school garden.

## **Lesson Plan for Experimental Group I (laboratory)**

### **Week Six**

Subject: Biology

Class: SSII

Topic: Balance in nature

Duration: 45minutes

Instructional materials- Hot object, water, box/empty carton, source of light.

Behavioral objectives- By the end of the lesson, the students should be able to

- Identify biotic and abiotic factors affecting a population
- Mention some environmental resistance
- Explain difference between abiotic and biotic factors

Previous knowledge: Students are familiar with the factors affecting population size

Introduction: Teacher introduces the lesson by asking the students questions based on their last lesson. E.g. List major factors affecting the population (natality, mortality, food, immigration, emigration, unfavorable conditions etc.)

Presentation: Teacher presents the lesson in the following ways.

**Step1:** Teacher defines balance in Nature as the way organisms (plants and animals) species accommodate and survive at a stable condition with available resources in a given habitat or environment. However, a number of factors are referred to as environmental resistance control of population of organisms in a particular habitat.

The factors are classified as abiotic and biotic factors.

**Step II:**Teacher displays the instructional materials and describe the laboratory work.

Teacher further explains the difference between the abiotic and biotic factors as follows

Abiotic factors include:

Heat: The degree of hotness of a place can determine the size of a population. Hot environment generally is not conducive for habitation as organisms tend to run away from such areas. Heat can cause stress and death of an organism.

Water: Availability of water in a habitat determines the rate of survival of the population. While availability of water can also cause increase in population growth, shortage of water can cause decrease or death of organisms in a population

Space: Space is an important factor in a population. For an organism to live freely and survive, there must be space to enhance its movement. Lack of space leads to overcrowding, competition among organisms and sometimes death of such organisms.

Light:

Light is an important abiotic factor which enables plants community for growth and development. Without light, green plants which are primary producers may not be able to manufacture food needed in the habitat or environment. Low light, or excess light can result in weak plant growth and development.

Nutrients: Plants require nutrients in the soil to synthesize their various food substances. Lack of nutrients can result in stunted growth and poor yield of crops.

### **Biotic Factors Affecting a Population:**

Food: Lack of food in a habitat can adversely affect population of organisms. Food is the basic material organism required for survival, for growth and development.

Competition: Lack of space, food and other resources leads to competition among organisms within the environment. Competition at its highest level can lead to fighting and cannibalism among organisms.

Natality: This refers to the rate at which organisms give birth to young ones. High birth rate increases a population and can result to overcrowding.

**Mortality:** This is the rate at which organisms die in a habitat, while low death rate increases a population high death rate decreases the population. Other factors affecting a population include dispersal, parasite, pathogens, predators.

**Dynamic Equilibrium (balance in nature)** An environment or habitat is said to have maintained an equilibrium or a balance when the abiotic factors such as heat, water, space and biotic factors i.e. food, competition and parasites are favorable, growth is promoted but when they are scarce or unfavorable, growth is retarded.

A factor which limits population growth is called limiting factors and the sum of all the limiting factors and the sum of all resisting factor is known as environmental resistance. Thus, the net effect of these abiotic and biotic factors in that. At a point, the population size of living organisms tends towards a dynamic equilibrium known as balance in nature. When population increases the environment resistance increases, and food availability decreases, this may lead to competition which eventually may result in death or weaker organisms.

**Step III:** Teacher designs experiment to show example of what happens in an environment or habitat using the instructional materials, i.e. the empty box/carton.

Teacher describes the effect of biotic and abiotic factors in an environment.

**Activity:** Teacher groups and engage students in practical in the laboratory, teacher allow them to compile their result and discuss.

**Evaluation:** Teacher evaluates the lesson based on the discuss with the students.

**Conclusion:** Teacher concludes the lesson by summarizing the lesson and answering questions from the students.

## APPENDIX V

### Lesson Plan for Experimental Group 2(Problem Solving)

#### WEEK ONE

Subject: Biology

Class: SS II

Sex: Mixed

Topic: Ecological succession

Duration: 50 Minutes

**Behavioral objectives:** At the end of the lesson, the students should be able to;

Define Ecological Succession

Define the types of Ecological Succession

Differentiate between the different types of Ecological Succession

Define Ecological Terms

Be able to identify succession processes in their local environment.

#### **Previous knowledge:**

The students are familiar with basic Ecological Concepts, Ecosystem, and types (Decomposers, consumers, producers).

#### **Introduction:**

The teacher introduces the topic by asking the following questions and the student should indicate true or false.

Ecological succession is the process of vegetation change on a site over time?

The mechanisms that cause the group of species dominating a site to change over time are the same for all ecological communities.

Interactions between specie are important in ecological succession

Random events can change the ecological succession.

#### **Presentation:**

##### **Step I:**

Teacher defines ecological succession as a long term gradual or progressive series of changes occurring in the structures composition, variety or diversity and number of species in an area till, a stable or climax community is established. (Appendix A)

##### **Step II:**

Teacher lists and explains the types of ecological succession as in (Appendix ix pic B and C)

Primary succession which starts on a bare or virgin land surface which have not previously borne vegetation or tampered with. It usually starts with lower organisms and takes a longer time to reach a climax community... Examples of primary succession include ponds, vegetation in rocks, mangrove forest etc.

Factors which can give rise to primary succession are: - Erosion, deposition of sand  
duress: -Volcanic ash, land-slides earthquakes, emergence of bare surface, thunder-storms  
Hurricanes, Tornadoes

Extreme drought

Mining or construction activities

Secondary succession on the other hand starts on already colonial surface. It may start with fairly complex organisms and it takes a shorter period of time to reach a climax community. E.g. of secondary succession are found in abandoned farmland and grassland.

### **Step III:**

Teacher displayed the pictures of various changes as a result of succession. (Appendix IX pictures D,E,F,G,H,I and J)

### **Activity I:**

Teacher share student into five in a group and assigned a group leader. Each group member should list as many ecological disturbances as they can, in their school or home environment in their activity worksheet.

### **Activity II:**

Students were asked to identify the plants found in the school environment and suggest in the worksheet how many years such plants may have survived in the particular environment their observation and remark.

Teacher calls each group of students to report on their findings then made a general comment.

### **Conclusion:**

Teacher concluded the lesson by giving the students assignment as follows: -

Define the following terms

Ecological disturbance

Ecological succession

Climax community and Competition

## Lesson Plan for Experimental group 2(Problem Solving)

### WEEK TWO

Subject: Biology  
Class: SS 2  
Sex: Mixed  
Topic: Population size  
Time: 50 minutes

#### **Instructional materials:**

Pencils, meter, rule/stick, work sheet, textbook, chalkboard.

#### **Behavioral objectives:**

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

describe the biosphere and its components

describe an organism.

identify the methods of estimating population size on population density to the development of a community (plant and animal community).

#### **Previous knowledge:**

The students are familiar with:

Basic measuring, multiplication and division skills

Basic understanding of the Biosphere and Environments.

#### **Introduction:**

The teacher introduces the topic by reviewing what the Biosphere is (i.e. Apart of the earth that includes living and non-living things).

The teacher explains the different types of environments and ecosystems such as tropical rainforests, deserts etc.

#### **Presentation:**

##### **Step I:**

Teacher explains the terms population, population density. Bio domes (which contains both biotic and a biotic factors).

##### **Step II:**

Teacher list the types and methods of estimating population such as (capture – mark – release – recapture method, quadrature method, removal method, direct counts, random sampling etc. Teacher further explain the method of estimating population size using the following the instruments. Mark and recapture is a method commonly used in ecology to estimate an animal population's size. A portion of the population is captured, marked, and

released. Later, another portion is captured and the number of marked individuals within the sample is counted. Since the number of marked individuals within the second sample should be proportional to the number of marked individuals in the whole population, an estimate of the total population size can be obtained by dividing the number of marked individuals by the proportion of marked individuals in the second sample. The method is most useful when it is not practical to count all the individuals in the population. Other names for this method, or closely related methods, include; capture-recapture, capture-mark-recapture, mark-recapture, sight re-sight, mark-release-recapture, multiple systems estimation, band recovery the Petersen method, and the Lincoln method

**Quadrat:** It is a frame structure made of wooden material which forms a square shape of a known area.

The size of a quadrat depends on the organisms to be studied e.g.  $0.25\text{m}^2$  for lichens,  $1\text{m}^2$  for plants in an open field,  $10\text{m}^2$  for trees in a wood area. Quadrats are particularly useful when studying a habitat supporting several species of plants.

Teacher also explains other methods of estimating population size through.

Direct observation which involves direct counting of large mobile or slow moving organisms and plants.

Removal method: This is suitable for estimating number of small organisms e.g. insects within a known area of grassland.

### **Activity I:**

Teacher divides the class into groups of five students each, assign one student to be the group leader (with the meter stick) and the other recorder (using the worksheet the students calculate the population size of the classroom.

### **Activity II:**

The students make the following measurements and record them on their worksheets: -

Use a meter stick to measure the length and width of the classroom.

Multiply the length and width to get area of the classroom in square meters.

Count the number of individual students in the classroom.

Calculate how much space each person has by dividing the number of square meters in the classroom by the number of people.  $\text{Space} = \frac{\text{Area (Length} \times \text{width)}}{\text{Number of people.}}$

**Activity III:**

Students practice more population density problems by completing the worksheet table.

**Evaluation**

Teacher goes round the class during the activity, studies and observe the teams as they work.

**Conclusion**

Teacher concludes the lesson by going through the worksheet and allow students to ask questions on the area they did not understand.

**Assignment:**

The students to list the organisms that might be in the environment near where they live.

## Lesson Plan for Experimental group 2(Problem Solving)

### WEEK THREE

Subject: Biology  
Class: SS2  
Sex: Mixed  
Topic: Food shortage  
Time: 50 minutes

#### **Instructional materials:**

Charts and pictures showing various causes of food shortage such as bush burning, flood, poor storage facility etc.

#### **Behavioral: objectives:**

By the end of the lesson, the students should be able to:

Define food shortage

State at least 5 causes of food shortage.

Mention the effects of food shortage on the size of a population.

#### **Previous knowledge:**

The students have knowledge on population size of an area.

#### **Introduction**

The teacher introduces her lesson by asking the students some questions based on what was discussed during the last class and linking it to the present topic to be taught.

#### **Presentation:**

The teacher presents her lesson by;

##### **Step I:**

Definition of food shortage

Food shortage is when there is not enough food available for people to eat due to difficulties in food distribution as result of famine, drought, hunger etc.

##### **Step II:**

Teacher lists causes of food shortage as follows

Overpopulation, Flood, Drought, Pests, Diseases, Bush burning, Poor harvest

Poor soil or infertility of the soil, Water and Poor storage facilities

##### **Step III:**

Effects of food shortage on the size of a population.

Competition by species

Emigration

Decline in the rate of reproduction.

Scarcity of a particular food.

**Activity:**

Teacher displays some samples of healthy fruits and seeds and some weak and unhealthy ones, then asks students to identify and state reasons for difference in appearance of the fruits in activity worksheets.

**Evaluation:**

Teacher evaluates her lesson by asking the students some questions which are: -

Define food shortage

Mention causes of food shortage on the size of a population

**Conclusion:**

The teacher concludes her lesson by summarizing all she has taught the students and the teacher gives the students assignment.

**Assignment:**List and explain 10 effects of food shortage of the size of a population.

## Lesson Plan for Experimental group 2(Problem Solving)

### WEEK FOUR

Subject: Biology

Class: SS2

Sex: Mixed

Topic: Overcrowding

Time: 50 minutes

#### **Instructional materials:**

Charts on a card board paper showing various factors that may cause overcrowding.

#### **Behavioral objectives:**

By the end of the lesson, the students should be able to:

define overcrowding

list at least 5 factors that may cause overcrowding.

mention at least 5 effects of overcrowding

enumerate the various adaptations to avoid overcrowding

#### **Previous knowledge:**

The students have knowledge on food shortage and its effects

#### **Introduction**

Teacher introduced her lesson by asking the student some questions based on what was discussed during the last class and linking it to the present topic to be taught.

#### **Presentation:**

The teacher presents her lesson in the following steps.

##### **Step I:**

Definition of overcrowding

Overcrowding is defined as a situation which occurs when a population in a given habitat increase beyond a point where the resources in the habitat such as space and food are not enough to support all the individuals in the population. In other words, overcrowding occurs where there is an increase in the population of a particular species beyond the carrying capacity of that particular area. For instance, a space designed to accommodate only 10 rabbits can be said to be overcrowding if 20 or rabbits have to live in such place.

**Step II:**

Factors that may cause overcrowding

Increase in birth rate (Natality)

Increase in food supply

Mortality

Immigration

Lack of dispersal

Inadequate space

Absence of predators

**Step III:**

Effects of overcrowding

The effects of overcrowding include: -

Shortage of space

Shortage of food

Competition

Anti-social behavior

Spread of disease

Preying on each other

Death of organism

Teacher further explains each of the above points.

**Step IV:**

Adaptation to avoid overcrowding: plants and animals have developed various organs and means to avoid overcrowding such means and ways includes: -

Territorial behavior

Dispersal of seeds and fruits

Emigration

Swimming

Production of chemicals by plants

Productions of canopies

Teacher explains each completely with notes

**Evaluation:**

Teacher evaluates her lesson by asking the students questions which are: -

define overcrowding

list 5 factors that may cause overcrowding

list 5 effects of overcrowding

itemize three adaptations to avoid overcrowding.

**Conclusion:**

Teacher concludes her lesson by summarizing all she has taught the students and teacher gives them assignment.

**Assignment: `**

List and explain 5 adaptive features undertaken by plants and animals to avoid overcrowding.

## **Lesson Plan for Experimental group 2(Problem Solving)**

### **WEEK FIVE**

Subject: Biology

Class: SS2

Sex : Mixed

Topic: Population studies

Duration: 50 minutes

#### **Instructional materials:**

An improvised quadrat, insect net, worksheet, a pencil and a tape.

#### **Behavioral objectives:**

by the end of the lesson the students should be able to;

define population

explain what a habitat is

identify factors affecting population.

#### **Previous knowledge:**

The students are familiar with the major Biomes of the world

#### **Introduction:**

The teacher introduces the lesson by asking the students questions based on their previous knowledge; List the major biomes of the world?

Tropical rainforest, savanna, desert, shrub, afro-alpine, swamp.

#### **Presentation:**

The teacher presents the lesson in the following steps;

#### **Step I:**

The teacher defines population as the total number of organisms of the same species living together in a given area at a particular time. The teacher went further to explain that in an ecosystem, the community is made up of many populations of different species.

#### **Step II:**

The teacher explains that in a population studies of a habitat, the following are studies; Types of organisms, this involves the listing of various types of population that are found in a particular habitat it helps to determine the relationship that exist between various organisms e.g. plant and animal in a habitat.

Dominance: - Dominance refers to those species that exert greater influence or major controlling effect on the other members of the community dominance could be expressed in terms of their: -

Number

Occupation of largest portion of space

Possession of the largest biomass and

The largest contribution of energy flow in the habitat

i. Population size: - This refers to the total number of the same kind in a given area of habitat. A large population stands a better chance of surviving dangerous and unfavorable conditions such as fire, disease etc.

ii. Population density: - Population density is defined as the number of individual organism's per unit area or volume of the habitat. Mathematically, population density.

Total population or population size

iii. Population frequency: - This refers to the number of times an organism occurs within a given area of habitat.

iv. Percentage cover: - This refers to the Area covered or occupied by given species in its habitat and it is expressed in percentage.

population growth rate: - This refers to the net result of the influence of natality (birth rate) and mortality (death rate) of organism in a given habitat.

### **Step III:**

The teacher identifies factors affecting population as;

Natality (birth rate): - This refers to the rate of given birth to new organisms. This generally, be it plant or animal leads to increase in population.

Mortality (death rate): - This refers to the rate at which organisms die in a habitat. Mortality generally leads to a decrease in population.

Immigration (dispersal): - This is the movement of organisms from different habitats into a new habitat. This tends to increase the population of the new area.

Emigration: - This is the movement of organisms out of habitat due either scarcity of food or unfavorable conditions this however, reduces the population of a habitat.

Availability of food: - The availability of food in a given habitat tends to increase the population of that habitat.

Seasonal climate changes: - Unfavorable climate change may result in the decrease of a population.

Breeding period: - Most organisms move out of a habitat during breeding period thereby reducing the population of that habitat.

Natural disasters: - Natural disasters like fire, drought flood earthquake etc. may lead to decrease in population as many organisms may die or move out of that habitat to a new area.

**Activity:**

Students to answer questions in their activity worksheets provided and determine or suggest the possible solution to the problem.

**Evaluation:**

The teacher evaluates the lesson by asking the students questions such as:

what is population

list 5 factors affecting population

**Conclusion:**

The teacher concludes the lesson by giving the students the summary of the note and assignment to:

Describe how population studies can be conducted in a school garden.

What are the things to study in a population?

## **Lesson Plan for Experimental Group 2 (Problem Solving)**

### **Week Six**

Subject- Biology

Class- SSII

Topic- Balance in nature

Duration- 45minutes

Instructional materials- Hot object, water, box/empty carton, source of light.

Behavioral objectives- By the end of the lesson, the students should be able to

- Identify biotic and abiotic factors affecting a population
- Mention some environmental resistance
- Explain difference between abiotic and biotic factors

Previous knowledge: Students are familiar with the factors affecting population size

Introduction: Teacher introduces the lesson by asking the students questions based on their last lesson. E.g. List major factors affecting the population (natality, mortality, food, immigration, emigration, unfavorable conditions etc.)

Presentation: Teacher presents the lesson in the following ways.

**Step I:** Teacher defines balance in Nature as the way organisms (plants and animals) species accommodate and survive at a stable condition with available resources in a given habitat or environment. However, a number of factors are referred to as environmental resistance control of population of organisms in a particular habitat.

The factors are classified as abiotic and biotic factors.

**Step II:** Teacher displays the instructional materials and possess a problem for the students to solve. Teacher further explains the difference between abiotic and biotic factors as follows.

Abiotic factors include:

Heat: The degree of hotness of a place can determine the size of a population. Hot environment generally is not conducive for habitation as organisms tend to run away from such areas. Heat can cause stress and death of an organism.

Water: Availability of water in a habitat determines the rate of survival of the population. While availability of water can also cause increase in population growth, shortage of water can cause decrease or death of organisms in a population

Space: Space is an important factor in a population. For an organism to live freely and survive, there must be space to enhance its movement. Lack of space leads to overcrowding, competition among organisms and sometimes death of such organisms.

Light:

Light is an important abiotic factor which enables plants community for growth and development. Without light, green plants which are primary producers may not be able to manufacture food needed in the habitat or environment. Low light, or excess light can result in weak plant growth and development.

Nutrients: Plants require nutrients in the soil to synthesize their various food substances. Lack of nutrients can result in stunted growth and poor yield of crops.

### **Biotic Factors Affecting a Population:**

Food: Lack of food in a habitat can adversely affect population of organisms. Food is the basic material organism required for survival, for growth and development.

Competition: Lack of space, food and other resources leads to competition among organisms within the environment. Competition at its highest level can lead to fighting and cannibalism among organisms.

Natality: This refers to the rate at which organisms give birth to young ones. High birth rate increases a population and can result to overcrowding.

**Mortality:** This is the rate at which organisms die in a habitat, while low death rate increases a population high death rate decreases the population. Other factors affecting a population include dispersal, parasite, pathogens, predators.

**Dynamic Equilibrium (balance in nature)** An environment or habitat is said to have maintained an equilibrium or a balance when the abiotic factors such as heat, water, space and biotic factors i.e. food, competition and parasites are favorable, growth is promoted but when they are scarce or unfavorable, growth is retarded.

A factor which limits population growth is called limiting factors and the sum of all the limiting factors and the sum of all resisting factor is known as environmental resistance. Thus, the net effect of these abiotic and biotic factors in that. At a point, the population size of living organisms tends towards a dynamic equilibrium known as balance in nature. When population increases the environment resistance increases, and food availability decreases, this may lead to competition which eventually may result in death or weaker organisms.

**Step III:** Teacher designs experiment to show example of what happens in an environment or habitat using the instructional materials, i.e. the empty box/carton.

**Step IV:** Teacher describes the effect of biotic and abiotic factors in an environment.

**Activity I:**

Teacher groups the students five per group and possess problems for them solve in their worksheets.

**Activity II:**

Teacher allows them to sort out and compile their result.

**Evaluation:**

Teacher evaluates the lesson based on the discuss with the students.

**Conclusion:** Teacher concludes the lesson by summarizing the lesson and answering questions from the students.

## APPENDIX VI

### Lesson Plan for Control Group

#### WEEK ONE

Subject: Biology  
Class: SS II  
Sex: Mixed  
Topic: Ecological succession  
Duration: 50 Minutes

**Behavioral objectives:** At the end of the lesson, the students should be able to;

Define Ecological Succession

Define Ecological Terms

List the types of Ecological Succession

Differentiate between the different types of Ecological Succession

Be able to identify succession processes in their local environment.

**Previous knowledge:**

The students are familiar with basic Ecological Concepts, Ecosystem, and types (Decomposers, consumers, producers).

**Introduction:**

The teacher introduces the topic by asking the following questions and the student should indicate true or false.

Ecological succession is the process of vegetation change on a site over time?

The mechanisms that cause the group of species dominating a site to change over time are the same for all ecological communities.

Interactions between specie are important in ecological succession

Random events can change the ecological succession.

**Presentation:**

**Step I:**

Teacher defines ecological succession as a long term gradual or progressive series of changes occurring in the structures composition, variety or diversity and number of species in an area till, a stable or climax community is established.

**Step II:**

Teacher lists and explains the types of ecological succession:

Primary succession which starts on a bare or virgin land surface which have not previously borne vegetation or tampered with. It usually starts with lower organisms and takes a longer time to reach a climax community. Examples of primary succession include ponds, vegetation in rocks, mangrove forest etc.

Factors which can give rise to primary succession are: - Erosion, deposition of sand dunes: -

Volcanic ash, land slides

Earthquakes, emergence of bare surface

Thunderstorms

Hurricanes, Tornadoes

Extreme drought

Mining or construction activities

Secondary succession on the other hand starts on already colonial surface. It may start with fairly complex organisms and it takes a shorter period of time to reach a climax community. E.g. of secondary succession are found in abandoned farmland and grassland.

**Conclusion:**

Teacher concluded the lesson by giving the students assignment as follows: -

Explain the following terms

Ecological disturbance

Ecological succession

Climax community

Competition

## Lesson Plan for Control Group

### WEEK TWO

Subject: Biology  
Class: SS 2  
Duration: 40 minutes  
No. of students: 30  
Sex: Mixed  
Age: Between 14 – 17  
Topic: Population size

#### **Instructional materials:**

Chalk and board.

#### **Behavioral objectives:**

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

Describe the Biosphere and its components

Describe an organism.

Identify the methods of estimating population size on population density to the development of a community (plant and animal community).

#### **Previous knowledge:**

The students are familiar with:

Basic measuring, multiplication and division skills

Basic understanding of the Biosphere and Environments.

#### **Introduction:**

The teacher introduces the topic by reviewing what the Biosphere is (i.e. Apart of the earth that includes living and non-living things).

The teacher explains the different types of environments and ecosystems such as tropical rainforests, deserts etc.

#### **Presentation:**

##### **Step I:**

Teacher explains the terms population, population density. Bio domes (which contains both biotic and a biotic factors).

##### **Step II:**

Teacher list the types and methods of estimating population such as (capture – mark – release – recapture method, quadrature method, removal method, direct counts, random

sampling etc. Teacher further explain the method of estimating population size using the following the instruments.

Quadrat: It is a frame structure made of wooden material which forms a square shape of a known area.

The size of a quadrat depends on the organisms to be studied e.g.  $0.25\text{m}^2$  for lichens,  $1\text{m}^2$  for plants in an open field,  $10\text{m}^2$  for trees in a wood area. Quadrats are particularly useful when studying a habitat supporting several species of plants.

Teacher also explains other methods of estimating population size through.

Direct observation which involves direct counting of large mobile or slow moving organisms and plants.

Removal method: This is suitable for estimating number of small organisms e.g. insects within a known area of grassland.

### **Evaluation**

Teacher goes round the class during the activity, studies and observe the teams as they work.

### **Conclusion**

Teacher concludes with a class discussion to review the worksheet, and discuss population density as (e.g. how does the population density of the classroom affect the amount of resources (e.g. paper, chair, table, desk, tape etc.)

### **Assignment:**

The students to list the groups of living things that might be in the environment near where they live.

## Lesson Plan for Control Group

### WEEK THREE

Subject: Biology

Class: SS2

Topic: Food shortage

Time 50mins

#### **Instructional materials:**

Chalk and board

#### **Behavioral: objectives:**

By the end of the lesson, the students should be able to:

Define food shortage

State at least 5 causes of food shortage.

Mention the effects of food shortage on the size of a population.

#### **Previous knowledge:**

The students have knowledge on population size of an area.

#### **Introduction**

The teacher introduces her lesson by asking the students some questions based on what was discussed during the last class and linking it to the present topic to be taught.

#### **Presentation:**

The teacher presents her lesson by;

##### **Step I:**

Definition of food shortage

Food shortage is when there is not enough food available for people to eat due to difficulties in food distribution as result of famine, drought hunger etc.

##### **Step II:**

Teacher lists causes of food shortage as follows

Overpopulation, Flood, Drought, Pests, Diseases, Bush burning, Poor harvest

Poor soil or infertility of the soil, Water, Poor storage facilities.

##### **Step III:**

Effects of food shortage on the size of a population.

Competition by species, Emigration, Decline in the rate of reproduction,

Scarcity of a particular food.

**Evaluation:**

The teacher evaluates her lesson by asking the students some questions which are: -

Define food shortage

Mention causes of food shortage on the size of a population

**Conclusion:**

The teacher concludes her lesson by summarizing all she has taught the students and the teacher gives the students assignment.

**Assignment:**

State and explain 10 effects of food shortage of the size of a population.

## LESSON PLAN FOR CONTROL GROUP

### WEEK FOUR

Subject: Biology

Class: SS2

Sex: Mixed

Topic: Overcrowding

Time: 50 minutes

#### **Instructional materials:**

Chalk and board

#### **Behavioral objectives:**

By the end of the lesson, the students should be able to:

Define overcrowding

List at least 5 factors that may cause overcrowding.

Mention at least 5 effects of overcrowding

Mention the various adaptations to avoid overcrowding

#### **Previous knowledge:**

The students have knowledge on food shortage and its effects

#### **Introduction**

The teacher introduces her lesson by asking the student. Some questions based on what was discussed during the last class and linking it to the present topic to be taught.

#### **Presentation:**

The teacher presents her lesson by

#### **Step I:**

Definition of overcrowding

Overcrowding is defined as a situation which occurs when a population in a given habitat increase beyond a point where the resources in the habitat such as space and food are not enough to support all the individuals in the population. In other words, overcrowding occurs where there is an increase in the population of a particular species beyond the caring capacity of that particular area. For instance, a space designed to accommodate only 10 rabbits can be said to be overcrowding if 20 or more rabbits have to live in such place.

**Step II:**

Factors that may cause overcrowding

Increase in birth rate (Natality)

Increase in food supply

Mortality

Immigration

Lack of dispersal

Inadequate space

Absence of predators

**Step III:**

Effects of overcrowding

The effects of overcrowding include: -

Shortage of space

Shortage of food

Competition

Anti-social behavior

Spread of disease

Preying on each other

Death of organism

Teacher further explains each of the above points.

**Step IV:**

Adaptation to avoid overcrowding plants and animals have developed various means to avoid overcrowding such means and ways includes: -

Territorial behavior

Dispersal of seeds and fruits

Emigration

Swimming

Production of chemicals by plants

Productions of canopies

Teacher explains each completely with notes

**Evaluation:**

The teacher evaluates her lesson by asking the students questions which are: -

Define overcrowding

Mention 5 factors that may cause overcrowding

List 5 effects of overcrowding

What are the adaptations to avoid overcrowding?

**Conclusion:**

The teacher concludes her lesson by summarizing all she has taught the students and teacher gives them assignment.

**Assignment:**

List and explain 5 adaptive features undertaken by plants and animals to avoid overcrowding.

## Lesson Plan for Control Group

### WEEK FIVE

Subject: Biology  
Class: SS2  
Sex: Mixed  
Topic: Population studies  
Duration: 50 minutes

#### **Instructional materials:**

An improvised quadrat and a tape

#### **Behavioral objectives:**

By the end of the lesson the students should be able to;

Define population

Explain what to studying in a habitat

Identify factors affecting population

#### **Previous knowledge:**

The students are familiar with the major Biomes of the world

#### **Introduction:**

The teacher introduces the lesson by asking them students questions based on their previous knowledge; List the major biomes of the world?

Tropical rainforest, savanna, desert, shrub, afro-alpine, swamp.

#### **Presentation:**

Teacher presents the lesson in the following steps;

#### **Step I:**

The teacher defines population as the total number of organisms of the same species living together in a given area at a particular time. The teacher went further to explain that in an ecosystem, the community is made up of many populations of different species.

#### **Step II:**

The teacher explains that in a population studies of a habitat, the following are studies; Types of organisms, this involves the listing of various types of population that are found in a particular habitat it helps to determine the relationship that exist between various organisms e.g. plant and animal in a habitat.

Dominance: - Dominance refers to those species that exert greater influence or major controlling effect on the other members of the community dominance could be expressed in terms of their:

Number

Occupation of largest portion of space

Possession of the largest biomass and

The largest contribution of energy flow in the habitat

i. Population size: - This refers to the total number of the same kind in a given area of habitat. A large population stands a better chance of surviving dangerous and unfavorable conditions such as fire, disease etc.

ii. Population density: - Population density is defined as the number of individual organism's per unit area or volume of the habitat. Mathematically, population density.

Total population or population size

iii. Population frequency: - This refers to the number of times an organism occurs within a given area of habitat.

iv. Percentage cover: - This refers to the Area covered or occupied by given species in its habitat and it is expressed in percentage.

v. population growth rate: - This refers to the net result of the influence of natality (birth rate) and mortality (death rate) of organism in a given habitat.

### **Step III:**

The teacher identifies factors affecting population as;

Natality (birth rate): - This refers to the rate of given birth to new organisms. This generally, be it plant or animal leads to increase in population.

Mortality (death rate): - This refers to the rate at which organisms die in a habitat. Mortality generally leads to a decrease in population.

Immigration (dispersal): - This is the movement of organisms from different habitats into a new habitat. This tends to increase the population of the new area.

Emigration: - This is the movement of organisms out of habitat due either scarcity of food or unfavorable conditions this however, reduces the population of a habitat.

Availability of food: - The availability of food in a given habitat tends to increase the population of that habitat.

Seasonal climate changes: - Unfavorable climate change may result in the decrease of a population.

Breeding period: - Most organisms move out of a habitat during breeding period thereby reducing the population of that habitat.

Natural disasters: - Natural disasters like fire, drought flood earthquake etc. may lead to decrease in population as many organisms may die or move out of that habitat to a new area.

**Evaluation:**

The teacher evaluates the lesson by asking the students questions such as:

What is population

List 5 factors affecting population

**Conclusion:**

The teacher concludes the lesson by giving the students the summary of the note and assignment to:

Describe how population studies can be conducted in a school garden.

## **Lesson Plan for Control Group**

### **Week Six**

Subject: Biology

Class: SSII

Topic: Balance in nature

Duration: 45minutes

Instructional materials- chalkboard and chalk

Behavioral objectives- By the end of the lesson, the students should be able to

- Identify biotic and abiotic factors affecting a population
- Mention some environmental resistance
- Explain difference between abiotic and biotic factors

Previous knowledge: Students are familiar with the factors affecting population size

Introduction: Teacher introduces the lesson by asking the students questions based on their last lesson. E.g. List major factors affecting the population (natality, mortality, food, immigration, emigration, unfavorable conditions etc.)

Presentation: Teacher presents the lesson in the following ways.

Step1: Teacher defines balance in Nature as the way organisms (plants and animals) species accommodate and survive at a stable condition with available resources in a given habitat or environment. However, a number of factors are referred to as environmental resistance control of population of organisms in a particular habitat.

The factors are classified as abiotic and biotic factors.

Abiotic factors include:

Heat: The degree of hotness of a place can determine the size of a population. Hot environment generally is not conducive for habitation as organisms tend to run away from such areas. Heat can cause stress and death of an organism.

Water: Availability of water in a habitat determines the rate of survival of the population.

While availability of water can also cause increase in population growth, shortage of water can cause decrease or death of organisms in a population

Space: Space is an important factor in a population. For an organism to live freely and survive, there must be space to enhance its movement. Lack of space leads to overcrowding, competition among organisms and sometimes death of such organisms.

Light:

Light is an important abiotic factor which enables plants community for growth and development. Without light, green plants which are primary producers may not be able to manufacture food needed in the habitat or environment. Low light, or excess light can result in weak plant growth and development.

Nutrients: Plants require nutrients in the soil to synthesize their various food substances.

Lack of nutrients can result in stunted growth and poor yield of crops.

### **Biotic Factors Affecting a Population:**

Food: Lack of food in a habitat can adversely affect population of organisms. Food is the basic material organism required for survival, for growth and development.

Competition: Lack of space, food and other resources leads to competition among organisms within the environment. Competition at its highest level can lead to fighting and cannibalism among organisms.

Natality: This refers to the rate at which organisms give birth to young ones. High birth rate increases a population and can result to overcrowding.

Mortality: This is the rate at which organisms die in a habitat, while low death rate increases a population high death rate decreases the population. Other factors affecting a population include dispersal, parasite, pathogens, predators.

Dynamic Equilibrium (balance in nature) An environment or habitat is said to have maintained an equilibrium or a balance when the abiotic factors such as heat, water, space and biotic factors i.e. food, competition and parasites are favorable, growth is promoted but when they are scarce or unfavorable, growth is retarded.

A factor which limits population growth is called limiting factors and the sum of all the limiting factors and the sum of all resisting factor is known as environmental resistance. Thus, the net effect of these abiotic and biotic factors in that. At a point, the population size of living organisms tends towards a dynamic equilibrium known as balance in nature. When population increases the environment resistance increases, and food availability decreases, this may lead to competition which eventually may result in death or weaker organisms.

Step II: Teacher designs experiment to show example of what happens in an environment or habitat using the instructional materials, i.e. the empty box/carton.

Step III: Teacher describes the effect of biotic and abiotic factors in an environment.

Step IV: Teacher groups and engage students in practical in the laboratory, teacher allow them to compile their result and discuss.

Evaluation: Teacher evaluates the lesson based on the discuss with the students.

Conclusion: Teacher concludes the lesson by summarizing the lesson and answering questions from the students.

## APPENDIX VII

### Facility and Discrimination Index

S/N	$FI = \frac{U+L}{N}$	$DI = \frac{R_u - R_l}{\frac{1}{2}N}$
1	0.7	0.5
2	0.2*	0.1*
3	0*	0.2*
4	0.7	0.5
5	0.1*	0.2*
6	0.8*	0.8*
7	0.2*	0.2*
8	0.5	0.4
9	0.1*	0.1*
10	0.2*	0.1*
11	0.7	0.5
12	0.1*	0.2*
13	0.6	0.5
14	0.3	0.3
15	0.5	0.4
16	0.4	0.4
17	0.2*	0.1*
18	0.2*	0.1*
19	0.2*	0.1*
20	0.7	0.5
21	0.2*	0.2*
22	0*	0.1*
23	0.5	0.6
24	0.5	0.6
25	0.4	0.5
26	0.4	0.5
27	0.3	0.5
28	0.4	0.5
29	0.4	0.5
30	0.4	0.5
31	0.4	0.5
32	0.5	0.4
33	0.4	0.4
34	0.4	0.5
35	0.4	0.5
36	0.3	0.4
37	0.5	0.5
38	0.4	0.5
39	0.5	0.6

40	0.5	0.5
41	0.5	0.5
42	0.6	0.5
43	0.5	0.7
44	0.5	0.6
45	0.6	0.5
46	0.6	0.5
47	0.8	0.8*
48	0.6	0.5
49	0.8	0.8*
50	0.9	0.8*

## APPENDIX VIII

### Reliability of the Instrument (SAQ)

#### Scale: ALL VARIABLES

##### Case Processing Summary

		N	%
Cases	Valid	20	80.0
	Excluded <sup>a</sup>	5	20.0
	Total	25	100.0

a. Listwise deletion based on all variables in the procedure.

##### Reliability Statistics

Cronbach's Alpha	N of Items
.807	25

##### Item-Total Statistics

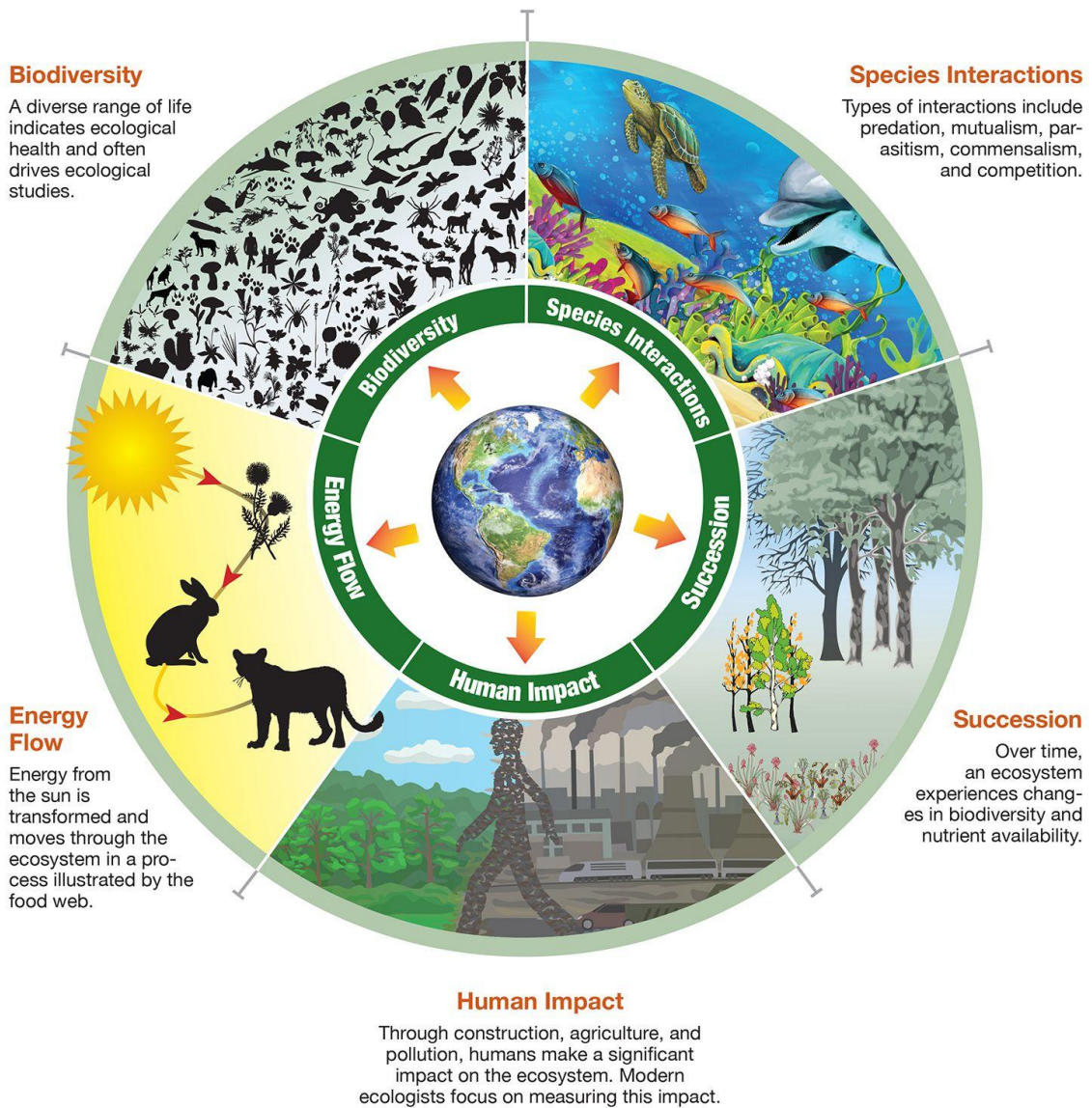
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	53.45	92.787	.631	.785
Q2	52.65	102.450	.453	.799
Q3	53.75	99.882	.232	.807
Q4	53.15	96.345	.566	.790
Q5	54.15	99.818	.437	.797
Q6	53.90	102.305	.219	.805
Q7	53.85	95.397	.592	.788
Q8	54.70	104.011	.181	.806
Q9	52.80	92.484	.703	.782
Q10	53.95	95.839	.423	.796
Q11	53.80	101.642	.243	.804
Q12	54.05	97.313	.471	.794
Q13	53.20	91.537	.562	.787
Q14	54.45	103.313	.256	.803
Q15	53.80	104.695	.076	.812
Q16	54.15	96.555	.554	.791
Q17	53.90	106.937	-.022	.815
Q18	53.80	99.747	.442	.797
Q19	54.15	99.608	.350	.800
Q20	54.30	98.853	.457	.795
Q21	54.10	103.147	.208	.805
Q22	54.05	110.155	-.191	.822
Q23	53.50	99.737	.259	.805
Q24	53.65	102.661	.126	.813
Q25	53.95	95.208	.451	.794

## Appendix IX

### Samples of Instructional Materials used in the Study

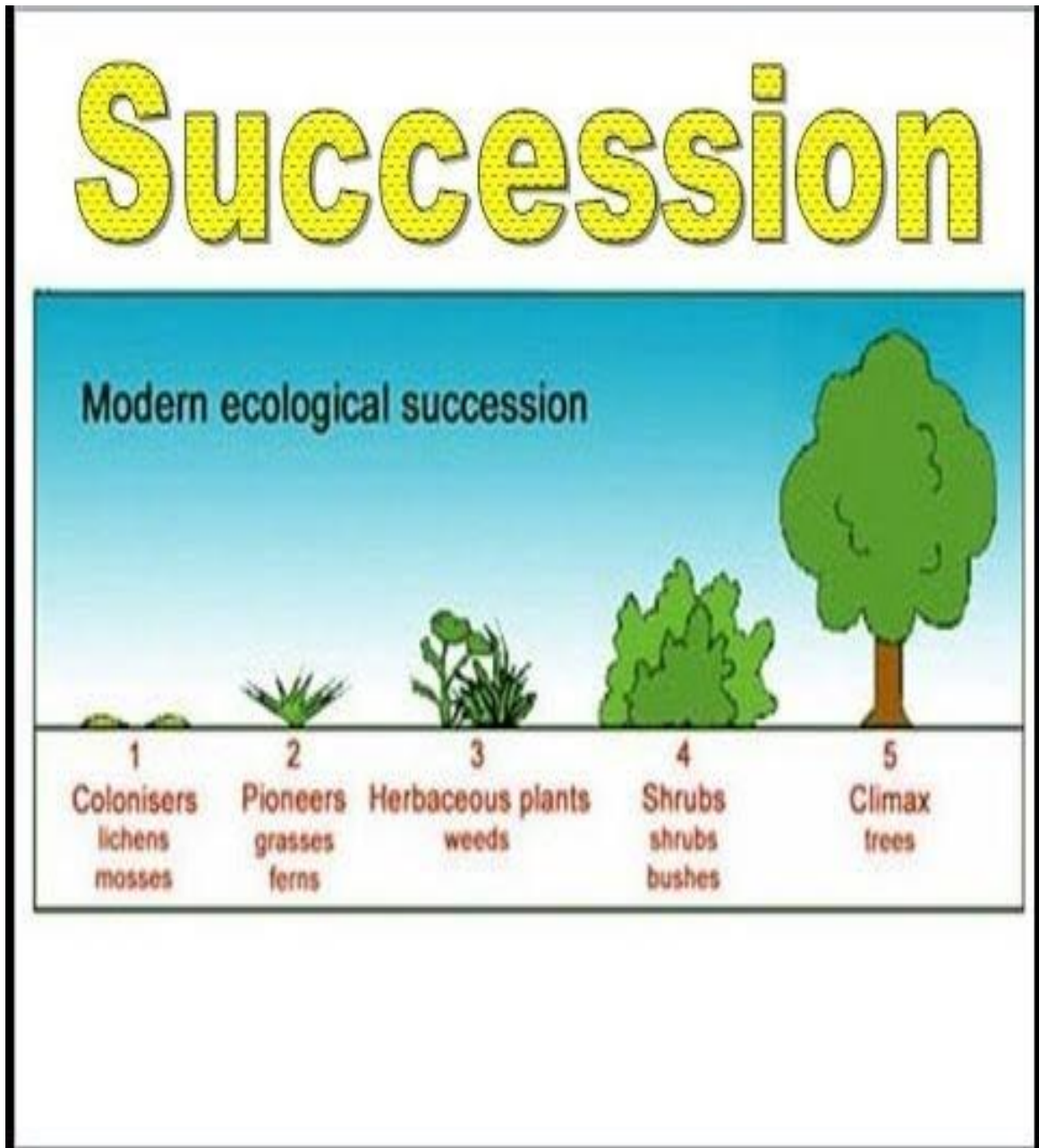
# ECOLOGY: The Study of the Place We Live

Ecology examines the relationships between the living and non-living at scales ranging from the individual organism to the biosphere.



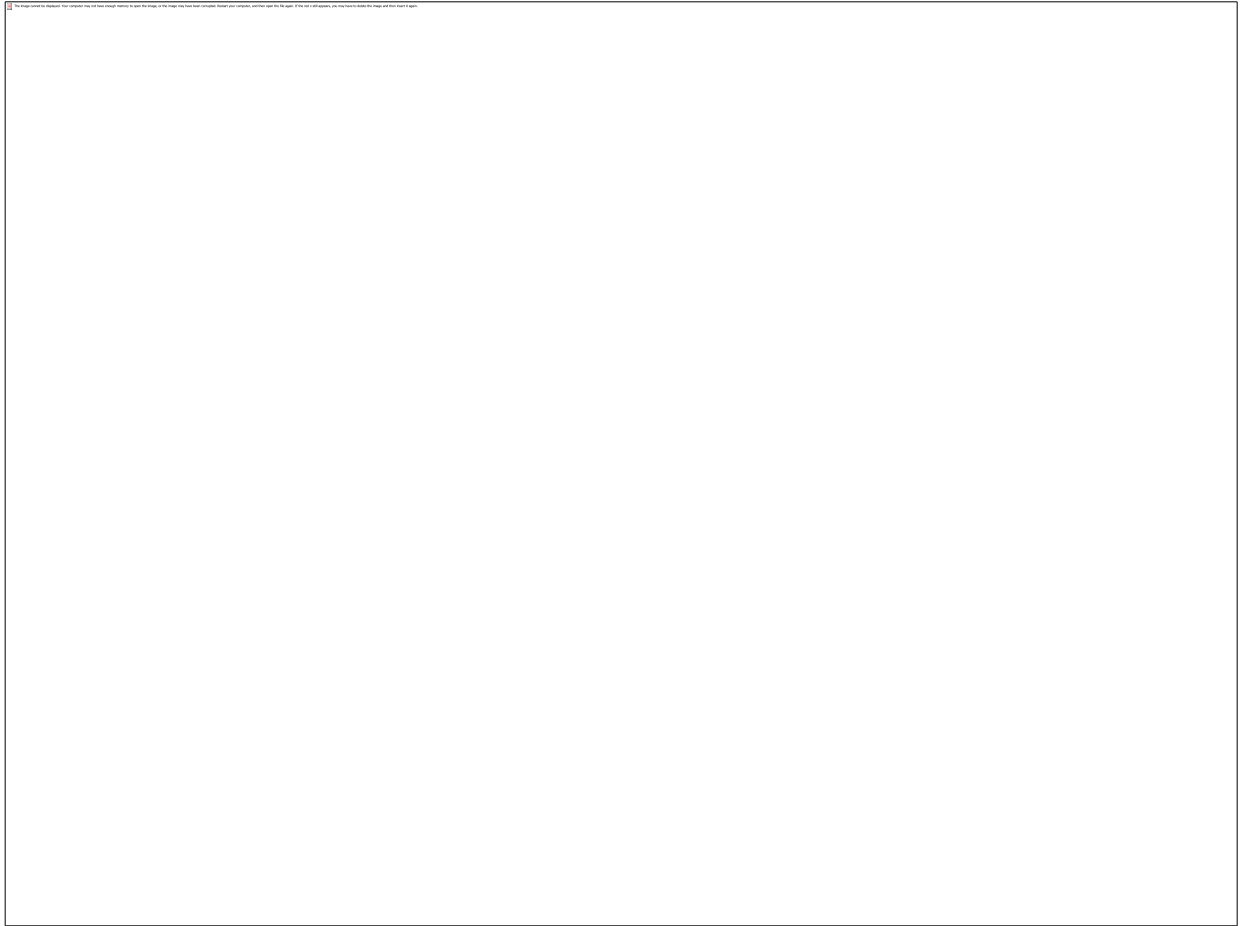
(A)

Ecological Succession



(B)

## Interaction



(C)

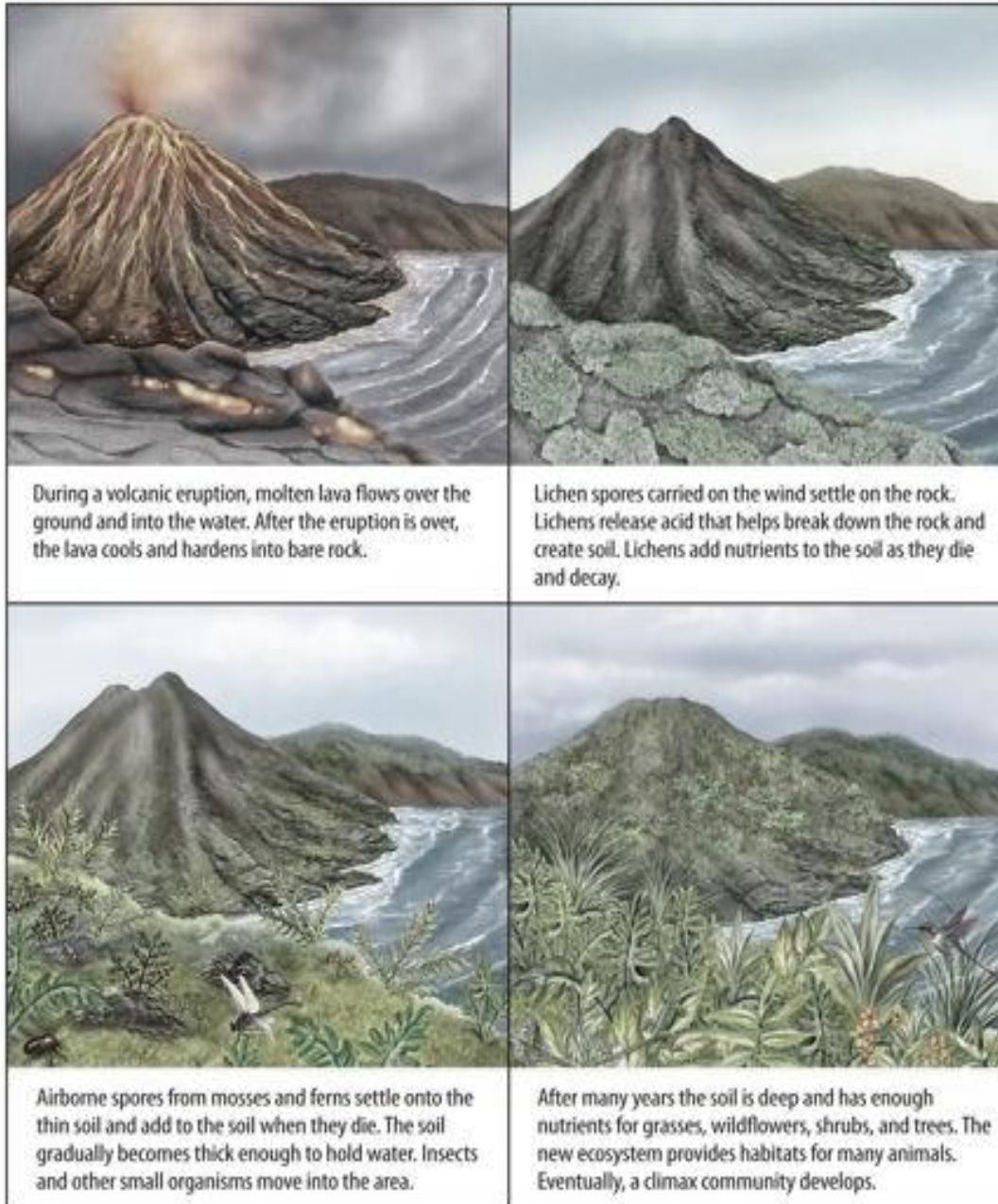
# Primary Succession

- The development of an ecosystem in an area that has never had a community living within it occurs by a process called **PRIMARY SUCCESSION**.
- An example of an area in which a community has never lived before, would be a new lava or rock from a volcano that makes a new island.



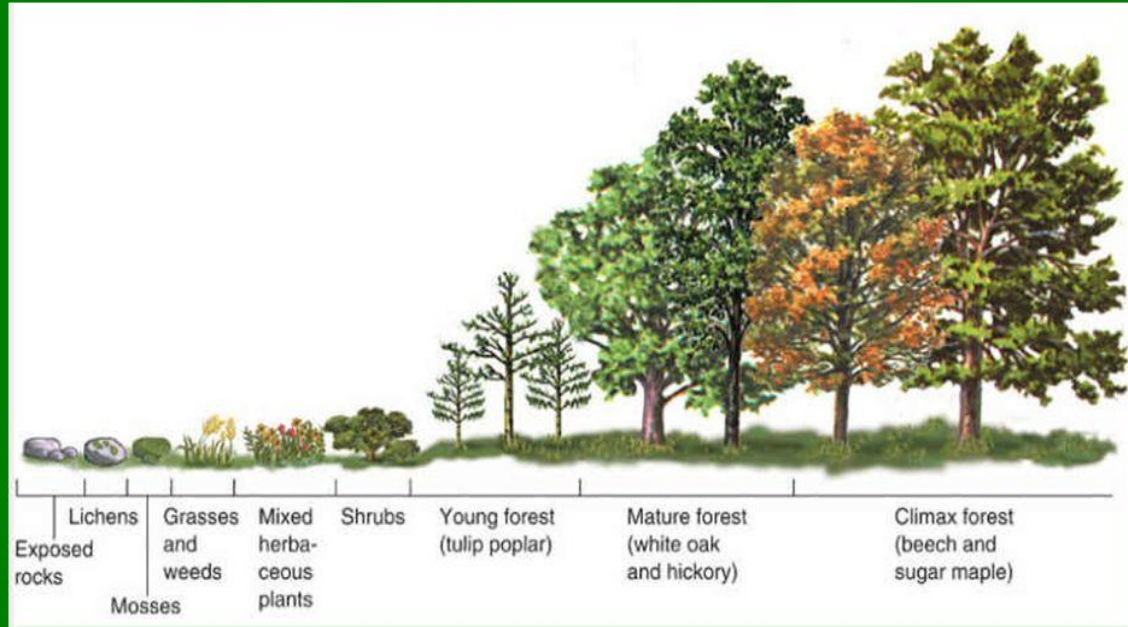
(D)

## VOLCANIC ERUPTION



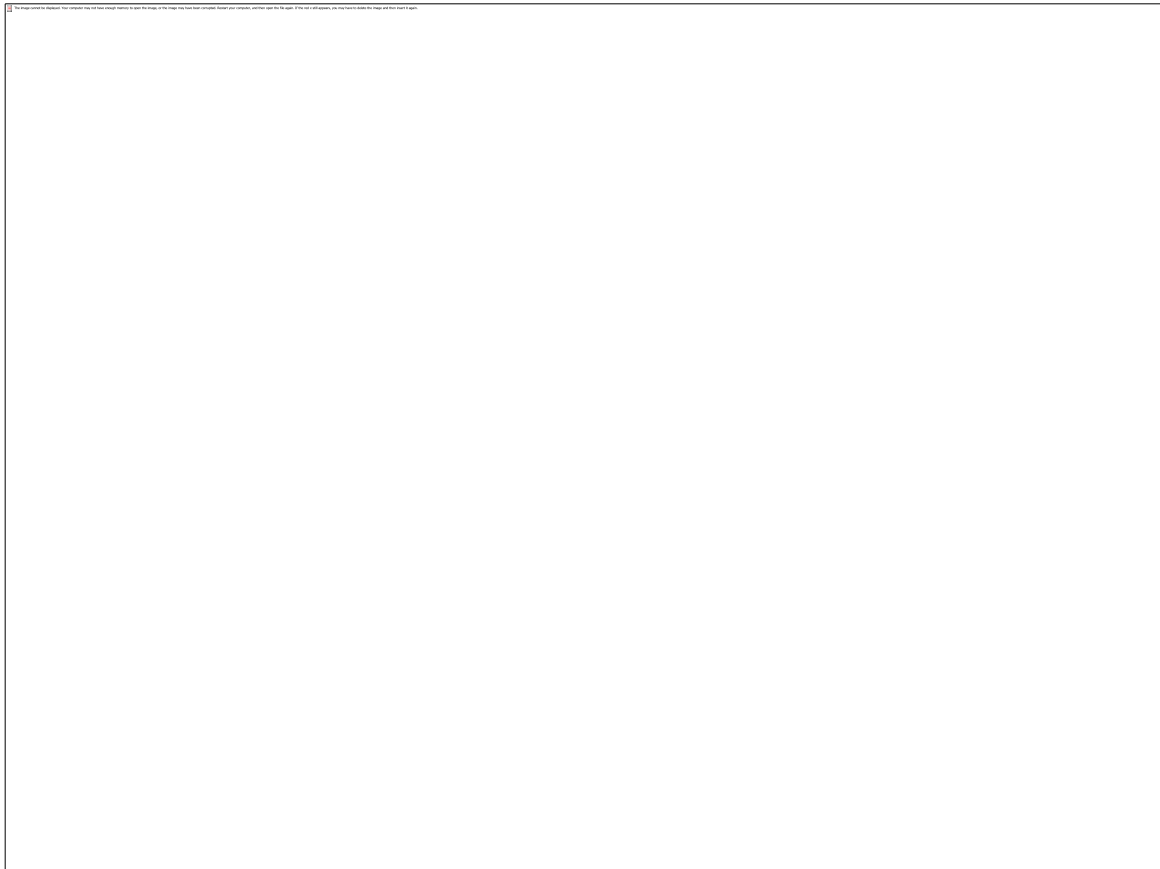
(E)

# Primary Succession: Sand Dune to Forest



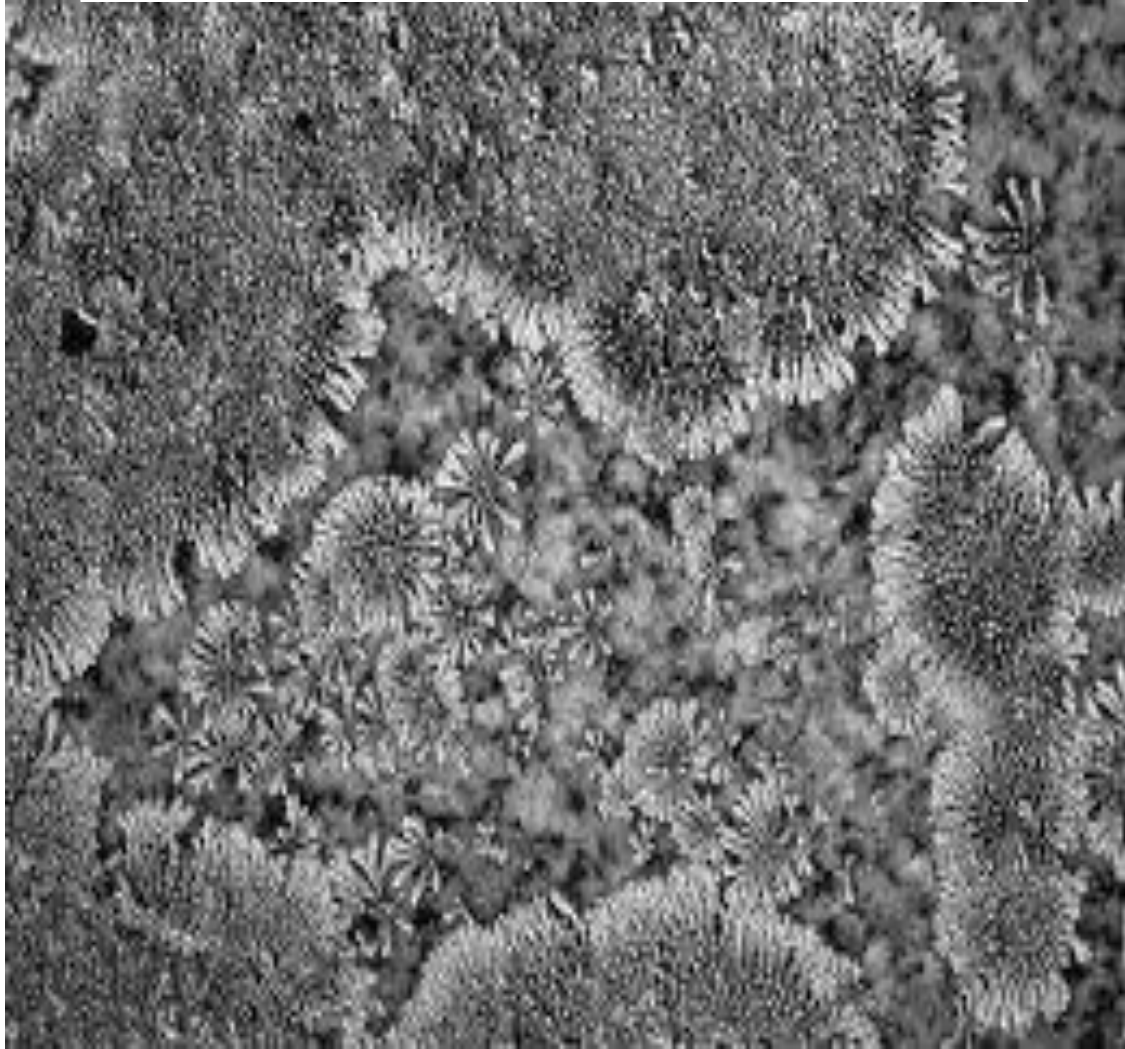
(F)

# Effect of Volcanic Eruption



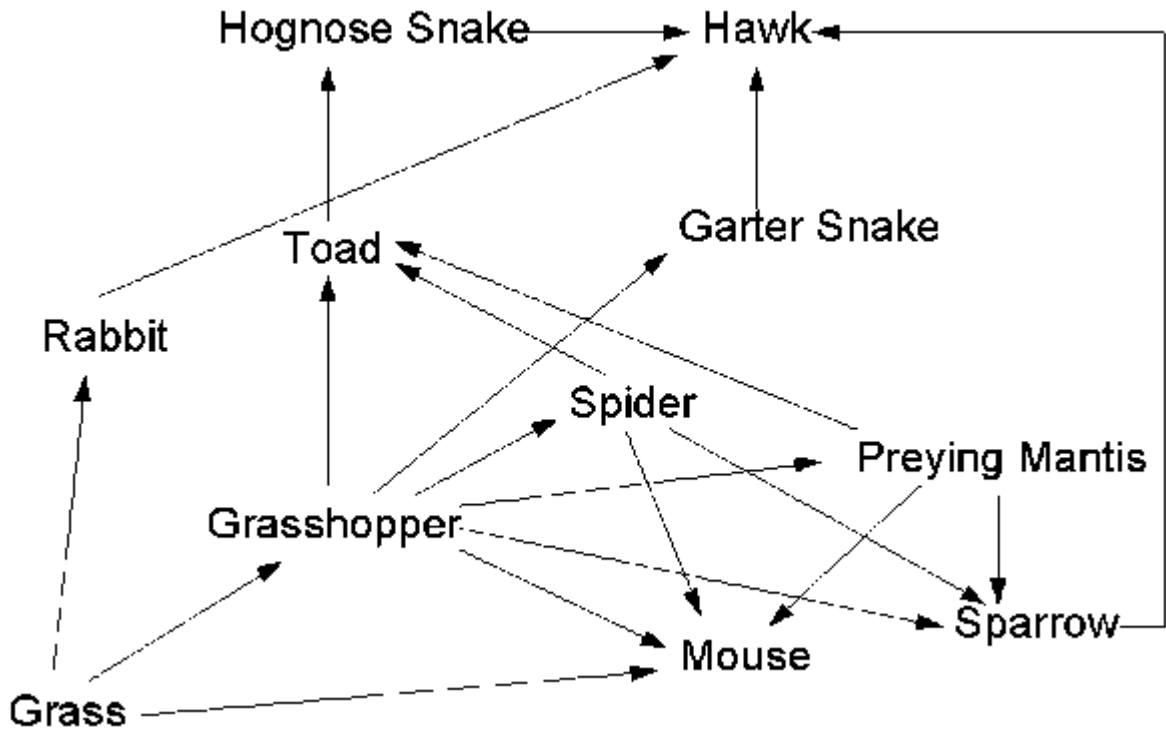
**(G)**

## Result of Secondary Succession



(H)

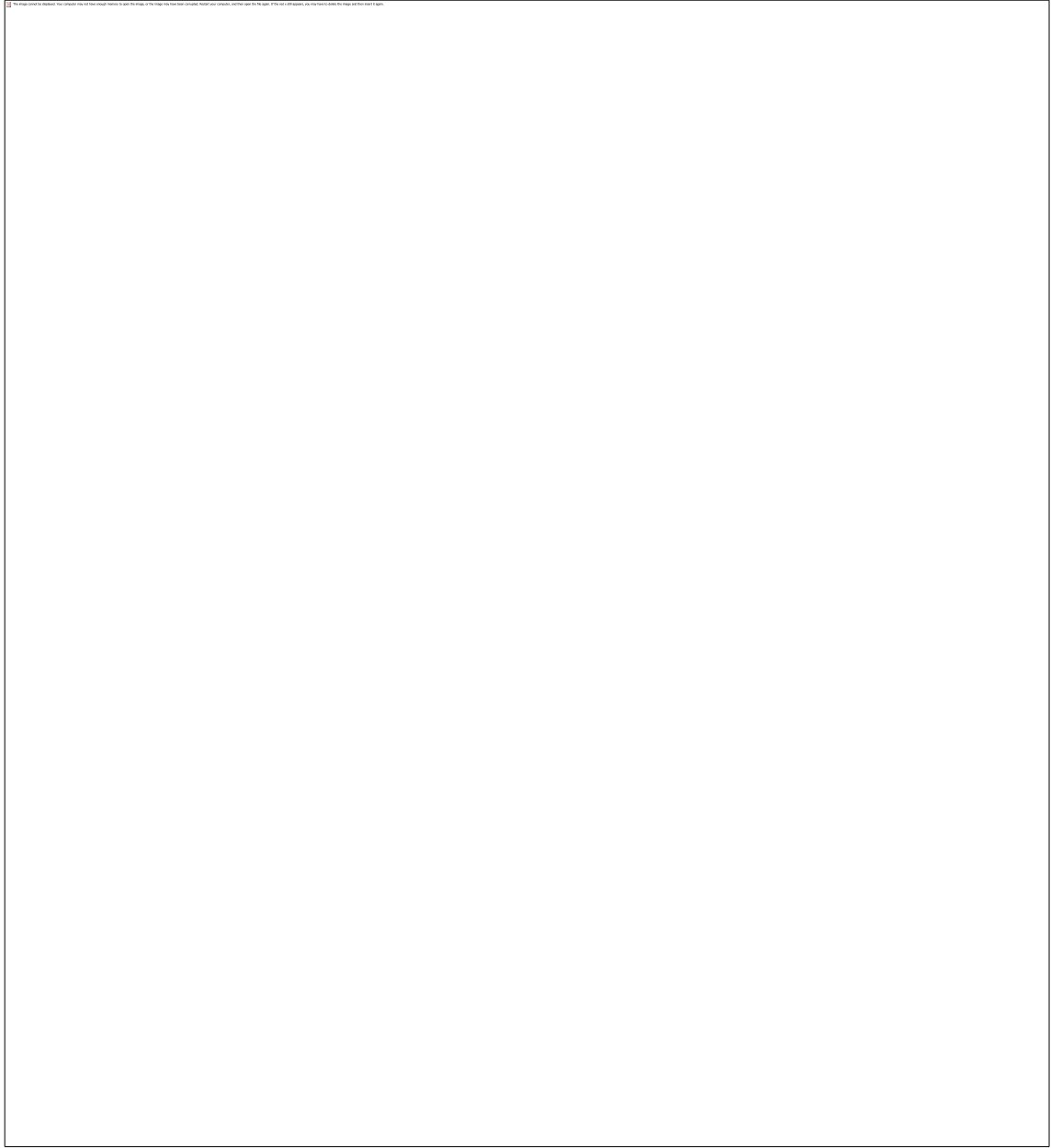
**Food Web (Students Activity)**



(I)

**QUESTIONS**

1. In which trophic level would you place a herbivore? .....
2. How much energy is transferred from one trophic level to the next? .....
3. In which trophic level do you find the greatest amount of biomass?.....
4. What is transpiration?.....
5. What interactions occur within?.....
6. How does biotic and abiotic factors influence an ecosystem?.....



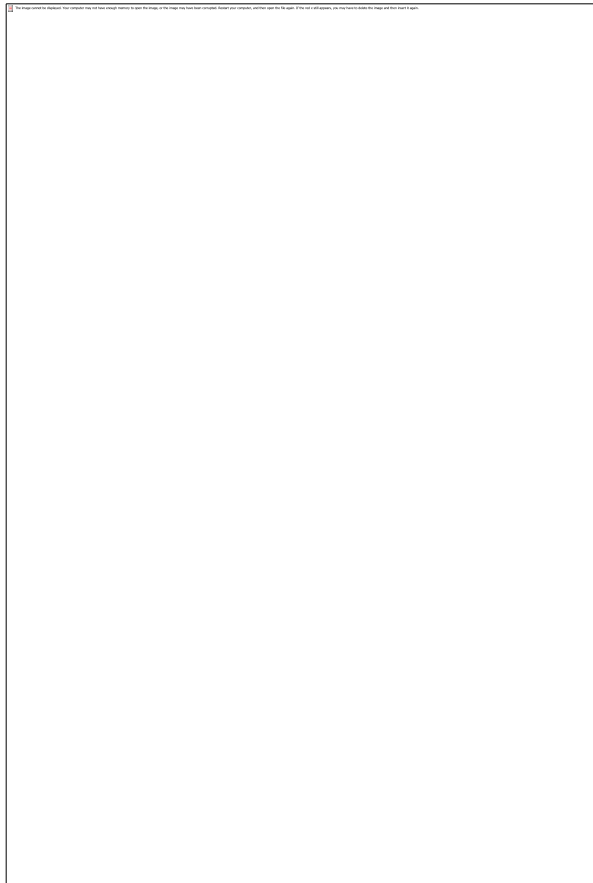
(J)

**Appendix X**  
**Instructional Material for Estimating Population Size**

The screenshot shows an interactive educational interface titled "Estimating Population Size". At the top, there are navigation buttons: "TABLE OF CONTENTS", "HELP", and "EXIT". Below these are tabs for "PROBLEM", "EXPLORE", and "PROCEDURE", with "EXPLORE" currently selected. An "AUDIO" section contains play, stop, and volume icons. To the right, there are buttons for "BACKGROUND" and "LAB NOTEBOOK", which shows a notebook icon. A central text box reads: "Explore the lab to learn what is available for your investigation. You must click on each item in the checklist. Once you are ready to move on, click **PROCEDURE**." On the right side, a "Checklist" box lists the following items: "NORTH AMERICAN MEADOW", "PAINT AND PAINT BRUSH", "2 INSECT SWEEP NETS", and "LARGE PLASTIC CONTAINER WITH LID". The main area features a 3D illustration of a meadow with tall grass, trees, and orange flags. In the foreground, several items are displayed: a large clear plastic jar with a white lid, a small orange bottle, a paintbrush, and two insect sweep nets.

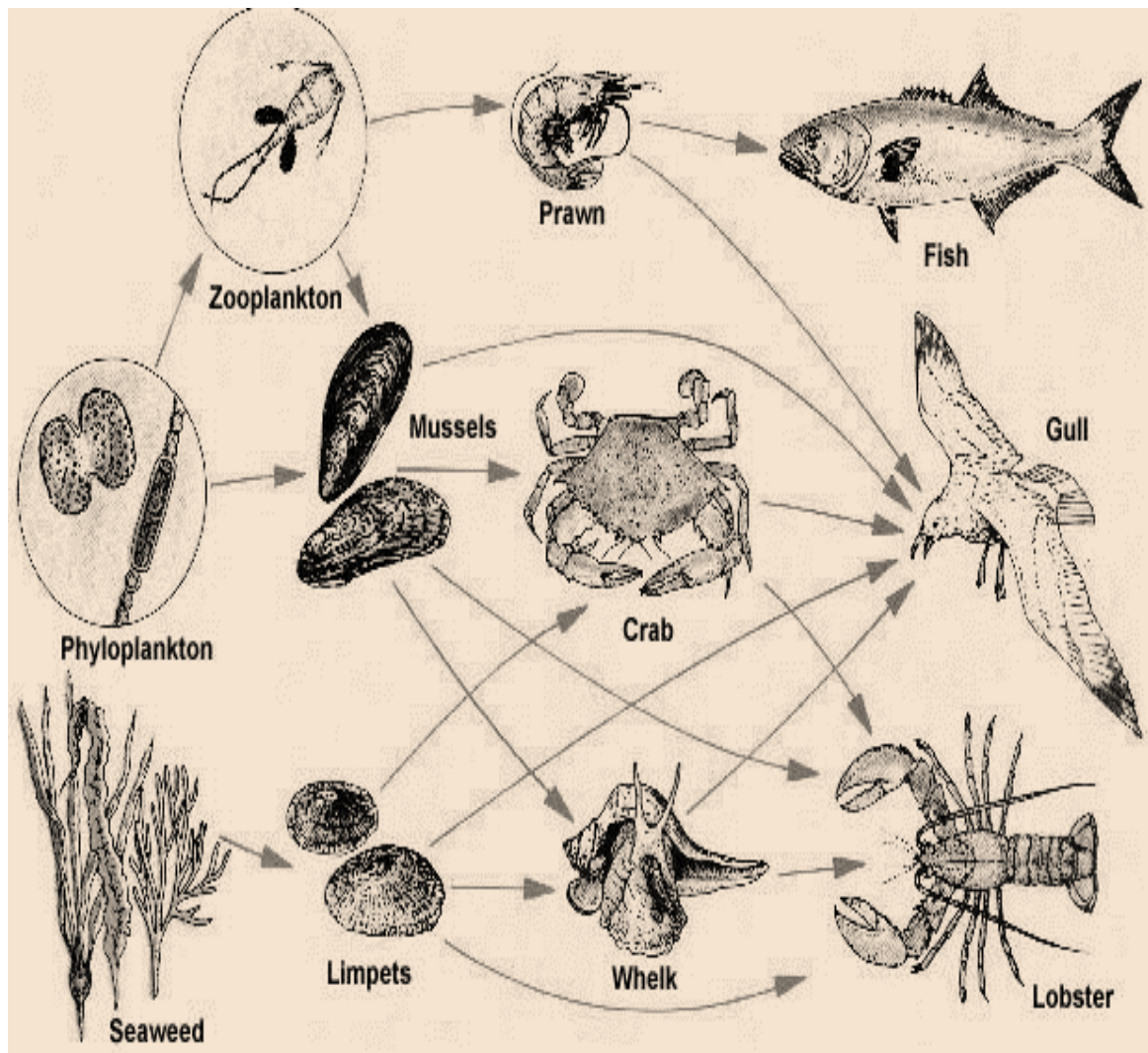
(K)

**Quadrat: Instrument for estimating population of lower organism**



**(L)**

## Energy Flow in an Ecosystem



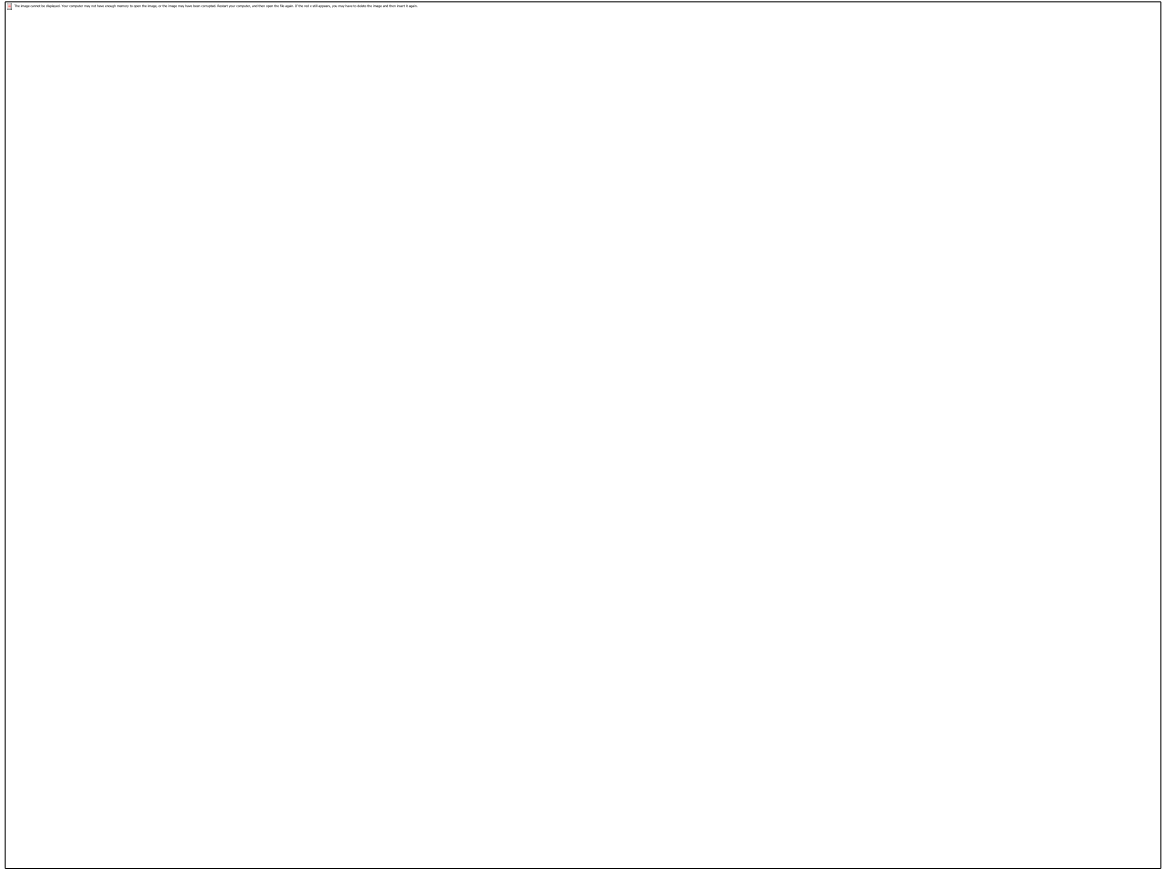
(M)

## Rain Forest Zone



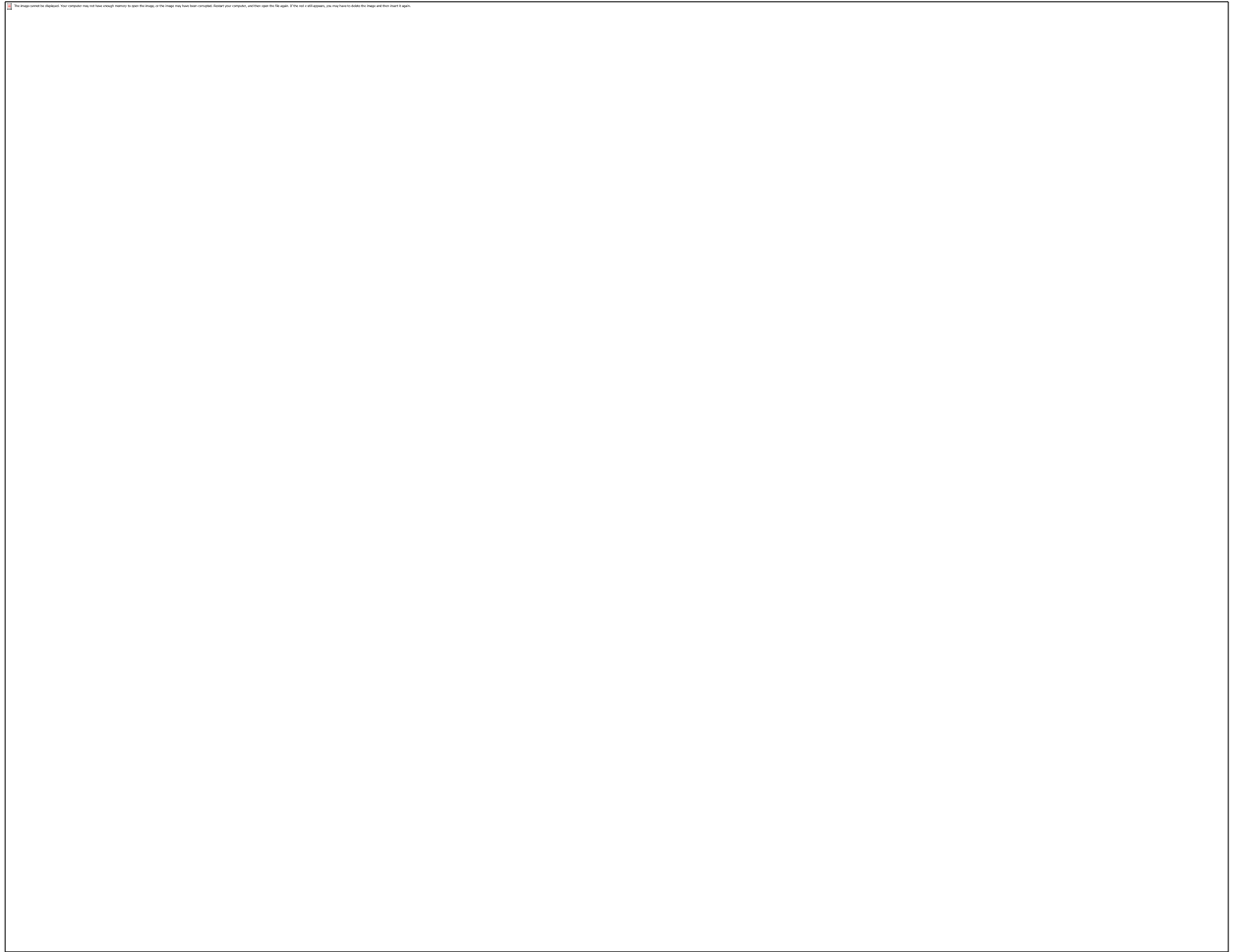
(N)

## Time Lag for Primary Succession among Plants



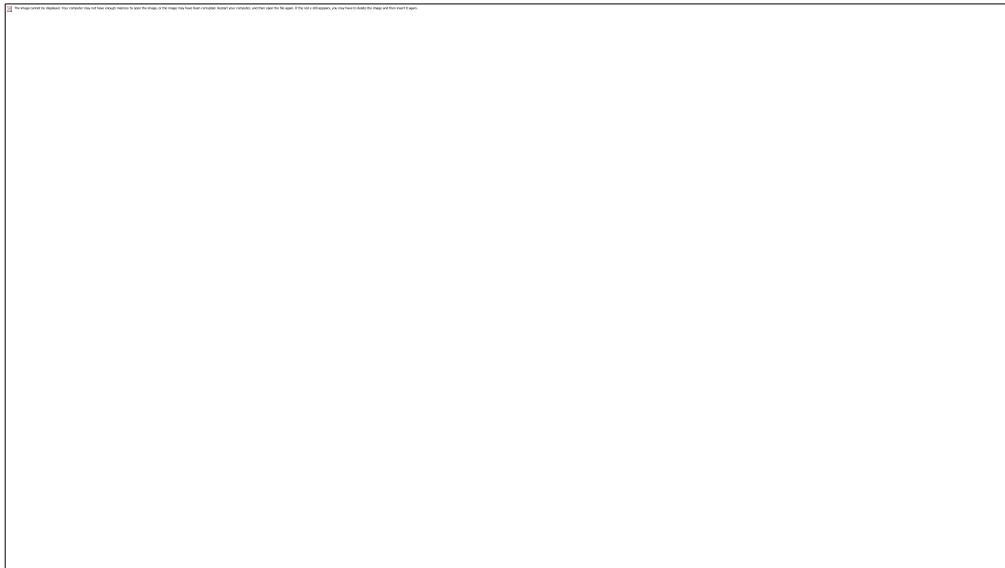
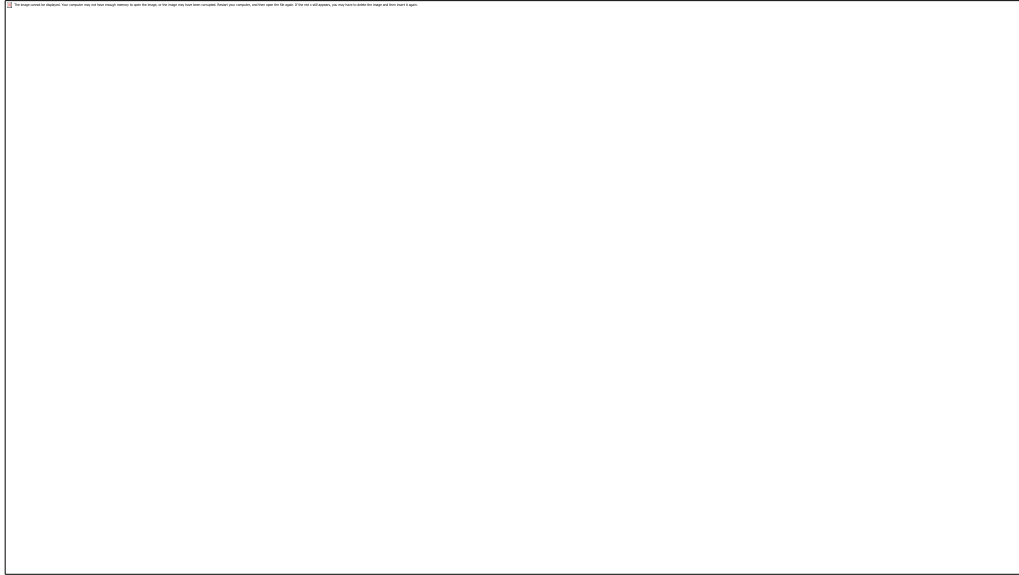
(O)

## A Forest Biome

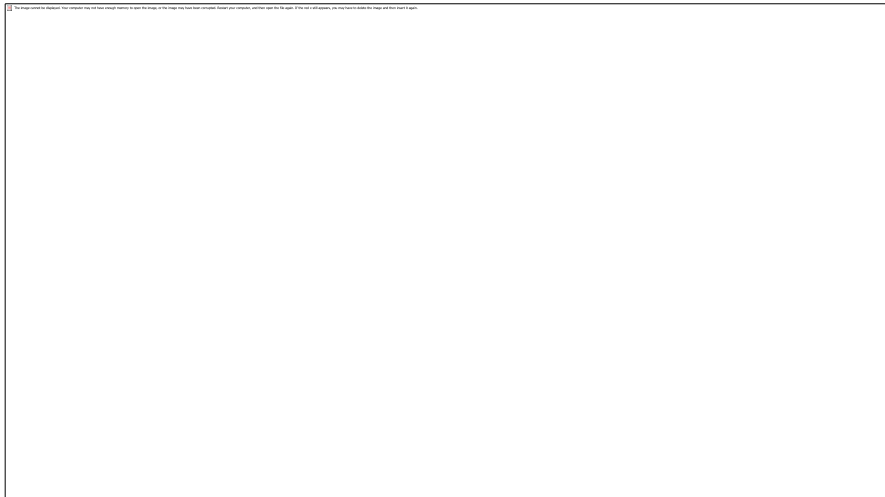
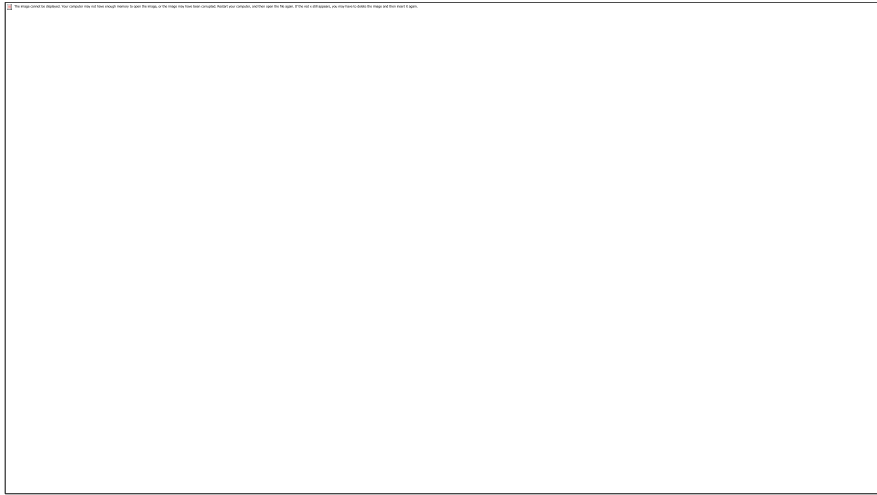


(P)

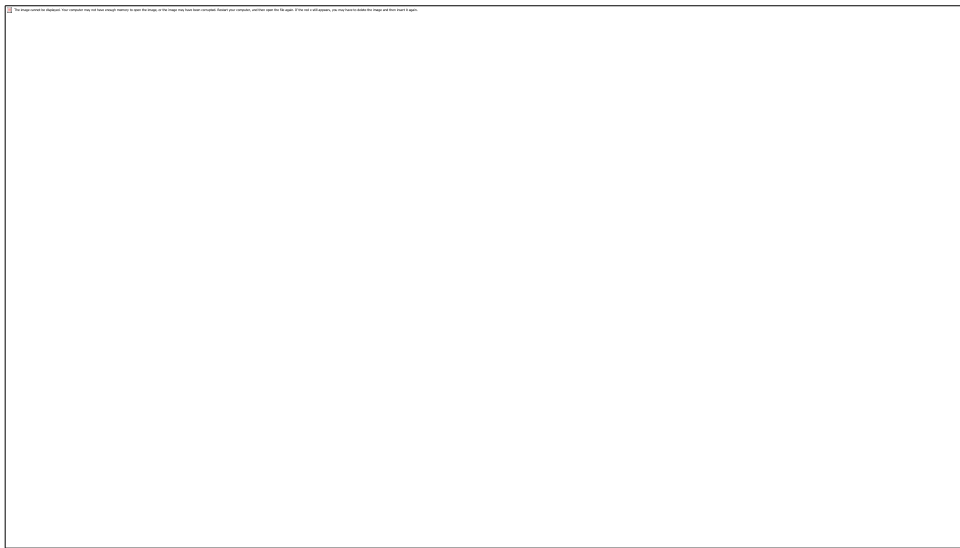
**Appendix XI**  
**Pictures Taken during Data Collection**



(A) Interactive Session EG<sub>1</sub> (Laboratory)



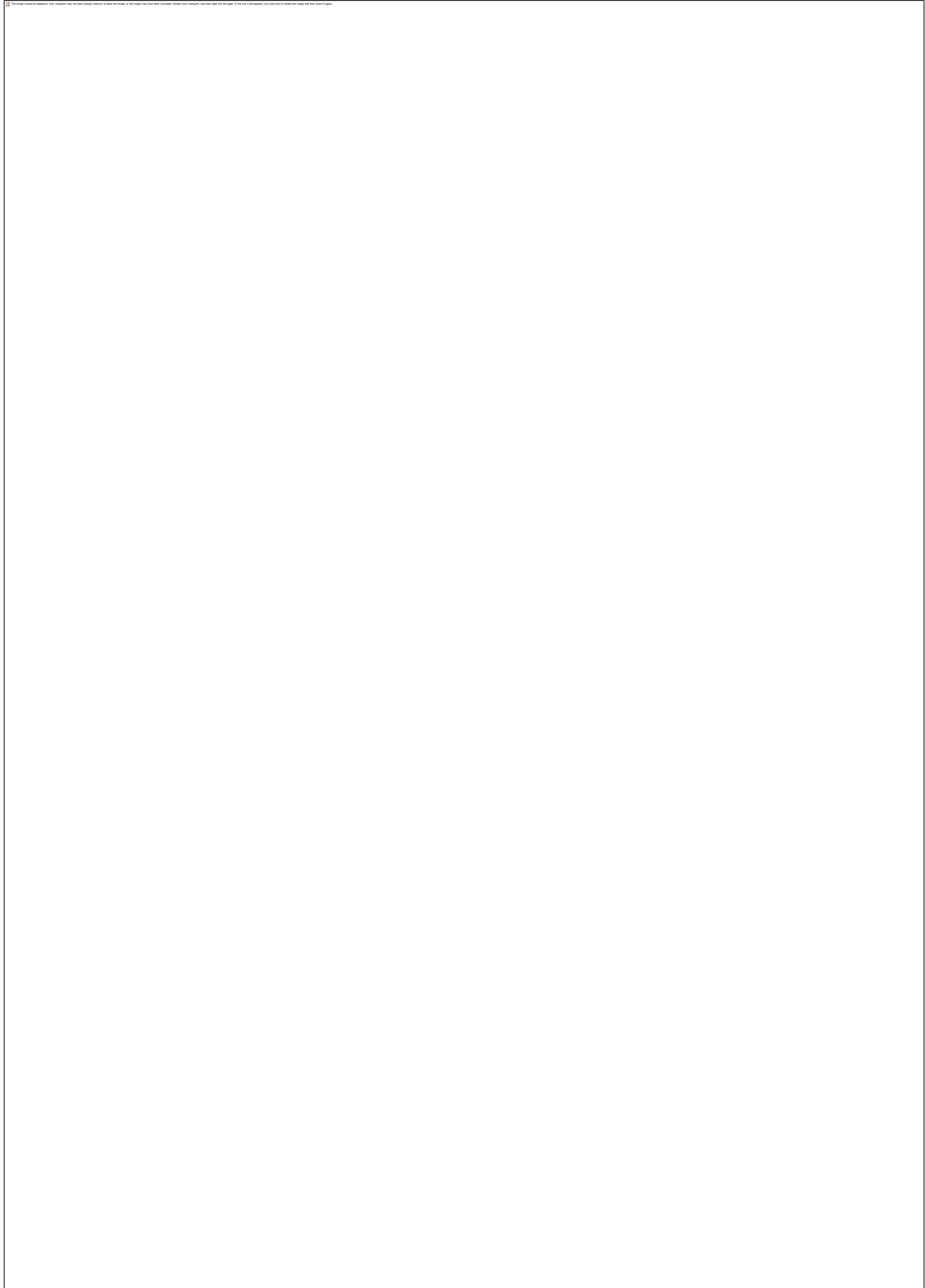
**(B) Interactive Session EG<sub>2</sub> (Problem Solving)**



**(C) Interactive Section of Lecture Method CG (Control Group)**

## Appendix XII

### Validating of Instrument for Ecology Performance Test



## Appendix XIII

### Biology Attitude Scale Questionnaire (BASQ)

#### BIOLOGY ATTITUDE SCALE QUESTIONNAIRE (BASQ)

TIME: 40 MINUTES

SCHOOL:

CLASS:

SEX:

SUBJECT:

This instrument is a five point like type scale consisting of 20 statements about your attitude toward biology. For each statement, think about what and how you feel toward biology and ecology topic (s) how confident will you be to carry out any experiment in any of the related topics. They are not yes or no questions; they are just your feelings and perceptions about the subject or topic. For each of the topic below, indicate the degree to which you agree or disagree with the statement (s) and then tick one of the following options of your choice on the boxes provided.

The responses and their points are as follows:

- Strongly agree (5)
- Agree - (4)
- Disagree - (3)
- Strongly disagree - (2)
- Indicated - (1)

The above indicates that any positive response or option ticked earns the point that tally to it.

However, any negatively worded statements are scored by reversing the numeric value.

Key:

- SA - Strongly agree
- A - Agree

*Effect corrections  
overleaf.*

*OK*

*Jill 1/8/2016  
Prof. I. S. Ndzing*

- D - Disagree
- SD - Strongly disagree
- UD - Undecided

S/N	STATEMENTS	SA	A	D	SD	UD
1	I like biology as a subject					
2	I enjoy biology class (s) at all times					
3	I like ecology topics when taught in the class					
4	In my school we do biology practical more than theory					
5	Topics in ecology are difficult to <del>easy to</del> understand					
6	There is a biology laboratory in my school					
7	Materials for experiment (s) available for use in the laboratory					
8	I participate fully during practicals					
9	I score higher in biology subject more than any other subject					
10	We work in groups during practical class					
11	My teacher assigns individual work in every practical class					
12	I can easily understand biology through direct observation via practical and experiments.					
13	Practical classes are more interesting to attend than theory classes					
14	I can perform biology experiment on my own					
15	Ecology related questions in exams are easier to answer					
16	I can draw biology diagrams without much difficulty					
17	Biology materials and apparatus are difficult to handle					
18	We have enough time at least two periods for biology practical					
19	I want to do biology relate courses in my further studies (medicine, pharmacy, micro biology)					
20	I would not like to do biology after secondary school.					

**Appendix XIV**  
**Validating of Attitude Scale Questionnaire**

Department of Science Education,

Faculty of Education,

A.B.U. Zaria

10<sup>th</sup> October, 2015.

The Lecturer,

Department of Biological Science,

Faculty of Science,

A.B.U. Zaria.

Dear sir,

**VALIDATING OF RESEARCH INSTRUMENT**

I have developed a research instrument designed to generate data for my PhD thesis, titled 'Impact of Laboratory and Problem Solving strategies on Retention Performance and Attitude Towards Biology among Secondary Students in Zaria, Kaduna State. The instrument is titled 'Students Attitude Questionnaire [SAQ].

As a specialist in biology and research methodology, I would like you to kindly examine the items with reference to the following:

1. Would these items test what they meant to test?
2. What general criticisms and suggestions could you give to improve the instrument?

I will very much appreciate your assistance.

Thanks

Yours faithfully,

Osochi Lebe M.

PHD Candidate 9373/2014-2015.

OK.  
JRM  
17/10/2015

**Appendix XV**

**Introductory Letter to Access Research Data from Science Education Department**

**ABU Zaria**



**DEPARTMENT OF SCIENCE EDUCATION  
AHMADU BELLO UNIVERSITY ZARIA**

Vice Chancellor: **Professor Ibrahim Garba** B.Sc, M.Sc(ABU) Ph.D DIC (London), FNMGS  
Head of Department: **Dr. Mamman Musa** B.Ed, M.Ed, Ph.D (ABU), FMAN, FANF, DAC.

Your Ref:

Our Ref: DSE/R/1/Vol.1

Date:

13-10-2016

Dear Sir/Madam,

**PG AN INTRODUCTORY LETTER TO ACCESS RESEARCH DATA**

This is to introduce the bearer, OBOCKE UCHIE MARIA, with registration number Ph.D. | EDU | 9373 | 2011-2012, as one of our

P.G

students who is conducting a research on the topic:

IMPACT OF USING LABORATORY AND PROBLEM-SOLVING TEACHING STRATEGIES ON ACADEMIC PERFORMANCE, RETENTION AND ATTITUDE AMONG SSSII BIOLOGY STUDENTS IN ZARIA EDUCATIONAL ZONE K STATE, NIGERIA

Please accord HER every necessary assistance to build on to be able to usefully contribute HER quota to knowledge.

Yours faithfully,

**Dr. Mamman Musa**  
Head, Science Education Department

**Appendix XVI**

**Letter of Introduction from Ministry of Education Science and Technology, Zonal Office Headquarters, Zaria to GSS Tudun Jukun**

Ministry of Education Science and Technology,

Zonal Office Headquarters,

Zaria.

Date 25-10-2016

The Principal/Proprietor,

G.S.S. Tudun Jukun

ZARIA

LETTER OF INTRODUCTION

Obacht M. Uche

The bearer is a Ph.D. RESEARCHER in the department of/from  
SCI. EDU FAC. OF EDU. ABU. ZARIA and  
wish to conduct a research in the following areas:-

1. IMPACT OF LABORATORY AND PROBLEM SOLVING
2. STRATEGIES ON RETENTION, ATTITUDE AND
3. ACADEMIC PERFORMANCE AMONG SEC SCH
4. STUDENTS IN ZARIA EDU. ZONE KAD. STATE
5. NIGERIA

I am directed to request you to allow him/her the use of your facilities accordingly please.

*H.O.D. science,  
Pls assist attend to her request to  
gather necessary and available data for  
her research.  
[Signature] 25/10/16*

[Signature]  
**H.O.D.**  
Ministry of Education (M.E.T.)  
Zonal Office  
H.O.D., PRS  
For: Director

## Appendix XVII

### Letter of Introduction from Ministry of Education Science and Technology, Zonal Office Headquarters, Zaria to GSS Aminu (Senior)

Ministry of Education Science and Technology,

Zonal Office Headquarters,

Zaria.

Date 25-10-2016

The Principal/Proprietor,

GSS Aminu (Senior)

SIGARI ZARIA

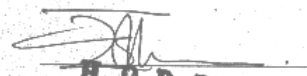
#### LETTER OF INTRODUCTION

OBOCHI M. UCHE

The bearer is a Ph.D Researcher in the department of/~~from~~  
SCIENCE EDUC. FAC. OF EDU. AMINU BELLO UNI ZARIA and  
wish to conduct a research in the following areas:-

1. IMPACT OF LABORATORY AND PROBLEM SOLVING
2. STRATEGIES ON RETENTION ATTITUDE AND ACADEMIC
3. PERFORMANCE AMONG SEC. SCH. STUDENTS IN
4. ZARIA EDUCATIONAL ZONE KADUNA STATE
5. NIGERIA

I am directed to request you to allow him/her the use of your facilities accordingly please.

  
**H. O. D. PRS**  
Ministry of Education  
Zonal Office, Zaria.  
H O D, PRS

For: Director

**Appendix XVIII**

**Letter of Introduction from Ministry of Education Science and Technology, Zonal Office Headquarters, Zaria to GSS Magajiya**

Ministry of Education Science and Technology

Zonal Office Headquarters,

Zaria.

Date 25-10-2016

The Principal/Proprietor,

G.S.S. MAGAJIYA

ZARIA

LETTER OF INTRODUCTION

OBODIN M UCHE

The bearer is a P.h.D RESEARCHER in the department of ~~PHED~~  
SCI EDU. FAC OF EDU ABU. ZARIA and

wish to conduct a research in the following areas:-

1. IMPACT OF LABORATORY AND PROBLEM SOLVING
2. STRATEGIES ON RETENTION, ATTITUDE AND ACADEMIC
3. PERFORMANCE AMONG SEC SCH STUDENTS IN
4. ZARIA EDUCATIONAL ZONE KADUNA STATE
5. NIGERIA

I am directed to request you to allow him/her the use of your facilities accordingly please.

  
**H. O. D. P.R.S**  
Ministry of Education  
Zonal Office, Zaria

H O D, PRS

For: Director