IMPACT OF COLLABORATIVE STRATEGY ON RETENTION AND PERFORMANCE IN ECOLOGY CONCEPTS AMONG CONCRETE AND FORMAL REASONING ABILITY STUDENTS, ZARIA NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS DEGREE IN SCIENCE EDUCATION

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JANUARY, 2016

DECLARATION

I hereby declare that the work in this dissertation entitledImpact of Collaborative Strategy on Retention and Performance in Ecology Concepts among Concrete and Formal Reasoning ability Students in Zaria Kaduna State. has been carried out by me in the Department of Science Education. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution

_____ _____

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CERTIFICATION

This dissertationentitled Impact of Collaborative Strategy onRetention and Performance in Ecology Concepts among Concrete and Formal Reasoning Ability Students. Zaria, Kadna State. Nigeria written by Adeola Yemi OYAROLE meets the regulations governing the award of Master degree in Science Education of Ahmadu Bello University, and is approved for its contribution to knowledge.

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DEDICATION

Dedicated to my mother Deaconess O. Oyarole and my Late father Deacon Oyarole.

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LIST OF ABBREVIATIONS

The following abbreviations are used in this study

CO: Concrete Operational

CG: Control Group

EG: Experimental Group

EAT: Ecology Achievement Test

FO: Formal Operational

NPE: National Policy on Education

STAD: Students Team Achievement Division

GALT: Group Assessment of Logical Thinking

WAEC: West African Examination Council

OPERATIONAL DEFINITION OF TERMS

Below are the definition of the terms used in this study:

Ability Grouping: Is a practice that distributes students into classroom taking into account their perceived capacities for learning.

Performance: The overall measure of performance of students in a given test after a period of teaching.

Collaborative Strategy: Is an approach to teaching and learning in which students of various ability work together in groups toward a common goal.

Concrete Reasoning: A reasoning ability that relay on concrete / real situation

Concept: Is the basic unit of all types of learning. Is an ideal or understanding of what a thing is.

Formal Reasoning: A higher order reasoning ability that goes beyond concrete /real situation. It makes use of hypothetical situation as well.

Pretest: This is test administered to the subjects before the treatment. It is normally used to determine group equivalence.

Posttest: This is test administered to the subjects after treatment. It is used to determine achievement at the end of the instruction.

Post-posttest: This is the test administered to determine retention**.**

Retention: The ability to store information which can be easily recalled from the short term memory and long term memory.

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ABSTRACT

The study investigated Impactof Collaborative Strategy on Retention and Performance in Ecology Concepts among Concrete and Formal Reasoning ability Students in Zaria Kaduna State. A sample of 60 students drawn from a population of 1,642 using simple random sampling techniques were used for the study. Quasi-experimental control group design was adopted involving pretest, post-test and post-posttest.Two instruments were used GALTs and EPT duly validated by experts with reliability coefficient of(r) 0.85 and 0.65 respectively were used for the data collected. One of the research questions raised was(1) what is the difference between the mean scores of concrete and formal operational students taught ecology concepts using collaborative teaching strategy and their counterparts taught using lecture method? One of the research hypotheses raised was there is no significant difference between the academic performance of concrete and formal operational students taught using collaborative strategy and those exposed to lecture method. The null hypotheseswere analysed using ANOVA, t-test and Dunnettstatistics at $p \leq 0.05$ level of significance. The findings from the study revealed that i) Collaborative learning strategy significantly improved the academic performance of formal and concrete ability students exposed to it. ii) Collaborative strategy is gender friendly as it enhanced meaningful learning and performance in both gender iii) Collaborative strategy significantly improved the performance of ecology students exposed to it. Based on the findings, the collaborative learning is efficacious in eliminating gender related differences in teaching andlearning science, indicating that the strategy is gender friendly also ecology concepts are retained when collaborative strategy was used as medium of instruction to teach both formal and concrete reasoning ability students. The researcher recommended among others that: Workshops, seminars and conferences should be organised for Biology teachers on the use of Collaborative Instructional Strategy in secondary schools.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science has been described as a dynamic field of human creation, it has been realised that the development of any country depends largely on the teaching and learning of science, consequently the country's educational policies and programmes are being directed toward the sciences which include biology. The economic strength of a nation is always assessed in term of its achievement in science and technology (Wasagu, 1999, Olarinoye, 2001; and Otuka, 2006). In view of its importance, the Federal Government of Nigeria emphasized the teaching of science and technology in all institutions as contained in the National Policy on Education (FRN, 2005).

As a science subject, biology serves as a prerequisite to the study of medicine, pharmacy, agriculture among others. Biology concepts according to Chew (2004) can sometimes be difficult particularly when describing ideas that are abstract or cannot be fully comprehended by learners for the first time. Research finding by Oyedokun (2002); West African ExaminationCouncil (2010) have also shown that a number of concepts in biology which include Ecology, Evolution and Genetics contains topics that pose difficulty for biology students to understand. Ecology is an aspect of the biology syllabus that senior secondary students at SS2 must study. However, it is considered as abstract in nature and difficult to understand which has resulted in poor performance among students (Danmole & Femi-Adeoye,2004).

The problem of poor performance in science subjects including Biology has persisted over the years(Eguabor, 2001; Olalekan & Jerome, 2006; and Enesi, 2007). This observation has evoked much research efforts aimed at evolving means of re-addressing the situation.

Science education researcher like Akibuilo, (2004) attributed the poor performance in science including Biology to problems such as low morale of students, poor preparation of teachers, overcrowded classroom, inadequacyof laboratory, poor attitude of students to work, gross underfunding and inadequacy of rewards for excellence in science teaching and learning.However, with all the problems associated with poor performance, efforts are being made to find solutions to the recurringfailure rate among science students. One of such efforts is on the issue of instructional methods which has attracted a lot of researcherssuch as Ibrahim (2008); Abdullahi, (2007); Olalekan and Jerome,(2010).Studies revealed the use of poor teaching methods as a major cause of poor performance in science subjects. Adamu & Ahmad, (2000); Akibuilo (2004) viewed the use of inappropriate teaching methods as a major cause of students' poor performance in science examinations.

Teaching methods otherwise called instructional methods are many and varied. According to Nkebem and Okon (2006), teaching method is described as interplay of activities whose combined effect enhances the accomplishment of specific instructional objectives. They enumerated some commonly used teaching methods as lecture, tutorial methods. All these methods aim at enhancing teaching and learning leading to the attainment of specific instructional objectives. Predominant instructional method used in teaching at all levels of education, is through the use of lecture method. Lecture method on the other hand has been reported by Awodi (1994) and Okeke (2006), to be ineffective in science instruction. Theuse of lecture method entails a one way flow of communication from the teacher to the students. It is teacher-centre or teacher dominated approach. Most of the talking is carried out by the teacher while the students remain as passive listeners taking down notes. Hence is refered to as didactic approach or talk and chalk method. Though lecture method has its advantages as large amount of information can be presented to students within a limited

time.Most teachers embrace the use of lecture method due to the fact that it enhances coverage of the syllabus. It can be used to teach large and small class sizes. The teacher may ask few or no question in the process. To this effect, the students are denied the opportunity of developing manipulative skills. Ausubel (1986) believed lecture method was only concerned with verbal presentation of concepts and ideas to the students. Science educators such as Danjuma (2005); Otuka, (2006) and Abdullahi (2007) reported that about 80-90% of the scientific information or principles students received from their teachers came through lecture method.

There are many methods adopted by the teachers in the classrooms. One of the methods recommended in teaching is the incorporation of collaborative learning (Kellough & Kellough, 2002) which provide settings where students from different background, classes, gender and ability level can learn to work in a mutually beneficial environment, which also allows students to share across their differences enriching their experience. According to Johnson and Johnson (1991) collaborative learning instruction could enhance performance; One of the elements of collaborative learning is positive interdependence, where students perceived that their success or failure lies within their working together as a group (Johnson & Johnson, 2002). From a motivational perspective,Collaborative goal structure creates a situation in which the only way group members can attain their personal goals, is if the group is successful (Slavin, 2000). Therefore, in order to attain their personal goals, students are likely to encourage members within the group to do whatever helps the group to succeed and to help one and another with a group task.

Collaborative learning foster interaction among students around appropriate tasks and increase their mastery of critical concept (Damon, 2004). When students interact with other students, they learn to explain, discuss and see each other's perspectives, which lead to

greater understanding of the materials to be learned. The struggle to resolve potential conflicts during collaborative activity result in the development of higher levels of understanding (Slavin, 2000).The present study is poised to determine the impact of collaborative strategy onretention and performance in ecology concepts among concrete and formal reasoning ability students.

Retention of concept is an essential factor in determining students' achievement in a given task or activities carried out. When concepts are taught, the wish of the teacher is that the concepts taught should be remembered. Retention as the name implies is the ability to keep what is leant in memoryand consequently remember them at a later time (Bichi 2002). When teaching is characterized by rote learning, meaningless memorization on verbalism, students make ineffective learning, and the facts thus learned are not long retained, nor do they seemto have much effect in changing behaviour (Akinbobola & Folashade, 2009). However, when it is organised and meaningful in which students apply principles, solve problems and interpret experimental data, learning become effective and the facts thus learned are retained with the passage of time.

Research studies by Nwosu (2004), Ayodele (2010) and Opatoye (2010) have shown that improved instructional strategies lead to improvement of the learner's achievement and retention. However, studies that have included students' retention test have revealed the effects of teaching strategies on retention. Orji (1996) in his study showed that problem solving model enhanced students' retention of physics concepts. Lawal, (2009) also revealed in her study that the use of activity-oriented teaching strategy, like conceptual change instructional strategy, aided retention of concepts learnt among students. In collaborative learning, when students learn ideas meaningfully the knowledge seems more organize for them to retain whatever they have learn. In the present study, therefore, it is intended to

determinethe impact of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

Piaget, organized patterns of behaviors or thoughts that allow mentally representing or thinking objects or event in our world evolve through four stages. Although these stages reflect a generally continues pattern of cognitive development, children do not suddenly jump from one stage to the next. These stages of cognitive development are sensory motor (0-2 years), preoperational (2-7 years), concrete operational (7-11 years), formal operational (11-adult). Understanding occurs in concrete and formal operational level (Johnson, 1993). While Piaget (1964) explains that, in concrete operational stage, a student's uses concrete reasoning patterns in tackling problems. The reasoningpatterns are applied to concrete objects or directly observable properties and simple relationships. Moreover, Bigs and Collins (1982) reported that students who are identified as the concrete operational students might have an inefficient working memory and have difficulty in understanding concepts simultaneously and they fail to recognize which concepts best answer to the problem. Concrete operational students will often consider a problem to have a single correct solutionand will have difficulty in identifying responses for open-ended questions that have multiple answers. Formal operational students have deep working memory so they are able to solve abstract problems in logical fashion, become more scientific in thinking such as testing hypothesis and analyzing data and they can keep concepts and their interrelationships in their mind while considering answers.To enhance achievement, educators must first teach students how to think. Lawson,(2007) argued that the teacher's role is not to tell students what to believe, but to help them learn how to come to a belief, there exist differences of opinion regarding the most effective group composition (when composition is based on some forms of cognitive ability). Ability grouping is the practice of dividing students for instruction on the basis of

their perceived capacities for learning. It is the practice of placing students of similar academic level in the same class for instruction (Kulik, 2005).Putting students in class according to ability grouping increases students achievement by allowing teacher to tailor the pace and content of instruction to students need. In the present study, therefore, it is intended to determine the impacts of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

Another important issue is that of the influence of gender and teaching strategies in science. Some studies (Ogunleye, 2001; Adesoji, 2008, and Bunkure, 2008) on the effects of instructional strategies on students' achievement in science suggest that that there is a relationship between gender and teaching approaches. Difference in the achievement of both male and female students in science subjects when exposed to various instructional strategies are reported by Okeke (2001) to be insignificant. However, some research findings such as Ezeeugo & Agwagah (2000); Mari, (2001) and Adepoju, (2009) revealed consistent differnces between the achievements of male and female learners in achievement tasks in science. Mari,(2001) reported that students' achievement in science was significantly high when taught by teachers of opposite sex. The reasons researcher attribute to gender-related differences in achievement between male and female learners include the innovative nature of the instructional approach used, students ability levels, psychological and socio-cultural factors, (Okeke 2001). It will therefore be interesting to find out if there may be link between collaborative strategy and gender differences in achievementbetween male and female learners. This study therefore, investigates the impact of collaborative strategy on retention and performance in ecology among concrete and formal reasoning ability students.

1.1.1 Theoretical Framework

Collaborative learning situation is based on constructivist theory of learning. Learning theories linked with constructivism that is very relevant in collaborativelearning strategy is that of Vygotsky, (1978) and Piaget theory (1978) who believed that a child's cognitive development is a result of social interaction with adults. Through the process of internalization, children create mental structures from the social processes they have witnessed (Ormrod, 2000).The theory of scaffolding and its zone of proximal development emphasizes on the role of active involvement in learning in relation to the child's environment. The teacher acts as a facilitator who encourages students to discover principles for themselves and to construct knowledge by working to solve realistic problems. This implies that the students must takesome responsibility for learning. This is because they have to be actively involved in teaching and learning process.

According to Piagets (1978), theory of constructivism the construction of knowledge is a process of dynamic interaction between the individual and the environment. As the individual interacts with the environment, innate mental structures are re-organized as gaps and contradictions are recognized. This process is called self-regulations.It is a process of assimilation and accommodation.

When new information is presented, it can be assimilated into current cognitive system which enables the construction of a structure that gives the information meaning in the child's current system. Thus through accommodation, the new information can be assimilated into a new cognitive system that is ever growing in complexity (Cobb & Wood, 1991; Flavell, 1993; Lawson, 2002; O'Donnelle, Hmelo & Erkens, 2006).

On the basis of this explanation of Piaget's theory of cognitive development, it would appear to support the use of collaboration in classroom. The process of equilibration that naturally follows leads to acquisition of knowledge and the development of more complex cognitive structures.

With Piaget's and Vygotsky's theories in mind, cognitive perspective for the effectiveness of group learning is well supported. According to this perspective, more intense information processing is a direct result of interactions among students due to the cognitive conflicts that arise, the inadequate reasoning that is exposed, and the elaboration that they are forced to participate in to clarify their understanding.This study is therefore hinged on the theories of Piaget and Vygotsky.

1.2 Statement of the Problem

Over the years, there has been an upsurge in thenumber of candidates sitting for the public examination such as the West African Examination Council (WAEC) and particularly biology papers as contained in (Table 1.1). This is because though Biology is not a core curriculum subject in the senior secondary but because of the stipulation that students must offer one of the basic science subjects, according to the new curriculum of 2013/2014 it is preferred by most students. The results obtained by candidates have been abysmal and do not justify the popularity as observed by researchers (Ajayelemi, 1990;Okoye& Okeke, 2007; Gyuse, 2009). The statistics of performance in Biology May/June Senior Secondary Certificate Examination (SSCE) from 2007-2014revealed a poor percentage score at credit level in grade 1-6. The highlight of the performance is asindicated in Table 1.1

Table 1:1Statistics ofBiology Result in May/June 2007-2014

Year	Total entry	Total pass with credits & above	%pass with credits & above	% failed
2007	745439	2007232	27.8	71.2
2008	620565	119762	19.3	80.7
2009	917041	278122	30.3	69.7
2010	931219	392249	42.1	57.9
2011	838945	253483	30.2	69.8
2012	1261971	421120	33.37	66.63
2013	1285048	436145	33.94	66.06
2014	1364655	390019	28.58	71.42

Source: WAEC Annual Report (2007-2014).

From the Table 1.1the performance in biology within a period of 8 years have been abysmal. Despite the increasing number of candidates over the year under review, the percentages of candidates with credit pass and above is below 45% for the whole year under review. Consistent poor performance of students in Biology at SSCE leaves one in doubt about the effectiveness of the teaching method popularly used by biology teachers. The use of talk and chalks methods of teaching leads to memorization of facts and concept,which has not proven to be effective for all reasoning abilities. The use of collaborative learning strategy has been advocated by researchers, such as Abimbade, (1997); Njoku, (2004) and Adesoji & Ibrahim, (2009) that the use of collaborative learning strategy enhances academic achievement in science subjects atSS level. Research studies suggested that reasoning ability also influence achievement in biology. Studies conducted by scholars such as (Cavallo, 2004; Lawson and Sharan 2007) found that ability level is a predictor of student's achievement in solving genetic problem. Similarly Lawson (2002) found substantial correlation between formal reasoning and biology achievement. From the observation of the researcher, most

schools in Nigeria grouping concrete and formal learners in the same class have been the practise for concrete learners to interact with formal learner. This grouping has not helped to improve academic achievement of students which might have been affected by the teaching method which is teacher –centred. This study therefore seeks to determine if collaborative strategy would enhance retention and performance of concrete operational learners when compared with their counterparts of the formal operational learners. Also the study seeks to determine if collaborative strategy would also enhance retention of learnt ecology concepts among the different groups. However, the study intended to determine impact of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

1.3 Objectives of the Study

The objectives of this study were to:

1) determine the impact of collaborative instructional strategy on academic performanceof concrete and formal reasoning abilitystudents.

2) Investigate the impact of collaborative instructional strategy on academic performance and retention based on gender.

3) determine the impact of collaborative instructional strategy on the retention ability of ecology concept taught to students of concrete and formal reasoning abilities

1.4 Research Questions

The following research questions were formulated for answering:

1. What is the difference between the mean scores of concrete and formal operational students taught ecology concepts using collaborative teaching strategy and their counterparts taught using lecture method?

2. What isthe difference between the retention ability of male and female students taught ecology concepts using collaborative strategy?

3.What is the difference between retention ability of concrete and formal ability students taught ecology concepts groups using collaborative learning strategy and those taught lecture method?

1.5 Null Hypotheses

The following null hypotheses were stated for testing at 0.05 level of significant:

$HO_{1:}$ There is no significant difference between the academic performanceofconcrete and formal operational students taught using collaborative strategy and those exposed to lecture method.

HO_2: Thereis no significant difference between retention of ecology conceptsbetween male and female students taught using collaborative strategy.

$HO_{3:}$ There is no significant difference in the retention of ecology concepts between concrete and formal operational students taught using collaborative strategy and those taught using lecture method.

1.6 Significance of the Study

The finding of this study is hopefully expected to be significant in many ways. It is hoped that the study would:

1) serve as a foundation for further studies and also the findings will provide new information to the existing literature.

2) help Biology teacher to plan sequence and organise properly the contents of ecology in order to enhance and encourage students to avail themselves to the learning opportunities that are available in the study of ecology through the use of collaborative strategy.

3)be of benefit to the Federal Ministry of Education, States Ministries of Education and professional bodies to reorient their ecology teachers through workshops, seminars/conferences on how to include collaborative strategy to enhance the quality of teaching and learning in schools.

1.7 Scope of the Study

The study aims at identifying the Impact of Collaborative Strategy on Retention and Performance in Ecology Concepts among Concrete and Formal Reasoning ability Students in Zaria Kaduna State . The two schools used for the study were Barewa College, Zaria, and Government Day Senoir Secondary School Dogon Bauchi. The students used for the study were SS 11 students.

Ecological concepts used for this study were selected from SS II syllabus.The concepts were: Basic concepts, Major biomass of the world, Population studies and Ecological factors.These concepts were selected because ecology is considered abstract in nature and difficult to understand which has resulted in poor performance among students. (Danmole & Femi-Adeoye,2004). The chronological age of the students range between 17-18 years.

1.8 Basic Assumptions

For this study, it is assumed that:

1) the students are familiar with activity-based learning.
2) the students have been used to working together in groups.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The focus of this study aims at determing the impactof Collaborative Strategyon Retention and Performance in Ecology among Concrete and Formal Reasoning Ability Students in Zaria. Presented under the following sub-headings:

- Science Teaching Instructional Strategy
- Teaching Biology at Senior Secondary Level
- Concepts of Collaborative Instruction
- Different Methods of Collaborative Learning Strategy
- Collaborative Learning in Biology Teaching
- Concept of Reasoning Ability
- Formal and Concrete Reasoning Ability in Biology
- Gender and Academic Performance in Science
- .Effects of Teaching Strategies on Retention in Biology
- . Effects of Collaborative Learning on Academic Performance in Biology
- Overview of Similar Studies
- Implication of Literature Reviewed on Present Study.

2.2 Science Teaching Instructional Strategies

Method of teaching could be regarded as the vehicle through which a message is delivered (Salawu 1999). With the strong link between science achievement and teaching strategies, it behoves science and technology teachers and educators to device teaching methods among other factors as the centrepiece of improving science outcomes, reversing the current negative trend in science achievement through instructional strategies. A competent science teacher must acquaint himself or herself with science methodology and be well groomed in the application of the various methods for effective teaching of science. The problem of devising effective teaching techniques has preoccupied many science educators for a long time. In recent years, this problem has come into sharper focus as a decline in students' performance in science is becoming more and more evident in many countries around the world (Okebukola & Jegede, 1988).

The dominant teaching method in secondary schools is lecture method. This instructional method, according to scholars, is mainly authoritarian in nature. Teaching methods, which can help the development of reasoning, skills and processes through scientific approach, are conspicuously lacking. James (1991) observed that teachers who provide good classroom conditions, good teacher–student relationship and of course apply good teaching methods might improve the academic achievement of students, thereby motivating them to score high marks. According to James, (1991) Lecture method is the prevailing method of disseminating knowledge at virtually all levels of academics in Nigeria. It is the traditional method, the expository method or the talk and chalk as well as conventional method of teaching. The teacher does the bulk of the talking as he presents large body of facts and principles to many students in a teacher-centred mode.

Lecture method provides careful, lucid presentation of materials. Participants see the professional mind at work, and it effectively conveys large amount of information in a short

space of time. This is why it is so appealing to teachers. Although the method is an accepted format by educational community teachers and students, it is an efficient means of distributing a vast amount of knowledge. It allows a great deal of information to be passed to the learner and favours handling of large classes. The use of lecture method is only encouraged when new information is to be passed quickly to a large group, and to illustrate how at least one person is able to wrestle with a large amount of information, integrate, and make sense out of it. Science teachers use mostly the lecture method for imparting information. However, under the lecture method, the teacher, simply becomes only the expositor and drillmaster while the learner remains the listener and a storehouse of facts that can be retrieved by the teacher when needed (Usman, 2001). This results in poor performance by the students. Therefore, the lecture method is not effective for teaching and learning scientific concepts. The search for improved strategies as an alternative to lecture method for teaching and learning of science is a continuous process.

One way to learn is to combine lecture with opportunities for the students to reflect on and use the material actively. Skills such as being able to think critically, inquire into value, and work in groups can be acquired along with the lecture information if active and collaborative learning technique supplements the lecture. This study investigated the impact of collaborative strategy on retention and performance in ecology among concrete and formal reasoning ability students.

2.3 Teaching Biology at Senior Secondary Level.

Science teaching generally and teaching of Biology in particular cannot be effectively done unless instructional materials are employed. There are various methods of teaching Biology, some of which are Lecture, Demonstration, Field-trip and Laboratory method. James (2000) viewed Lecture method as one of the most popular method of instruction

commonly used for science teaching,. He described lecture method as that traditional approach which is referred to as didactic approach, thus can be defined as a teaching technique in which one person usually the teacher presents a spoken discourse on a particular subjects. More than 80% of scientific information and principles are delivered as lectures (Bichi 2002). Teachers embrace this method for easy coverage of the school syllabus. It is characterized by one-way flow of information from the teacher who is always active, while the students are always passive. The method saves time and energy. It allows easy handling of large classes without much stress and is not expensive as only the chalkboard is required. In its true nature the lecture approach is not effective for science teaching. Usman (2000), James (2000) and Bichi (2002) all argued against it because it does not promote meaningfull learning of science. The difference in students' ability are not considered because it cannot satisfy the difference in individuals such as formal and concrete ability students. The students easily become restless and disruptive since their attention span is very limited.

Demonstration is another method in science teaching; which Anaso (2008) simply described as 'to display something'. This approach involves showing a particular procedure or skill to the students who after careful teaching and learning and interaction repeat and practice the same process shown to them.

Demonstration approach can be used when the available resources, equipment cannot go around for all the students in the class. The teacher or some groups of students usually carry it out. The method is less costly in term of materials and it can be used to teach certain techniques or skills, theory and practice. It allows teachers to handle activities that could be harmful to students if carried out by them. However, demonstration does not allow students to develop their skills or manipulation and therefore do not satisfy all there psychomotor domain. Students always have problems in seeing the details of the objects or activities being carried out during demonstration (Anaso, 2008 and Obeka 2010). Another method popularly

employed in the teaching of Biology is field trip which usually takes place outside the classroom in form of excursion for the purpose of making relevant observations and for obtaining specific information. Students are exposed to large number of stimuli and their curiosity is aroused.

Field trip teaching strategy is discovery-oriented, project-oriented, students oriented and encourage humanistic and students gain complete picture of the concept better than any other methods of teaching science (Dike,1997). However, field trip is expensive, time consuming and difficult to plan, Even with careful and adequate preparation, there is danger of accident in field trip.

Another activity-based method of instruction is laboratory activity method. Akano and Nma (2003) defined laboratory as a place where people engage themselves in human enterprises to examine and explain natural phenomena, similarly, Ardo (2004) described the school laboratory as an instructional facility for helping students learn what science is and how scientist work. One of the objectives of teaching, science in schools is to communicate the spirit of science and to ensure students acquire the process skills of science. This cannot be effectively achieved unless students are exposed sufficiently to practical work and laboratory for experimentation procedures, (Ogunkunle and Gbamaja 2006). Sciencecourses typically include laboratory sections in which students conduct experiments that replicate or illustrate a scientific principle introduced in the course. Laboratory sections usually augment lectures or discussions. A laboratory is a forum for science teachers and their student to interact with materials, under controlled conditions, when seeking to find answers to problems in nature in a bid to understand and interpret the natural phenomena (Ogunleye 1999). The use of indoor laboratory to carry out scientific experiment is what is commonly in practice in schools today. Laboratory method can be used to illustrate regulative principles of

science, instance and the development of laws, and develop in students the ability to write a report on laboratory exercise.

It provides opportunity for students to learn to use microscopes, balances, burners, and the use of other laboratory tools. It also leads to better retention of information and development of favourable attitude towards science.However, laboratory method is time consuming and makes high demand on material and equipment. It seems to emphasize on only cognitive and psychomotor domains of knowledge.

The use of collaborative learning approach stands as a paradigm shift from "chalk and talk" to interactive, collaborative mode of teaching and learning. In other words, collaborative learning represents a change from individual learning to social learning (Jensen &Johnson, 2002). It however, give the students the opportunity to work together to achieve common goal. This study therefore sought to investigate impact of Collaborative Strategy on Retention and performance in ecology concepts among Concrete and Formal Reasoning Ability Students in Zaria.

2.4 Concept of Collaborative Instruction.

The term 'Collaborative instructional strategy' refers to an instructional method in which students of different ability work together in groups toward a common goal (Gokhale, 1995).The students are responsible for one another's learning as well as their own. Therefore, the success of one student helps another student to be successful. Students are encouraged to draw on their individual experiences to create a common product. The social context created by collaborative approach allows students to shape ideas, modify them by listening to peers, question, express doubt, and jointly design and implement plans. Slavin (1990) states that the social dividends include positive interdependence, heterogeneity, and shared visions and responsibilities. The authentic learning environment of collaborative strategies also enhances

potentials for transfer to team based activities in professional practice (Johnson & Johnson, 2002). The concept of collaborative learning strategy has also been described, as a social situation in which the goals of separate individuals are so linked together that an individual can attain his/her goal only if the other persons with whom he/she is cooperatively linked to attain theirs as well. As an instructional technique, collaborative learning strategy requires students to work together in groups.

The concept of collaborative learning therefore, stems from the prevailing principles that learners in a cohesive group, work mutually together for the attainment of set educational objectives. The underlying principle here is that there is social cohesion and the willingness of members of the group to work together. The collaborative learning technique works on this principle to encourage students working in groups to achieve lesson objectives under the guidance of the teacher. Johnson and Johnson (2002) also define collaborative learning as the instructional use for small groups in which pupils/students work together to maximize and gain from each other. In collaborative learning, pupils are expected to help, discuss and argue with each other, assess each other's current knowledge, and fill any gaps in each other's understanding (Slavin, 2001).

Students who participate in collaborative learning have been shown to perform significantly better on critical thinking than students who studied individually. Bruffee (2005) sees collaborative learning as a set of processes that help people interact in order to accomplish a specific goal or develop a product, which is usually content specific. King (2002) describes collaborative learning as a group of learners who work together as a team to solve a problem, complete a task or accomplish a common goal. When students are in a collaborative learning environment, it is assumed that they see information and understanding through active mental search without discrimination in gender or ability and the learning is long term (Lefrancois, 1994).

Proponents of collaborative learning claim that the active exchange of ideas within groups not only increases interest among the participants but promotes critical thinking. According to Johnson and Johnson (2002), there is persuasive evidence that collaborative teams achieve at higher levels of thoughts and retain information longer than the students who work quietly as individuals.

Studies of Keraro, *et. al*(2007) and Yabo(2012) have recommended the efficacy of collaborative structures in that they lead to increase cohesiveness among the students involved, which are beneficial in classes that are diverse in ethnic composition, ability level or because of the inclusion of mainstreamed handicapped students (Gillies,2002).

2.4.1 Advantages of Collaborative Learning Strategy

The Collaborative learning classroom, it increases student's engagement and it creates a positive learning environment in the classroom by improving relationships among students. There is great value for students to learn how to work with each other, Mc Craken(2005). Other advantages are as follows-

- Collaborative learning promotes students' learning thereby enhancing academic achievement.
- Collaborative learning helps to increase students' retentive memory on the topic.
- Helps in the development of certain skills like oral communication skills and help to boast self-esteem among students.
- With collaborative learning, students are highly motivated in their learning process and foster mutual responsibility among members while working with collaborative learning.
- Using collaborative learning, students learn to be patient with each other.

- Collaborative learning experiences promotes greater interpersonal attraction between different ethnic groups.(Aronson, 2000)

2.4.2 Disadvantages of Collaborative Learning Strategy

- Some students may find it difficult in using adapting collaborative learning strategy while some weak students may hide under the bright students and are not actually contributing in the lesson(Johnson and Johnson 2002).
- Some bright students may be deprived the opportunity to move as fast as they may want to go in the learning process.
- It is time consuming. It cannot be used for large content coverage of the syllabus.

2.4.3 Teachers Role in a Collaborative Classroom

Across this nation, teachers are defining their roles in terms of mediating learning through dialogue and collaboration. While mediation has been defined in different ways by (Vygotsky , 1957 ; Slavin ,2007).

Facilitator: The teacher facilitating involves creating rich environments and activities for linking new information to prior knowledge, providing opportunities for collaborative work and problem solving, offering students a multiplicity of authentic learning tasks. This may first involve attention to the physical environment.

Additionally, teachers may structure the resources in the classroom to provide a diversity of genres and perspectives, to use and build upon cultural artefacts from the students' home and communities, and to organize various learning activities. Thus, a collaborative classroom often has a multiplicity of projects or activity centres using everyday objects for representing numerical information in meaningful ways.

Facilitating in collaborative classrooms also involves people. Inside the classroom, students are organized into heterogeneous groups with roles such as Team Leader, Encourager and facilitator.

Another way that teachers facilitate collaborative learning is to establish classrooms with diverse and flexible social structures that promote the sort of classroom behaviour they deem appropriate for communication and collaboration among students. These structures are rules and standards of behaviours, fulfilling several functions in group interaction, and influencing group attitudes.

Finally, teachers facilitate collaborative learning by creating tasks that encourage diversity, but which aim at high standards of performance for all students. These tasks involve students in high-level thought processes such as decision making and problem solving that are best accomplished in collaboration. These tasks enable students to make connections to real-world objects, events and situations in their own. Learning tasks foster students' confidence and at the same time, are appropriately challenging.

2.4.4 **Students Roles in a Collaborative Classroom**

According to Lawson (2002), students also assume new roles in the collaborative classroom. Their major roles are collaborator and active participator. It is useful to think how these new roles influence the processes and activities students conduct before, during and after learning. For example, before learning, students set goals and plan learning tasks, during learning, they work together to accomplish tasks and monitor their progress, and after learning, they assess their performance and plan for future learning.

- **Goal setting**: When students collaborate, they should talk about their goals. For example, one teacher asked students to set goals for a unit on garbage. In one group, a

student wanted to find out if garbage is a problem, another wanted to know what happens to garbage, a third wanted to know what is being done to solve the problem of garbage. The fourth member could not think of a goal that the first were important and adopted them. These students became more actively involved in the unit after their discussion about goals, and at the end of the lesson, could better evaluate whether they had attained them.

- **Designing Learning Tasks and Monitoring**

While teachers plan general learning tasks, for example, to produce product to illustrate a concept, historical sequence, personal experience, and so on, students assume much more responsibility in a collaborative classroom for planning their own learning activities. Ideally, these plans derive in part from goals students set for themselves. Thoughtful planning by the teacher ensures that students can work together to attain their own goals and capitalize on their own abilities, knowledge and strategy within the parameter set by the teacher.

Self-regulated is important in collaborative classroom. Students learn to take responsibility for monitoring, adjusting, self-questioning, and questioning each other.

2.4.5 Collaborative Learning Strategy

There seems to be an increasing consensus in pedagogy worldwide about the need to shift from traditional, teacher-centred method of teaching (where the teacher does all the talking with students remaining passive); to a more students centred approach (with leaners actively involved in the learning process).Under collaborative learning, students are paired or grouped together and given specific tasks to perform. Each member is responsible for their own learning as well as those of other group members. Thus play vital roles in each other's learning King, (2002). Students have the opportunity to discuss with peers, present and

defend ideas, exchange diverse beliefs, question other conceptual frameworks, and are actively engaged in the learning process. Importantly, by engaging in discussion and taking responsibility for their learning, students are encouraged to become critical thinkers (Gall, 2005). The students teach one another and teacher serves as mediator. The teacher tends to think of herself as expert transmitter of knowledge to students, and more as expert designer of intellectual experiences for students are responsible for one another's learning process (Njoku, 2011). More importantly, the students are responsible for one another's learning. Therefore, achieving a group goal implies that students have helped each other to understand and learn. Hence, the basis of collaborative learning strategy is constructivism where knowledge is constructed and transformed by students (Dool, 2008). Collaborative learning activities allow students to provide explanations of their understanding, which can help students elaborate and reorganize their knowledge. Social interaction stimulates elaboration of conceptual knowledge as group mates attempt to make themselves understood, and research demonstrates that providing elaborated explanations improves student comprehension of concept. Also, students do not passively receive knowledge from the teacher rather teaching is a transaction between teachers and students in the learning process. In collaborative learning, there is always a group and individual accountability. This therefore, implies that collaborative learning ensures that every group member has learnt something. Each member is responsible for some concept necessary to complete

2.4.6 Different Methods of Collaborative Learning Strategy

Elliot and Shapiro (1990) identified four basic methods of collaborative learning strategies:

i) The "JIG-SAW" Method

ii) Johnson and Johnson's method of learning together

iii) Student Team Achievement Division "STAD" Method

1) Jigsaw method:- is a specific type of group learning experience that requires everyone's collaborative effort to produce the final product (Aronson,2000). It is an efficient way for students to be engage in their learning. Learn a lot of material quickly, share information, individual are accountable for their learning. Since each group needs member to do well in order for the whole group to do well, Jigsaw maximize interaction and establishes an atmosphere of collaboration and respect for other students.

This teaching method according to Aronson (2000) was developed by Elliot (1978) and was based on the idea that collaboration will develop each individual, and each individual can reach a goal only if all other individuals in the group reach their goals. Jigsaw, students are assigned to five member teams to work on academic material that has been broken down into sections. Each team members reads his or her section. Net members of different teams have studied the same sections meet in expert groups to discuss their sections. Then the students return to their teams and take turns teaching their teammates, they are motivated to support and show interest in one another's work. Eliot (1978) used collaborative learning specifically to bring children of different races and ability together. In "JIGSAW" METHOD,

- Students were divided into 6-persons Jigsaw group. The groups were heterogeneous in terms of gender, reasoning ability.
- One students from each group was appointed as a leader.
- The day's lesson was then divided into segments by the teacher corresponding to the number of the groups.
- One segment of the lesson was assigned to each student in a group to learn and teacher ensures that students have direct access only to their own segment
- Each student was given time to study the segment assigned to him/her .

Temporary “expert group” Were formed. This was done by having one student from each jigsaw group join other students assigned to the same segment. Gave students in these expert group time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group

- Bring students back to their jigsaw groups.
- Each student who studied a particular was asked to present his/her segment to the rest of the members. Other group segment to the group. Encourage to discuss and contribute.
- The teacher moved from group to group, observing the process. If any group is having Problem make an appropriate intervention.
- At the end of the lesson, give post-test so that students quickly come to realize that the lesson are not just fun.

ii) Johnson and Johnson’s method (1975)

This method simply used classroom groups of four or five members.
Groups worked on a common assignment, and submitted a group report of their results
Classroom evaluation is based on the group-work: no individuals identified.p.232

Findings by the Johnsons consistently showed this collaborative method to be effective at promoting learning than competition.

iii) Student Team Achievement Division “STAD” Method

This is Slavin’s method of collaborative learning. This design of collaborative learning is derived from Allport’s (1954) contact theory. This theory stresses that superficial contacts between people usually hinders the development of positive relationships and promotes competitive differences between these people. For contact between individuals from different backgrounds to be positive and effective, the group members must see themselves as working towards a common goal, must be allowed the opportunity to come to

each other, and must interact with each other on an equal footing. With the contact theory in mind Slavin designed classroom experiences that would avoid superficial contacts. "STAD" method takes the form:-

> Pupils in each classroom were divided into groups with four or five members per group. The group were a "heterogeneous" of the classroom, containing a cross-section of pupil characteristics: high middle and low ability, ethnic groups, and boys and girls.
> The teacher was responsible for introducing a class topics, and assigning sub-topics to each group. Team members worked out their own methods for approaching problems.
> Individuals were quizzed for their knowledge and a combined team score was obtained so that teams could complete against each other.
> Rewards were obtained on the basis of how well the group scores.p.104

In this method, pupils work together collaboratively to learn new material before they are assessed. Group members help each other to learn and correct each others work. Marks are awarded for how much individual pupil have learned during lesson. Essentially, the individual is the focus of learning, but development and improvement scores were assessed for a team standings. Each individual is responsible for the team's standing thus avoiding any diffusion of responsibility.

Other methods of collaborative learning strategies are:-

- **Group Discussion**:- group discussion is a general unstructured discussion on an issue or topic by the group. Individual member are free to contribute or not contribute (Aronson, 2000). This is the most common form of collaborative learning. It is also the form that requires the most skill to use successfully. Ideally, everyone is actively involved in the discussion and the discussion topics of equal interest to all group members, when group discussion is successful.
- **Assigned Discussion Leader:**- One person in the group is asked to present on a topic or review material for the group and then lead the discussion for the group. This person should not be regular group leader (Reese,2009,p.8).When assigning a discussion topic to individual members of the group, you may need to be prepared to

allow a little time for the person leading the discussion to prepare for the discussion, this techniques works best when everyone or nearly everyone in the group is given an assignment to be "expert" on.

- **Clusters**:- In clusters, group participants are divided into smaller group for discussion, They may also be allowed to self-select the small group they want to be in(Aronson,2000). After discussing the assigned topic, the cluster may report their finding to the last group.
- **Think/Pair/Share**:-Group members think about a question/topic individually, then share their thoughts with partner, Large group summarised sharing also occur. The goal of a think/pair/share is to allow participants time to think before the discussion. Research show that when people are given time to contemplate an answer to a question, their answers differ from those they would give if they responded immediately. When doing a think/pair/share, give participants a specific amount time of time (3second,5minutes) for the think portion. Hence, this study will adapt Jigsaw strategy of teaching for collaborative instruction. This study will therefore investigate the impact of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

Collaborative Learning in Ecology

Collaborative learning occurs when groups of students with different intellectual abilities engage in a variety of learning activities in order to enhance the understanding of a particular concept or topic Van Boxtel,2000) . In order words, it can also be seen as one in which the goals of each individual are linked together with that of the others so that there is a positive correlation in the attainment of these goals. Hence an individual student obtains or seeks an outcome that is beneficial to every member of the group. Gillies and Boyle (2006) Each member of the group engages in an activity not only for the purpose of learning but also

encouraging each other in learning. Here students work together until they have successfully completed their group work.

In collaborative learning, all the members of the group seek mutual benefit so that every member gains from each other's support. They worked and discuss the solution to their problems through explanation, listening and encouraging each other by providing academic help.

According to Lawson (2007).There are certain attributes of collaborative learning, which include:

- **Group Heterogeneity**

The size of each group is usually between 4 -6 students. Each group should be composed of both male and female students in mixed schools, different levels of academic ability, race, social status etc.

- **Group Objectives**

Each members of a group is geared toward achieving certain objectives. To this effect, every member of the group works very hard in order to achieve these objectives by supporting each others learning.

- **Equal Opportunities for Success by Group Members**

Due to the heterogeneous nature of the group, every member of the group interacts positively among members. To this effect, every member of the group will be given equal opportunity to participate actively within the group.

- **Increasing Interpersonal Skills**

Interpersonal skills in group activities are enhanced by use of cooperative learning. Such skills may be skills in leadership qualities, good oral communication, decision making

and skills in management of conflict which may arise among group members as a result of differences in opinion.

- **Promotes Interaction**

There is great positive interdependence among members of a group.

Students help each other to overcome problems by involving in peer tutoring, exchange of ideas or materials, challenging each other's views and opinions. All these help them to be highly motivated in the learning process.

Characteristics of a Collaborative Classroom

Bowen, (2000) claimed that collaborative classrooms have four general characteristics. The first two capture changing relationships between teachers and students. The third characterizes teachers' new approaches to instruction. The fourth addresses the composition of a collaborative classroom.

Shared Knowlegde among Teachers and Students

In traditional classrooms, the dominant metaphor for teaching is the teacher as information giver; knowledge flows only one way from teacher to students. In contrast, the metaphor for collaborative classrooms is shared knowledge. The teacher has vital knowledge about content, skills, and instruction, and still provides that information to students. However, collaborative teachers also value and build upon the knowledge, personal experiences, language, strategies, and culture that students bring to the learning situation.

ii) S**hared authority among Teachers and Students**

In collaborative classrooms, teachers share authority with students in very specific ways. In most traditional classrooms, the teacher is largely, if not exclusively, responsible for setting goals, designing learning tasks, assessing what is learned. Collaborative teachers

differ in that they invite students to set specific goals within the framework of what is being taught, provide options for activities and assignments that capture different student interests and goals, and encourage students to assess what they learn. Collaborative teachers encourage students' use of their own knowledge, ensure that students share their knowledge and their learning strategies, treat each other respectfully and focus on high levels of understanding. They help students listen to diverse opinions, support knowledge claims with evidence, engage in critical and creative thinking, and participate in open and meaningful dialogue.

iii) Teachers as Mediator

As knowledge and authority are shared among teachers and students, the role of the teacher increase singly emphasizes mediated learning. Successful mediation helps students connect new information to their experiences and to learn how to learn. Above all the teacher as a mediator adjusts the level of information and support so as to maximize the ability to take responsibility for learning.

iv) Heterogeneous Grouping of Students:

The perspectives, experiences, and background s of all students are important for enriching learning in the classroom. As leaning beyond the classroom increasingly requires understanding diverse perspectives, it is essential to provide students opportunities to do this in multiple contexts in schools. In collaborative classrooms where students are engaged in a thinking curriculum, everyone learns from everyone else, and no student is deprived of this opportunity for making contributions, and appreciating the contributions of others.

Thus, a critical characteristic of collaborative classrooms is that students are not segregated according to supposed ability, achievement, interests, or any other characteristic. Segregation seriously weakens collaboration and impoverishes the classroom by depriving all

students of opportunities to learn from and with each other. Students might label unsuccessful in a traditional classroom learn from "brighter" students, but, more importantly, the so-called brighter students have just as much to learn from their more average peers. Teachers beginning to teach collaboratively often express delight when they observe the insights revealed by their supposedly weaker students.

Thus, shared knowledge and authority, mediated learning, and heterogeneous groups of students are essential characteristics of collaborative classrooms. These characteristics, which are elaborated below, necessitate new roles for teachers and students that lead to interactions different from those in more traditional classrooms. Hence, this strategy will encourage students to interact with other students they learn to discuss, explain and see each others' perspectives. Therefore, this study intend to determine the impacts of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

2.4.7 Effect of Collaborative Learning on Academic Performance .

A number of instructional strategies have been successfully used to improve students' achievement in Biology. Gall (2005) affirmed that sensitive and controversial issues in biology could be most appropriately taught when collaborative group approach is utilized. Recent findings suggest that sixth-grade students who were in collaborative groups for their science class showed higher achievement levels and indicated higher levels of satisfaction than students in whole group conditions (Maheady, Harper & Sacca, 2002). More brilliant contributions to scientific knowledge take place whenever pupils talk together (Solomon, 1994); hence, the practice of group work for effective science teaching is an important feature of any science teaching strategy. The studies on collaborative learning techniques which have repeatedly shown increased academic performance include those of McClintock and

Shayer,(2003); Ingle and Shayer ,(2003), Lawson, Sharan, & Steinberg, (2007); Madden and Slavin, (2007); Slavin and Karweit, (2007); Sharan, Hertz-Lazarowitz , and Ackerman (2008); and Potthast, (2009).

Hudgins (1960) found that fifth grade students working in groups made higher scores on health science tests than students who worked individually. Jensen, Johnson and Johnson (2002), studied secondary pre-calculus classes and concluded "collaborative learning promotes achievement among science students" In undergraduate college statistics classes, groups using collaborative learning scored higher on tests (Gillies, 2002).Mcclintock and Shayer (2003) studied undergraduate college sociology students and found students participating in collaborative groups received higher than average grades on term papers than working individually. They also concluded that group's performance was often better than what could have been expected of the best student in the group. Sharan, Hertz-Lazarowitz , and Ackerman (2008) reported significantly higher gains in both normative and criterions measures of academic testing for students in collaborative learning groups In other studies, collaborative learning strategies were found to improve student performance (Peterson and Miller,2004) and cognitive achievement (Okebukola 2002) in biology classes. Augustine, Gruber, and Hanson (2006) reported higher achievement resulting from collaborative groups learning. Other studies also reported that students in collaborative groups were able to master and retain information better than students in individual or competitive situations (Humphreys, Johnson &Johnson, 2003). Duren and Cherrington (2000) observed significant improvements in long term retention of problem solving strategies of students participating in collaborative learning groups. They reported biology students in collaborative groups were more willing to tackle a problem longer, made qualitative strategies and corrective feedback and attempted to use learned strategies 7% more often than independent practice classes. Johnson, Johnson, andZaindman (2000) observed that the effects of collaboration would

increase the more students worked together, encouraged and tutored each other and rehearsed materials being learned. Peterson and Miller (2004) came to a similar conclusion but felt it might take some time for the benefits of collaborative learning to become apparent. They reported that although there were increasing group differences on the second chapter test administered after four weeks, the groups did not significantly differ until the scores on the third chapter test were compared, 6 weeks after the cooperative learning technique was initiated. Studies have also shown that cooperative techniques are more effective with higher levels of learning on Bloom's taxonomy. These include Sharan et al.(2008) Johnson, Meruyama, Johnson, Nelson and Skon (2002); Good,et al (2004); and Mervarech, (2006). Sharan et al (2008) found that the fundamental goals of collaborative learning are to promote processes of learning which are intellectually more complex and richer than the presentation recitation model. Their study showed little of Bloom's taxonomy. However, the small groups were able to build more high level concepts on the basis of low level information than were peers in the classrooms. Mevarech (2006) showed more pronounced differences in performance at higher cognitive levels while Peterson and Miller (2004) found that collaborative learning was more effective at enhancing the high achieving students.

Augustine et al (2006) reported heterogeneous groups generally improved performance for both low achieving and high achieving students and groups promoted critical thinking, although the reasons for improved cognitive abilities resulting from collaborative learning are not totally understood. Webb, (2002), as cited in Hooper, (1992), proposed that individuals received more attention from group members than a teacher can provide and a process of generating explanations required deeper processing of information. Properly structured collaborative learning activities are associated with positive educational outcomes (Jacobs & Ball, 1996). Okebukola (1988) found that collaborative learning technique featuring intra group collaboration with inter group competition is a very effective way of

improving students' achievement in science in large class situations. Other researches include that of Gillies (2006). He carried out a study with 60 high school students who learned ecology compared with two instructional modes; Group Investigation (GI) versus individualistic learning. He found that both methods were effective in learning an investigative approach. He concluded that in order for students learning in the GI method to achieve significantly higher scores, teachers involved in such instruction should be trained more in-depth in this mode of instruction. In Nigeria, Okebukola (2002) also found that rural school students preferred collaborative learning and that urban school students preferred competitive learning. Okebukola's explanations were that the eco-cultural factor and the environmental influence affect student's preferences for collaborative learning settings.

In another study, Okebukola and Jegede (2002) used a sample of high schoolStudent's studying biology, chemistry, physics, mathematics and English. Students learned topics related to the photosynthesis process using the concept collaborative strategy. Group learning was compared by students cognitive preferences and learning modes. The collaborative group students who preferred Principles, Questions, and Recall achieve significantly higher results compared to the individualistic group. In Applications, there were no differences between the two groups. Thus, students cognitive significantly influence the meaningful learning through collaborative mode of learning. Similarly,Alebiosu (2008) investigated the effects of two collaborative learning models (Student Team Achievement Division-STAD and Jigsaw II) on senior secondary school students' cognitive achievement, attitude towards chemistry and achievement in practical skill in chemistry. The researcher used 252 students in intact classes from nine secondary schools randomly selected to the treatments and control groups. Data collected both before and after treatment were analysed. The result showed among others that the treatment group performed significantly better in cognitive achievement, attitude and in practical skill. Adesoji & Ibrahim (2009) studied the effects of Student Team Achievement

Division strategies (STAD) and mathematics knowledge on learning outcome in chemical kinetics. The results show that STAD collaborative learning strategy had the potential to improve students' learning outcome in secondary school chemistry. This finding provided empirical support to earlier findings of Fuyun-yu, (1998), Popoola (2002), and Omosehin (2004) established that collaborative learning strategy promoted better achievement and productivity than the conventional lecture method.

The main objective of this study was to study the effectiveness of collaborativestrategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

2.5 Concept of Reasoning Ability

Observations of many children and adolescents attempting to perform similar tasks have led Jean Piaget and other developmental psychologists to formulate theories concerning the mental process individuals use to deal with problem situations. They called this mental process "reasoning pattern" Piaget (1964) created the concept of stages of intellectual development in relation to reasoning pattern an individual employed in solving problems. According to him, four major stages characterize human intellectual development. He observes that all persons progresses through the four stages in the same order, though not necessarily at the same rate. The stages are sensory-motor, pre-operational, concrete operational and formal operational. The first two stages are usually completed before a child is seven or eight years old. Thus, only the last two stages applicable to secondary school and are operating in either of the two stages. The reasoning patterns of the two stages are discussed below:

a) Concrete Operational Stage

According to Piaget (1964) in concrete operational stage, a person use concrete reasoning patterns in tackling problems. The reasoning patterns are applied to concrete objects directly observing properties and simple relationship. He categorized the concrete reasoning patterns as follows:

Class Inclusion- Classifying and generalizing based on observable properties (e.g., distinguishing consistently between acids and bases according to the colour of litmus paper; recognizing that all dogs are animals but that not all animals are dogs).

Conservation- realizing that a quantity remains the same if nothing is added or taken away, though it may appear different (.e.g when all the water in a beaker is poured into an empty graduated cylinder, the amount originally in the beaker is equal to the amount finally in the cylinder).

Serial ordering- arranging a set of objects according to an observable property and possibly establishing a one-to-one correspondence between two observable sets (e.g., small animals have a fast heart beat while large animals have a slow heart beat).

Reversibility- mentally inverting a sequence of steps to return from the final condition of certain procedure to its initial condition;(after being shown the way to walk from home to school, finding the way home without assistance).

According to Piaget (1970) a persons operating at concrete stage needs reference to familiar actions, objects and directly observable properties as well as step-by –step interaction with concrete objects in a lengthy procedure before he or she can understand the meaning of concepts and phenomenon.

b). Formal Operational Stage

According to Piaget (1964) a formal reasoner uses formal reasoning abilities in tackling problems. When applying formal thought, an individual reasons without referring to concrete objects or directly observable properties. He or she uses logical

mathematical relationships rather than relying primarily on familiarity and experiences. He categorized the formal reasoning patterns as follows:

Theoretical Reasoning-

applying multiple classification, conservation logic, serial ordering and other reasoning patterns to relationships and properties that are not directly observable.

Combinatorial Reasoning- considering all conceivable combinations of tangible or abstract items.

Functionality and proportional Reasoning-Stating and interpreting functional relationships in mathematical forms.

Control of variables-Recognizing the necessity of an experimental design that controls all variables but one being investigated.

Probability-This is the ratio that is expressing the chances that a certain event will occur. The concept of probability can only be comprehended when subjects understand what sort of events are probable (chance occurrences) and those that are necessary. According to Piaget (1958), those that have attained the concepts are to divide events in the world into two broad categories:

a) Things that must absolutely happen because they are governed by natural laws.
b) Things that should only happen because they are not governed by any natural laws.

-interpreting observations, show unpredictable variability and recognizing relationships among variables in spite of random fluctuations that mark them.

Correlation-This expresses a mutual relationship or connection in which one thing depends on another.

Formal and Concrete Reasoning Ability in Science Education.

Formal reasoning involves carrying out operations using symbols, abstract ideas from the mind. It also involves the use of inter-propositional operations and the exploration of all possibilities by subjecting the problem variables to a combinatorial analysis. According to Gage and Berlinger (2000), subjects at this stage can consider logical possibilities for a given problem. This capability is not mere imagination but entails systematic explanation, of logical alternatives. Webb (2002) further stressed that subjects can make accurate comparison and deduction from information not concretely presented by thinking on his own. They can draw conclusion, offer interpretations and develop hypothesis.

The stage of concrete operations is observed in children of approximately the age of seven to eleven. Children in this stage can think much more systematically and quantitatively. The child's reasoning processes become logical and they acquire operations or "system of internal mental actions that underlie logical thinking "The children can now conserve and classify, they no longer bound by egocentrism or perceptual centration and can follow the successive movements of a transformation. The concrete operational child can conserve in all forms, number, area and liquid.

In central role of cognitive development and its relationship to other areas of life span development have captured and held the interest of researchers and educators particularly over the last decade (Karplus, 2000). The growing concern for adapting curricular contents, achievement goals, instructional methods, and evaluation strategies, to students level of cognitive development has led to great usage of research in the field of the influence of Piagetian concepts of concrete and formal operational thought upon science education (Lawson and Renner, 1978; Shayer, 2003).

Investigators have shown that full comprehension of some science concepts by students requires what Piaget defines as formal reasoning (Ingle and Shayer,2003). For example, Herron (1975) suggests that certain chemical concepts are "formal" because they require formal reasoning patterns to understand whereas other concepts are "concrete" because they require concrete reasoning to comprehend.

According to Gillies (2002), to increase comprehension of science, we must either assist students in their development of reasoning or we must learn to teach so that ideas of science are understood by students who remain at concrete operational level. Other researchers pointed out that certain concepts no matter how they are taught cannot be comprehended by students at the concrete operational level. Goodstein and Howe (2008) after use of "hands-on" method to teach students some chemistry concepts, reported that concrete level students cannot learn concepts which require advanced formal reasoning, no matter how the concepts are taught.

Formal reasoning is also known to affect the application of scientific concepts in novel situations. Staver and Halsted (1985) reported that formal reasoning enhanced the application of concepts. This is expected, as students can only apply concepts when they have fully comprehended them. The ability to solve problems in science is also dependent on intellectual development Jensen and Johnson Sherwood (2002) pointed out that two factors appear to be related to student's problem solving ability are proportional reasoning ability and mathematics anxiety. Proportional reasoning ability is one of the schemas that comprise the concrete and formal operational stage which has been shown to be related to students' success in chemistry, particularly their problem solving ability was dependent on students' proportional reasoning ability. Lawson, et al (2001) observed that understanding of proportional relationship as being embedded in numerous physical and biological concepts.

Combinatorial reasoning is required for comprehension of Mendelian genetics, while correlations represent the corner stone of much of the descriptive investigative work of biologists and psychologists. In short formal operational schemas not only play a role in students understanding of important science content but also play a major part in the problem of scientific investigation.

The understanding of explanation concerning natural phenomena does not require formal and concrete reasoning. Jensen and Johnson (2002) pointed out that causal explanations exhibit formal operational reasoning ability in that they consist of implication statements chained together through transitive reasoning. Individuals who do not reason formally will have difficulty organizing explanations into memory in such a way that they can be reconstructed effectively. According to Inhelder and Piaget (1958), concrete operational subjects can deal with preposition and have an awareness of implications when reasoning tests upon direct observation and not upon assumption. Brass and Maddux (1982) suggested that the teaching of explanation should not be suspended until students demonstrate formal reasoning capacities. He stressed that concrete operational learners can likely follow step up by step logic of an explanation when the external structure are supplied, but they probably will not integrate the various steps into a "structural whole" that enables the explanation to be restructured on demand.

It has also been hypothesized that student's performance in science is a function of repertoire of information schemata. Lawson (2000) however, argues, that the effect of cognitive development on achievement depends upon what students are supposed to achieve. He emphasized that if the students is supposed to learn discipline specific facts and concepts, then the best predictor of his/her ability to do so should be number of discipline specific facts and concepts the students has already acquired. However, if the student is ask to think

beyond specific facts or concept and perform certain operational transformations on them, then his or her repertoire of information schemata as reflected by Piagetian development level should be a predictor of performance. Other studies have shown that even the acquisition of discipline concepts depends on the cognitive stage of the learner. For example, Herron (1975) outlined the capacities and limits of students who use concrete reasoning pattern. Therefore, this study seek to determine impact of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

2.6 Gender and Academic Performance in Ecology.

Many research works carried on gender effects on academic performance have described the proportionately low achievement of females in science education programmes and careers (Ogunsola-Bandele, 2000a). This gave the male a greater dominance than their female counterparts. Under representation of women science has led many feminist scholars to postulate that science as practiced today is 'gendered and use to the benefit of the 'the male world'.

In Nigeria, reports from a study requesting female and male adolescents to indicate their choice of subjects revealed that the adolescents selected different courses that followed gender stereotype. Males prefer mathematics and sciences while females opted for reading (Ogunsola-Bandele, 2000; Akanbi, 2004). Similarly, most girls have their fond under estimate their own academic ability and believe boys to be superior and intelligent than them and therefore more capable of handling different subject like mathematics.

The studies cited above dealt mainly with performance but the impact of collaborative strategy on both sexes was neglected, hence the focus of this study. Moreover, the implication of sex in the above studies necessitated the use of sex as a factor in this study. The present study, therefore, intends to examine the impact of collaborative strategy on

retention and performance in ecology and gender among other variables at SS II level in Zaria.

2.7 Effects of Teaching Strategies on Retention in Biology.

Retention is the ability to store information and consequently remember things experienced or learned by an individual later (Bichi, 2002). Retention of concepts is an essential factor in determining students' performance in a given task or activities carried out. Students must retain information from classes in order to benefit from the learning. The instructors' jobs are not finished until they have assisted the learner in retaining the information. In order for participants to retain the information taught, they must see a meaning or purpose for that information. They must also understand and be able to interpret and apply the information. This understanding includes their ability to assign the correct degree of importance to the materials. The amount of retention is directly affected by the degree for original learning. As the degree of original learning is greatly affected by the instructional method, therefore retention largely is affected by the instructional method. Simply stated, if the participants did not learn the material well initially, they will not retain it well either. When teaching is characterized by rote learning meaningless memorizing and emphasis on verbalism, students make ineffective learning, and the facts thus learned are not long retained, nor do they seem to have much effect in changing behaviour. Thus, when teaching is organized in such a way that students can apply principles, solve problems and interpret experimental data, learning becomes effective and the facts thus learned are long retained with the passage of time. Suleiman (2007) reported that better retention and recall of what is learned is achieved as more senses are involved, more so, as students see and do things by themselves. Retention by the participants is directly affected by their amount of practice during the learning. Instructors should emphasize retention and application. Reese

(2009) in his study found that when students were provided with the learning outcome, they retained and recalled the knowledge. Yabo (2012) investigated the retention ability to two groups of students. The experimental group was taught biological concepts using the analogical linkage strategy while the control group was taught same concepts using the lecture teaching method. The results showed that the experimental group performed significantly better and retained more of the biology concepts taught than their counterparts in the control group retain. Similarly, Anaso (2008) also found that the use of small class sizes in teaching chemistry concepts helps students of different abilities retain learnt concepts better than the medium and large classes.

The concern of this study was to find out the impact of collaborative learning strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students. The results might be able to help overcome their learning difficulties and thereby improve their performance leading to better retention of the concepts learnt.

2.8 Overview of Similar Studies

Studies related to the present research were conducted in different parts of this country as well as in other countries. Studies in collaborative learning in Africa include that of Keraro, Wachanga and Orora (2007) from Kenya. They investigated the effects of using the collaborative concept mapping teaching approach on secondary school students' motivation in biology. A non-equivalent control group design under the quasi-experimental research was used in which a random sample offour coeducational secondary schools was used. The four schools were randomly assigned to four groups. Each school provided one Form two class. The study sample comprised of 156-second grade students in all the secondary school cycle in Gucha District, Kenya. Students in all the groups were taught the same biology content but two groups, the experimental groups, were taught using the

cooperative concept mapping approach while the other two, the control groups, were taught using regular teaching methods. Both the experimental and the control groups were pre-tested prior to the implementation of the collaborative concept mapping intervention. After four weeks, all four groups were post-tested using the student's motivation questionnaire (SMQ). Data were analyzed using the t-test, ANOVA and ANCOVA. The results show that students exposed to the collaborative concept mapping approach had significant higher motivation than those taught through regular methods. The results further indicated that there was no statistically significant gender difference in motivation towards the learning biology among secondary school students exposed to cooperative control mapping. The researchers conclude that collaborative control mapping is an effective teaching approach, which biology teachers need to incorporate in their teaching.

Also study conducted by Olarewaju (2012) determines effects of cooperative learning strategy with models on academic achievement and retention of some osmosis concepts among pre-ND students in Kaduna state. A randomly selected sample of 100 students from four Federal Monotechnical Colleges in Kaduna state. The subjects were divided into four groups; experimental groups and one control group. A pre-test was administered to the subjects. Quasi experimental control design was adopted, the instrument used for data collection is Biology Achievement Test (BAT) which has reliability of (r) 0.89. Six research questions were raised while six null hypotheses were formulated and tested using t-test statistics at $P \leq 0.05$ level of significant The findings in the study include a significance difference in achievement of biology concept between the experimental groups and the control group in favour of the experimental groups., there was a significant retention of biology concepts between the experimental groups and the control groups in favour of the experimental groups.

Lee (2008) investigated effect of collaboration and inquiry on reasoning and achievement in biology among homogeneous and heterogeneous groupsusing 10^{th}grade class students. Students were grouped into experimental (exposed to STAD, N-28) and control (exposed to lecture method N-28). t-test and (2x2) factorial analysis of variance statistics at 0.05 level of significance were used. The study found out that the experimental group achieve significantly than the control group with insignificant difference in the aspect of retention between the two groups. It was also discovered that there was no significant difference in achievement between high achievers in both groups but the opposite was the case between low achievers from both groups.

Research work by Yabo (2012) on collaborative instruction determine the effects of collaborative team teaching model on student's academic performance of different ability levels in evolution concept in Sheu Shagari college of education Sokoto Nigeria. A total of 182 NCE11 students from biology department formed the population of the study, 80 students were sampled. This study tested two hypotheses and the data was analysed using ANOVA (F-test F,3.16 exceed P value of 2.76 andF,102.8 which exceed P, value of 2.67)at 0.05alpha level of significant, the extended Scheffe's test result obtained revealed that team teaching using collaborative instruction can improve academic achievement.

Ibrahim and Omar (2006) investigated effects of cooperative learning approach on conceptual change conditions over lecture method on 10^{th} grade students' conceptual understanding and achievement of computational problems related to chemical equilibrium concepts. The subjects of her study consisted of 8 tenth grade students from two intact classes of a Chemical Course instructed by the same teacher. One of the class was assigned as the experimental group, which was instructed with collaborative learning approach based on conceptual change conditions and the other class was assigned as the control group, which

was taught using lecture method. Chemical Equilibrium Concept Test (CECT) was administered to the experimental and the control groups as pre and post tests to measure the students' conceptual understanding, and Chemical Equilibrium Achievement Test (CEAT) was administered to the experimental and the control groups as a post-test to measure the students' achievements related to computational problems. Science Process Skills Test was used at the beginning of the study to determine the students' science process skills. Multivariane Analysis of Covariance (MANCOVA) was used to analysed the data. The result showed that students in the experimental group had better conceptual understanding, and achievement of computational problems related to the chemical equilibrium concepts. Furthermore, students' science process skills were accounted for a significant portion of variations in conceptual understanding and achievements related to the computational problems.

Therefore, the purpose of this study was to determine impact of collaborative strategy on retention and performance in ecology concepts amongconcrete and formal reasoning students.

2.9 Implications of Literature Reviewed on Present Study

The single best supported finding in the research literature is that the use of collaborative instruction as a supplement to traditional, teacher directed instruction produces achievement effects superior to those obtained with traditional instruction. Collaborative strategy among others facilitates students' academic achievement; It is found to be helpful in students' retention.Among the research work carried outon the use of collaborative learning strategy fromliterature reviewed are: Wachanga *et al*(2007) investigated the effects of using collaborative concept mapping teaching approach on student's in biology. Yabo,(2012) also work on collaborative team teaching model on student's academic achievement of different

ability levels in biology. However, the problem still persisted which may be due to difficulty. Different methods were used over the years, but what is gaining acceptance now is collaborative learning strategy other studies are conducted using different concept from literature reviewed no researcher has combined collaborative learning among concrete and and formal reasoning ability. However, this seeks to determine impact of collaborative strategies which could enhance the achievement and retention of ecology concepts among formal and concrete reasoners in ecology. All the available researches were done at the secondary and tertiary institution. Therefore, the present study is poised to determine impacts of collaborative learning strategy on retention and performance in ecology concepts amongconcrete and formal reasoning students.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The focus of this chapter is on the methodology employed in carrying out the study. The chapter is presented in the following subheadings:

2 Introduction

3 Research Design

4 The Population of the Study

5 Samples and Sampling Procedure

6 Instrumentation

7 Data Collection Procedures

8 Procedure for Data Analysis

3.2 Research Design

The study is quasi-experimental-control group design employing pretest, pottest and post-posttest was used for the study. The reason for using quasi experimental study was that intact class was used. All the students despite their ability levels were used as sample for the study, therefore, no randomization of the sample was done. Two groups of students were used for data collection; the experimental (EG) and the control groups (CG). A pretest was administered to the two groups in order to determine the equivalence in ability of the two groups. Moreover, the students in each of the groups were classified according as concrete and formaloperational reasoners using Group Assessment of Logical Thinking (GALT). In this design, the experimental group wastaught Basic ecological concept using Collaborative Strategy. The control group was taught using Lecture Method (LM). At the end of the six

weeks treatment period, a posttest was administered to both groups of students to evaluate the effectiveness of the treatment in enhancing students' academic performance in Biology. The post-posttest was administeredtwo weeks after the posttest to test for the student's retention ability. The research design is presented in Figure 3.1

$$\mathbf{EG} \text{ ----------} \rightarrow \mathbf{O_1}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix} \text{----------} \rightarrow \mathbf{X1}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix} \text{----------} \rightarrow \mathbf{O_2}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix} \text{----------} \rightarrow \mathbf{O_3}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix}$$

$$\mathbf{CG} \text{ ----------} \rightarrow \mathbf{O_1}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix} \text{----------} \rightarrow \mathbf{XO}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix} \text{----------} \rightarrow \mathbf{O_2}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix} \text{----------} \rightarrow \mathbf{O_3}\begin{Bmatrix}\text{FO}\\ \text{CO}\end{Bmatrix}$$

Figure3. 1 Research Design

Key

where:

EG = Experimental Group

CG = Control Group

O_1 = Pre-Test

O_2 = Post- test

$O_{3=}$ Post- post-test

X1 = Treatment using Collaborative Instructional Strategy

X0 = Lecture Method for control group

CO= Concrete Operational

FO= Formal Operational

3.3 Population of the Study

The population of the study is made up of all the Senior Secondary II student in ZariaMetropolis, whichhas a total of twenty senior secondary schools. The students in these schools which were considered as the population for this study comprise SS2 seniorsecondary

school. The suitability of SS2 students for this study is due to the fact that they have earlier been exposed to study of Biology for at least one year.

Table 3.1: Population of the Study

S/No	Name of School	School type	Gender		SS II Enrollement
			Male	female	
1	Barewa College Zaria	Public	40	-	40
2	GSS Tudun Jikun	-	75	85	160
3	G SS Zaria	-	46	54	100
4	GSS Magajiya	-	30	38	68
5	G GSS Dogon Bauchi	-	-	60	60
6	GGSS Zaria	-	-	48	48
7	G S S mada	-	40	30	70
8	S.I.A.S.S Karaurau	-	04	02	06
9	G SS Kofar Gayan	-	-	100	100
10	G GSS Pada	-	-	80	80
11	GSS Kaura	-	70	60	170
12	G SS Chindit	-	92	-	92
13	G S S Dakace	-	30	36	56
14	G SS T/ Saibu	-	29	20	49
15	G S S Kugu	-	04	06	10
16	G SS Muchia	-	30	30	60
17	G S S Likoro	-	20	15	35
18	AludahudaCollege Zaria	-	120	-	120
19	G S S Kuyanbana	-	25	30	55
20	G S S Rimim	-	30	30	60
	Total				1,642

Source: Zaria Zonal Education Office (2015)

3.4 Sample and Sampling Procedure

In selecting the sample used for the study, the names of the twenty schools in the metropolis were written on a pieces of papers and two pieces of papers were picked once at a time. The content were reshuffled each time a piece of paper was picked to ensure equal chance off picking each of the piece of paper. The two schools whose names were coded on the pieces of paper picked were used as sample schools. Barewa colledge and Government Day Senior Secondary School Dogon Bauchi were randomly selected. Before pre-test the students were classified as Concrete and formal reasoners using Group Assesment of Logical Thinking (GALT). The two schools were pre-tested using Ecology Performance Test (EPT).The experimental group has a total population of 30 students comprising of females while the control group had a total of 30 males. Hence the total number of subjects in the two schools was 60 subjects. This is in accordance with central limit theorem Tuckman (1975); Frankel & Wallen, (2000), Gay, Mills and Airasian (2009) who proposed30 as minimum sample size for an experimental study. However, the performance of the subjectsin the two schools in theGALT was used in classifyingsubjectsaccording to concrete and formal reasoners for both the experimental and control group.Students who score 0-4 are termed as concrete operational students while those who score 5-10 were termed as formal operational students as advocated by Mari, (2001).Out of the 30 students in the experimental group concrete operational were =13, formal operational were 17,for the control group concrete were 17and formal were13 totalling 30students. Details of the sample selected are presented in Table 3.21

Table 3.2: Samples for the Study

S/No	Name of School	Group Gender M/F		Concrete ability	Formal ability	Total
1	GGDSS D/Bauchi	**Exp**	**30**	**13**	**17**	**30**
2	Barewa Colledge	**Cont**	**30**	**17**	**13**	**30**
	Total			**30**	**30**	**60**

The sample size used for this study was 60.This sample size is sufficient enough for the study as it conforms with central limit theory that recommend minimum of thirty studentsTuckman (1975); Fraenkel & wallen, (2000).

3.5 Selected Ecology Concepts

Four Ecology topics were chosen for this study. The selected topics had not been taught to the study groups. The four topics chosen to be taught are from Biology textbooks used in secondary schools (i.e. Modern Biology and STAN Biology). The selected topics are basic ecological concepts, major biomes of the world, population studies and Ecology factors. Ecology is an aspect of biology syllabus that senior secondary students at SS II must study. It is considered as abstract in nature and difficult to understand which has resulted in poor performance among students. (Danmole & Femi-Adeoye,2004).

3.6 Instrumentation

Two instrument were used in this study to collect data.

Ecology Performance Test (EPT)

Group Assessment of Logical Thinking (GALTI)

3.6.1 Ecology Performance Test (EPT)

Ecology Performance Test (EPT) is a forty (40) items objective test involving multiple choice (a,b,c and d) developed by the researcher. The EPT was developed based on the following topics that were identified to be difficult to students. The topics are Basic concepts, Major biomes of the world,Population studies and Ecological factors. The items are presented in Table 3.3. The item were further prepared based on Bloom Taxonomy of Cognitive Domain to ensure the test items cover the different cognitive levels of the students adapted from Blooms Taxonomy (1957) and represented in the Table 3.3

Table 3:3 Table of Specification

	Weight	Knowledge	Comprehension	Application	Analysis	Syntheses	Evaluation	Total
Content	**%**	**40%**	**17.5%**	**15%**	**0%**	**15%**	**12.5%**	**100**
-Basic concept	37.5	4	3	3	-	3	2	15
-Major Biomes of the world	22.5	4	2	1	-	1	1	9
Population Studies	20	4	1	1	-	1	1	8
Ecological Factor	20	4	1	1	-	1	1	8
Total	**100%**	**16**	**7**	**6**	**-**	**6**	**5**	**40**

Source: - Researcher

3.6.2 Group Assessment of Logical Thinking (GALT)

This instrument was used to measure the reasoning ability of the experimental and control study subjects. It was adapted from (Mari 2002). The instrument consists of 12 questions testing six reasoning abilities namely;

a) conservation
b) proportional reasoning
c) controlling variables
d) probabilistic reasoning
e) correlational reasoning
f) combinational reasoning.

Items 1 and 2 deals with conservational ability, 3 and 4 test proportional reasoning, 5and 6 test controlling variables, 7 and 8 test probabilistic reasoning 9 and 10 test correlational reasoning and lastly 11 and 12 test combinational ability. Example of some tasks used to test some specific schemata described as formal reasoning ability are given.

a) Conservation tasks

   A picture of two balls of clay placed on a balance pan was given subjects were required to infer with suitable reason, if the weight of the two balls will remain the same when one of them is flattened.

b) Proportional tasks

   Subjects were provided with a picture of a small glass, a small jar and a large jar. They were asked that, if it takes 15 small glasses of water or nine large glasses of water to fill the large jar and 10 small glasses of water to fill the small jar. How many large glasses of water does it takes to fill the same small jar? They were also required to provide reason(s) for their answers.

c) Correlational tasks

   A picture of 16 fat mice with black tails, 6 fat mice with white tail and 6 thin mice with white tails and two thin mice with black tails was printed on the test booklet. Subjects were told that these mice represented a sample of mice captured by farmer from a part of his field. They were asked whether they there was a relationship between the size of the mice and the colour of their tails.

   In question 1-10, subjects were required to give reasons for their responses. This is to avoid guess work and to ensure that subjects make judgment based on reasons. Every item was followed with three alternative answers and four reasons for the subjects to choose the most suitable answer and reason. As these reasons could only be abstracted, subjects who make right responses with suitable reasons

might have acquired formal reasoning .For items 11 and 12, questions were posed and subjects were required to give possible combination

3.6.3 Scoring of test

Group Assessment of Logical Thinking (GALT) was scored adapting the mode of scoring by Mari (2002) in which a correct responses andreasons are tied to score. When there is a correct response with wrong reasonor vice versa, the item was not scored. However; Item 11 and 12 were scored differently. For item 11, marks were given to responses which show a pattern and not more than two errors or omissions. This is because the numbers of arrangements required to produce a pattern are more in question 12. Students who score 0-4 were termed as concrete operational students while those who score 5-10 were termed as formal operational students.The mode was adapted based on the observation by Mari, (2002). A correct response and reason earns one mark, correct pattern with one error or two errors earns a mark for question 11 and 12 respectively. A respondent can score a maximum of 12 marks and minimum of zero mark for a test.

3.7 Validation of the Instruments (EPT and GALT)

The content validation of the Ecology Performance Test (EPT and GALT) was carried out by a panel of experts comprising the following: Two senior lecturers from Biology department Ahmadu Bello University Zaria and two senior lecturers from science education of the department of education Ahmadu Bello University Zaria. One Biology teachers at the secondary school level and a specialist in Educational Statistics

These experts among other things, critically assessed EPT and GALTwith respect to these criteria:

a. the appropriateness of the items;

b. whether or not the statements in the tests were clear, readable, hard or too simple for SS11students;

c. whether or not the test items are related to ecology concepts of the senior secondary school syllabus;

Their suggestions were taken into consideration in the final formulation of the test instruments before administration.

3.7.1 **Pilot Testing**

In order to refine test – items of the two instruments, Ecology Performance Test (EPT) and Group Assessment for Logical Thinking (GALT) for the study, a pilot test was carried out in two senior secondary schools, namely, Government Day Girls Secondary School Commercial (GDGSS) and Government Secondary School Chindit (GSS) in Zaria, Kaduna State. The two schools were randomly sampled, the pilot testing was conducted with a group of 50 students from the two schools. These schools are within the target population for the study, but did not form part of the final study.

The researcher administered the instruments which lasted for one and a half hours personally. Instructions on how to answer the questions was read and explained to the students by the researcher. This was done to ensure that the students answered the items (EPT) carefully, problems and difficulties arising from the pilot study were carefully noted in order to improve upon the final instruments. Test-retest method was employed in the study.

The reasons and benefits of the pilot testing include:

i) to identify problems or difficulties that might arise before the final administration of the instruments to the study samples;

ii) to determine the appropriateness of the instruments;

iii) to determine the difficulty and discrimination features of the items;

iv) to determine the reliability of the instrument.

v) To determine the item characteristics

On the basis of the results obtained from the pilot testing, necessary amendments were made to the instruments.

3.7.2 Reliability of EPT

In order to ascertain the level to which EPT and GALT were reliableTest-retest method was used to statistically estimate the internal consistency of the items in the instrument.Tuckman (1975), who proposed the minimum interval of two or more weeks between the first and second administration, recommended the use of two weeks interval. Data thus collected from the pilot study were subjected to correlation using the Pearson Product Moment Correlation Coefficient statistic. The results of EPT showed a reliability coefficient of 0.85 and reliability of GALT was 0.65 respectively, which was considered reasonably reliable for this study.

3.8 Items Characteristics of the Instrument

For the purpose of standardization of the instrument (EPT) facility index and discrimination index will be determined as follows:

3.8.1 Facility Index (F.I)

Facility index of an item indicates the percentage of candidates that got an item right. The following are the rightful steps in computing the facility index for each items in the test, viz:

i. Rank the scores on the test from highest to lowest.
ii. Identify the high scoring group and the low scoring group.
iii. Identify one third of the top scoring group and the third of the bottom scoring group
iv. Determine the percentage of high scores and low scores of each item

Compute the item facility index by adding the percentage of those correct in low scoring and high scoring and then divide by the number of students involved in the analysis.

The formula is $F.I = \frac{U + L}{N}$

F.I = Facility index

N = Number of students involved in the analysis.

U = Number of students who passed the item in the upper percent.

L = Number of students who passed the item in the lower percent.

Facility index of 75% or higher is regarded as easy in terms of facility level, whereas an index of 25% or less is regarded as hard in terms of facility level. For this study Ecology Performance Test (EPT) with facility index which range from 0.30 to 0.70 was used in line with James (2000) and Usman (2008).

3.8.2 Discrimination Index (D.I)

The discrimination index of a test is a measure of its ability to discriminate between high and low achievers as a whole. This is used to identify high and low achieving students. The difficulty index of test items is its ability to separate or sort out high and low ranking students in a test. The calculation was done using sores of the top twenty seven percent (27%) and bottom twenty seven per cent (27%) of the total respondents. This was calculated using the formula given by (Furst date in Olorukooba,2001).

$$D_1 = \frac{R_U - R_i}{\frac{1}{2} N}$$

Where D = discrimination index

R_U = Number among upper 27% of respondents

R_i = Number among lower 27% of respondents

N= Total number of respondents.

Items showing little or no difficulty or items that show a percentage of success in favour of the poor group should either be eliminated or re-examined for vagueness and ambiguity and such should be re-worded.

Discrimination index for each item was calculated by subtracting the number of students in the lower group who answered the item correctly from the number of students in the upper group who got the item correctly. The figure is divided by half number of students in both groups by the number of students in one of the groups.

The discrimination index which ranges between 0.30 and 0.70 based on Furst in Olorukooba, 2001, was regarded as moderately positive and was accepted for the present study. This was used in selecting the final items of the test EPT. see Appendix C

3.9 Administration ofTreatment

Collaborative Strategy was used in treating the experimental group(Jigsaw class setting). The topics were shared into segments, the students were divided into group of 6 persons. A total of 30 students were taught using jigsaw collaborative strategy with a total of 5groups.The study was conducted during a normal class periods the remaining students were left for their class teacher to handle. Each group received a contact of lesson for a period of six (6) weeks, for collaborative instruction. The following specific steps were followedby teacher for lesson

1. Students were divided into 6-persons Jigsaw group. The groups were heterogeneous in terms of gender and reasoning ability.
2. One students from each group was appointed as a leader.
3. The day's lesson was then divided intosegments by the teacher corresponding to the number of the groups.

4. One segment of the lesson was assigned to each student in a group to learn and teacher ensures that students have direct access only to their own segment.
5. Each student was given time to study the segment assigned to him/her.
6. Temporary “expert group” Were formed. This was done by having one student from each jigsaw group join other students assigned to the same segment. Gave students in these expert group time to discuss the main points of their segment and to rehearse the presentations they will made to their jigsaw group
7. Bring students back to their jigsaw groups.
8. Each student who studied a particular topic was asked to present his/her segment to the rest of the members. Other group members were encouragedto discuss and contribute.
9. The teacher moved from group to group, observing the process.So that if any group hasproblem make an appropriate intervention.

This procedure was followed for all the remaining lessons. Treatment for the experimental group lasted for six weeks. Adapted the model illustrated in Figure 3.2

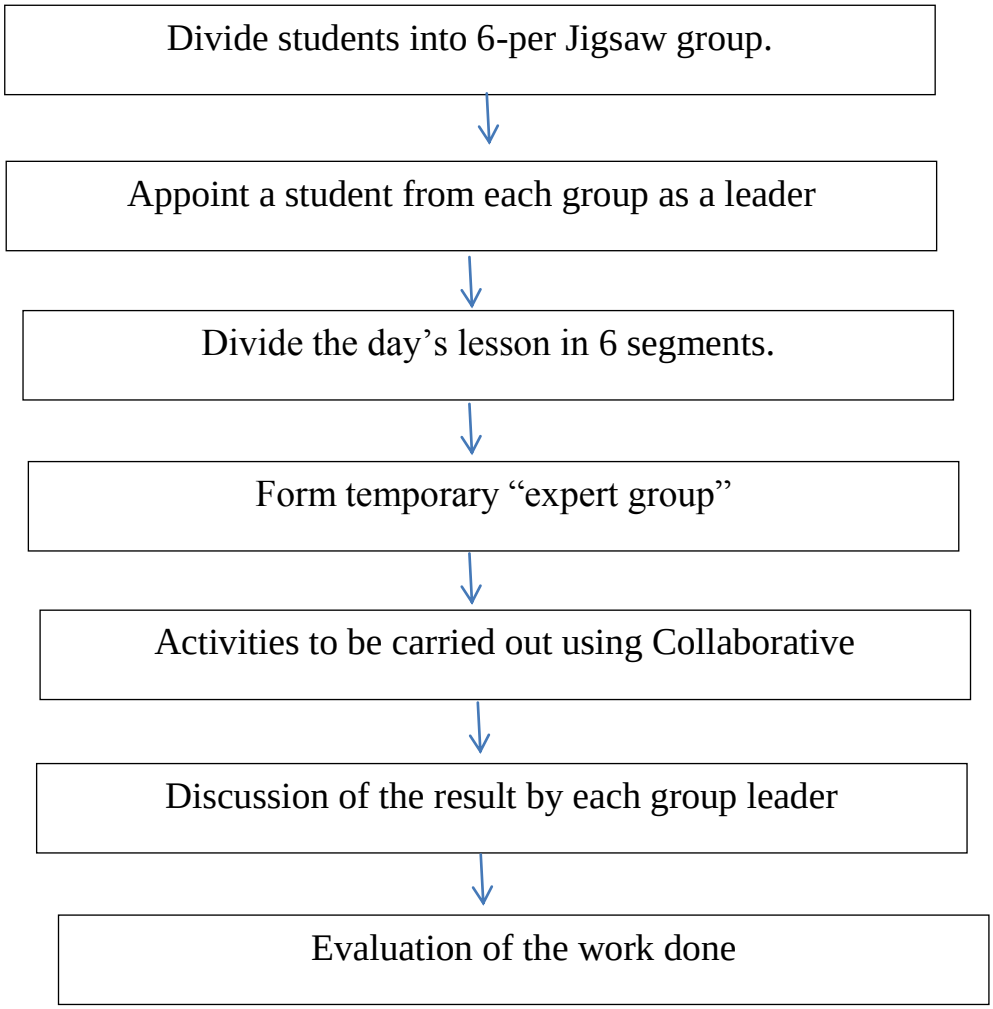


Fig 3.2 Flow Chat of Jigsaw Collaborative Strategy

Adapted from (Aronson 2002)

The detail of lesson plan is presented in AppendixE

CONTROL GROUP

The control groups were taught the same ecology concepts by the researcher using the traditional method of teaching. The notes of lesson prepared by the researcher and validated by panel of educationists were strictly adhere to in teaching the control group. Lessons were presented by teaching with important points written on the chalkboard. Notes were given to and taken by the subjects. Written assignment were given to the subjects after each lesson. The actual teaching lasted for six weeks. See detail of lesson plan in Appendix E.

3.10 Procedure for Data Collection

GALT was first administered to the students to classify them according as formal and concrete operational, for the experimental group. Students who score 0-4 were termed as concrete operational students while those who score 5-10 were termed as formal operational students which is as follows formal operational=17, concrete operational =13 totalling 30 students. The control sample (N=30) on the other hand consisted of 30 students. The groupings of students according into concrete and formal in the control group Students who score 0-4 were termed as concrete operational students while those who score 5-10 were termed as formal operational students as advocated by Mari, (2001).

EPT was administered to the respondents in the two schools and were latter retrieved and subjected to correlation using Moment Correlation Coefficient statistic.

3.11 Procedure for Data Analysis

The data collected for the purpose of answering research questions and testing null hypotheses were analysed as follows:

Research Questions:

In an attempt to answer the research question raised mean and standard deviation were used.

1. What is the difference between the mean scores of concrete and formal operational students taught ecology using collaborative teaching strategy and their counterparts taught using lecture method? In an attempt to answer the research question raised mean and standard deviation were used.
2. What is the difference between the retention ability of male and female students taught ecology using collaborative strategy? In an attempt to answer the research question raised mean and standard deviation were used.

3. What is the difference between retention ability of concrete and formal operational students taught ecology concepts using collaborative learning strategy and those taught lecture method? In an attempt to answer the research question raised mean and standard deviation were used.

Hypotheses: Testing

$HO_{1:}$ There is no significant difference between the academic performance of concrete and formal operational students taught using collaborative instructional strategy and lecture method.

ANOVA was used to test this hypothesis

HO_2:There is no significant difference between retention of ecology concepts between male and female students taught using collaborative instructional strategy.

t-test was used to test this hypothesis

HO_3 There is no significant difference in the retention of ecology concepts between concrete and formal operational students taught using collaborative learning instruction and those taught lecture method

ANOVA was used to test this hypothesis

CHAPTER FOUR

DATA, ANALYSIS RESULTS AND DISCUSSION.

4.1 Introduction

This study investigated the impact of Collaborative Strategy on Retention, Performance in Ecology Concepts among Concrete and Formal Reasoning Ability Students in Zaria, Kaduna State.

This chapter deals with analysis of data and discussion of the results in relation to the hypotheses stated in chapter one. The data were analysed using computer Software Package for Social Sciences (SPSS).

The hypotheses were either retained or rejected at $P \leq 0.05$ level of significance. The chapter is presented under the following subheadings:

- Data Analysis and Results Presentation
- Summary of Findings
- Discussion of the Results

4.2 Data Analysis and Result Presentation

The data obtained from the two groups in respect of different learning strategies were used in answering the research questions employing descriptive statistics such as means and standard deviations in testing the hypotheses, ANOVA and independent t-test were used for analysis and results are presented as follows.

4.2.1 Answering the Research Questions

Research Question 1.What is the difference between academic mean scores of students of the concrete and formal operational students taught ecology using collaborative teaching strategy and their counterparts taught using lecture method?

The data collected for the purpose of answering research question one was analysed using descriptive statistics of mean and standard deviations as shown in Table 4.1

Table 4.1: Means and Standard Deviation of Posttest Scores for the Experimental and Control Groups.

Strategy	N	Mean	Std. Deviation	M.d
Concrete	17	61.00	7.08	
Collaborative				0.85
Formal	13	60.15	9.94	
Concrete	17	38.11	16.75	
Lecture				5.47
Formal	13	32.64	8.33	

Table 4.1 reveals the mean score of students academic performance between concrete and formal reasoners for experimental and control group respectively. were 61.00 and 60.15 while for control had 38.11 and 32.64 respectively. With a mean difference of 0.85 and 5.47 respectively

The Ho_1: There is no significant difference between the academic performance of concrete and formal operational students taught using collaborative strategy and those taught with lecture method.

The HO_1: was analysed using ANOVA at $p \leq 0.05$ level of significance. The result is presented in Table 4.2

Table 4.2 Results One- way Analysis of Variance of Posttest of Concrete and Formal Reasoners in Experimental and the Control Group

	Sum of Squares	Df	Mean Square	F	P	Remark
Between Groups	9611.26	3	3203.75	24.26	0.01	□ S
Within Groups	7395.33	56	132.06			
Total	17006.60	59				

□ **Significant at $p \leq 0.05$**

From the Table 4.2 the result reveals that the calculated p value of 0.01 is lower than 0.05 level of significance with F calculated of 24.26 with df 3 and 59. From this result, There is significant difference between the academic performance of students of concrete and formal reasoning ability exposed to collaborative strategy and those exposed to lecture method. Hence the null which stated there is no significant difference between the academic achievement of students of concrete and formal reasoning abilities exposed to collaborative strategies and those exposed to lecture method is hereby rejected. To determine the group that shows the difference Dunnette test was carried out and the result is presented in Table 4.3

Table 4.3 Post Hoc Multiple Test using the Dunnett Method on Results of One- way Analysis of Concrete and Formal Groups on Postttest for the EG and the CG.

(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	P	Remark
Collaborative Concrete	Lecture Formal	27.50	4.23	0.01	□ S
Collaborative Formal	Lecture Formal	28.35	4.23	0.01	□ S
Lecture Concrete	Lecture Formal	5.47	3.94	.384	□ NS

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

a. Dunnett t-tests (2 sided) treat one group as a control, and compare all other groups against it.

In Table 4.3. The post Hoc analysis using the Dunnett method showed that significant differences were observed among the groups in their academic scores. Significant differences exist between the students in concrete reasoning ability students taught with collaborative strategy and their counterpart with formal reasoning taught with lecture method. Significant differences was also observed between students with formal ability exposed to collaborative strategy and those students with formal ability exposed to lecture method. In each of these comparisons the calculated p value in each case was 0.01 which was found to

be lower than the 0.05 alpha level of significance. But Lecture concrete versus lecture formal shows no significant difference.

Research Question2: What is the difference between the retention ability of male and female students taught ecology concepts using collaborative strategy?

Table 4.4 Data Collected for answering Research Question two was Analysed using Mean and Standard Deviation Statistics Descriptive Statistics.

Table 4.4: Means and Standard Deviation of Post- posttest Scores for Male and Female in Experimental Group.

Gender	N	Pre	Post	Std. Deviation	Mean gain
Female	30	39.54	68.50	6.16	28.96
Male	30	38.72	63.54	9.45	24.82

The result in Table 4.4 shows the retention ability of female and male of the experimental and control group before treatment recorded mean of 39.54 and 38.72, while after treatment the mean was 68.50 and 63.54 respectively with a mean gain of 4.96 indicating that the female score higher than the male counterparts. This means that there is difference in retention ability of male and female of the experimental group in favour of the females.

Hypothesis 2: There is no significant difference between retention of ecology concepts between male and female students taught using collaborative strategy.

The HO_2: was analysed using t-test at $p \leq 0.05$ level of significance. The result is presented in Table 4.5

Table 4.5 t-test Analysis of Post-posttest Mean Scores of Male and Female Students in Experimental Group.

Gender	N	$\bar{X}_1$	SD	t-CAL	DF	P	Remark
Female	30	68.50	6.16				
				2.28	58	0.26	NS
Male	30	63.54	9.45				

Table 4.5revealed that there is no significant difference in retention of ecology concepts betweenmale and female students in their academic scores after exposure to collaborative strategy i.e treatment. They female and male recorded a mean of 68.50 and 63.54 respectively**.** The calculated p value of 0.26 is higher than the 0.05 alpha level of significance.Therefore, the null hypothesis which stated that there is no significant difference between male and female students exposed to collaborative strategy is hereby retained.

Research Question 3: What is the difference between retention ability of concrete and formal reasoning students taught ecology concepts using collaborative learning strategy and those taught lecture method?

Table 4.6 The data collected for the purpose of answer research question three was analysed using Mean and Standard Deviation Descriptive Statistics.

Table 4.6 Mean and Standard Deviation of the Retention Ability Concrete and Formal abilities Exposed to Collaborative Strategy and Lecture Method.

Strategy	N	$Mean_2$	Std. Deviation	Mean gain
Concrete	13	72.53	3.50	33.81
Collaborative				
Formal	17	36.84	18.75	12.51
Formal	17	61.23	9.97	22.64
Lecture				
Concrete	13	37.52	6.24	17.24

Table4.6 shows the mean scores between the experimental and control group respectively. For collaborative concrete 72.53 and lecture formal 61.23 respectively. Though for the experimental group the concrete reasoners had relatively higher score of 72.53 against the lecture formal reasoners. The mean gain of 33.81 and 12.51 for experimental group while control group recorded 22.64 and 17.24 respectively.

HO_3: There is no significant difference between in the retention of ecology concepts between concrete and formal operational students taught using collaborative learning instruction and those taught with lecture method.

Table 4.7 One-way Analysis of Varianceof Post-Posttest scores of Concrete and Formal Reasoners taught Collaborative Strategy and Lecture Method.

	Sum of Squares	Df	Mean Square	F cal	Sig	Remark
Between Groups	13472.76	3	4490.92	38.18	0.01	□ S
Within Groups	6586.21	56	117.61			
Total	20058.98	59				

□ Significant at p ≤0.05

Table 4.7 the result reveals that the calculated p-value is 0.01 which is lower than 0.05 level of significance at df = 2 and 59 . This implies that there is significant difference between in the retention of ecology concepts between concrete and formal operational students taught using collaborative learning instruction compared with those taught using lecture method. The null hypothesis which stated there is no significant difference between in the retention of ecology concepts between concrete and formal operational students taught using collaborative learning instruction and those taught with lecture method is therefore rejected.

Table 4.8 Post Hoc Multiple Test using the Dunnett method on Result of One-way Analysis of Variance of Post-Posttest scores of Concrete and Formal Reasoners taught CS and Lecture Method.

(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig. Remark
Collaborative concrete	lecture formal	11.30	3.99	0.01 □S
Collaborative formal	lecture formal	24.38	3.99	0.01 □S
lecture concrete	lecture formal	33.70	4.71	0.39 NS

* The mean difference is significant at the 0.05 level.

Table 4.8 Gives a summary of the Post Hoc Analysis using Dunnett Method showed that significant difference were observed among groups in their mean score. Significant differences exist between students of concrete and formal reasoning students taught using collaborative strategy. A significant also exist when formal reasoners taught using collaborative and formal reasoners taught using lecture method; while, there is no significant when concrete and formal reasoners where taught using lecture method. In each of the comparisons, the calculated p value in each case were 0.01 below $p \leq 0.05$ alpha level of significance

4.3 Summary of Findings

The major findings from the analysis of the data and test of the study's hypotheses are summarized below:

1. Collaborative learning strategy significantly improved the academic performance of formal and concrete operational ability students exposed to it.

2. There is significant difference in the retention ability of male and female students exposed to collaborative instructional strategy.
3. The use of collaborative instructional strategy had significant effect on the retention ability of formal reasoners more than that of the concrete reasoners, the difference in the academic achievement between formal and concrete reasoners was found to be statistically significant.

4.4 Discussion

The study investigated the impact of Collaborative Strategy on Retention and Performance in Ecology Concepts among Concrete and Formal Reasoning Ability Ecology students in Zaria. Three hypotheses were tested, in the test of hypothesis 1, the academic performance of students exposed to the collaborative learning strategy and those exposed to lecture method were compared. The result in Table 4.4 revealed that the use of collaborative learning strategy significantly enhanced the academic performance of students exposed to it than lecture method. The finding of this study agrees with that of Ibrahim and Omar (2006) who also discovered that students working collaboratively together performed significantly better than those taught using lecture method.

The performance of thosein the collaborative learning strategy might have been engendered by the opportunity the members had to interact together, share ideas and had their misconceptions immediately corrected by their colleagues and have better grasp of concept which enhanced their performance.

Hypothesis two, no significant difference in the retention of ecology concept between males and females exposed to collaborative learning strategy and lecture method was tested. Female were significantly different from the male in their retention of ecology concepts. This result shows that collaborative learning strategy had impact on retention ability of the

femalethan the male students who were exposed to it. This findings agree with the findings of Gaduno (2006) who reported asignificant difference in the academic achievement girls than boys who were exposed to cooperative learning strategy. No significant difference between retention ability of ecology concept between males and females students exposed to collaborative learning strategy as revealed by the result of this study may be due to the fact that in collaborative learning student of different ability came together to work on the same task, share ideas and experiences freely. This equal opportunity for the students to learn together irrespective of their gender differences. However, the positive interdependence (sink or swim together) in which each member of the Jigsaw subgroup believes that the success of the group depends on the success of the individual member of the group, as well as individual accountability characteristics of the collaborative learning may be responsible for the observed result in this study.

Table 4.7,No significant difference between the retention ability of ecology between concrete and formal operational students taught using collaborative learning strategy than those exposed to lecture method. The result as indicated in Table 4.7 shows a significant difference in retention ability among formal and concrete reasoners exposed to collaborative learning strategy and those exposed to lecture method. This findings is in line with Yabo (2012) who investigated effects of collaborative team teaching model on students academic achievement of different ability levels in biology. Result of this study revealed asignificant difference in favour of the experimental group in the retention of biology students involved in the study. Lee (2008) in his study effect of collaborative strategy between homogeneous and heterogeneous groups also reported a significant difference in the studentsperformance in favour of the experimental group than those exposed to lecture. However, this result may be attributed to what Damon (1984) expressed as peer interaction influence. The interactions

among collaborative learning sub group make the learners to develop self-confidence through encouragement they receive from one another.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the summary of this investigation into study, the Impact of Collaborative Strategy on Retention, Performance and Reasoning Ability in Ecology Concepts among SS Students in Zaria, Kaduna.The chapter is presented under the following sub-headings:

- Summary
- Summary of major findings
- Contribution to Knowledge
- Recommendation
- Conclusion
- Limitation of the study
- Suggestion further studies

5.2 Summary

This study investigated the impact of collaborative strategy on retention and performance in ecology concepts among concrete and formal reasoning ability students.

The population of the study comprised of all senior secondary students of the twenty (20) senior secondary schools in Zaria, Kaduna State. The total population of students in these schools were 1,642 comprising 0f 960 males and 682 females. However, two (2) senior secondary schools out of the twenty from the population were sampled out and selected as experimental and control groups. The schools were Barewa College and Government Girls Day Senior Secondary School Dogon Bauchi were assigned experimental and control

group.In each of these schools, intact class was used so that the school academic calendar is not tempered with.

The experimental group had a total of 30 students comprising of 13 concrete reasoners and 17 formal reasoners, while the control group has a total of 30 students comprising 17 concrete reasoners and 13 formal reasoners Hence the total number of subjects in the two schools was 60. Three hypotheses were formulated to answer the research questions in this study. The study also used two instruments namely Ecology Performance Test (EPT) and Group Assesment of Logical Thinking (GALT).

The study was structured into five chapters. Chapter one gave the background to the study and the statement of the problem, the objectives, research questions, and the study's hypotheses. The scope and limitation of the study were also given within the chapter. Chapter two consisted of the review of the related literatures to the study. In chapter three, the methodology used in the study were stated. The statistical analysis and interpretation of the findings from the analysed data was presented in chapter four using SPSS. The summary of the chapter are presented as follows.

The major findings from the test and analysis of the data are stated.

5.3 Summary of Major Findings

The major findings from the analysis of the data and test of the study's hypotheses are summarized as follows:

1. Collaborative strategy significantly improved the academic performance of biology students who were exposed to it.
2. Collaborative strategy is gender friendly as it enhances meaningful learning and performance of both gender.

3. Collaborative learning strategy increased the performance of concrete and formal reasoners in ecology when compared with those taught using lecture method.

5.4 Conclusion

The findings of this study leads to the following conclusions:

1. The study established that collaborative strategy has been able to help the concrete and formal reasoners.
2. The findings in this study revealed that collaborative learning is efficacious in eliminating gender related differences in science learning, indicating that the strategy is gender friendly
3. Ecology concepts are retained when collaborative strategy is used as a medium of instruction for senior secondary biology students.

5.5 Contribution to Knowledge

The result and findings of this study has made the following contribution to knowledge

1. The study established that collaborative strategy has been able to help the concrete reasoners.
2. The findings in this study revealed that collaborative learning is efficacious in eliminating gender related differences in science learning, indicating that the strategy is gender friendly
3. Ecology concepts are retained when collaborative strategy is used as a medium of instruction for senior secondary biology students.

The findings has provided new information to the existing literature, also the collaborative package was developed by the researcher to teach different reasoning ability students ecology concept.

5.6 Recommendations

On the basis of the findings and conclusions emanating from this study, the following recommendations are made:

1. Workshops, seminars and conferences should be organised for Biology teachers on the use of collaborative instructional strategy in secondary schools, to enhance the use of collaborative strategy effectivey.
2. Biology teachers in senior secondary schools should use collaborative learning strategy because of its positive effect of enhancing students achievement.
3. Since collaborative learning strategy is not gender bias, it could appropriately be useful in coeducational setting where both males and females come together to learn.

5.7 Limitation of the Studies

This study has the following limitations:

1. The restriction of the study to only two senior secondary schools in Zaria, Kaduna State made the scope of the generalizations that can be made from the study fairly narrow.
2. The conclusions reached in this study were restricted to impact of collaborative strategy on retention and performance among concrete and formal reasoners in ecology.

5.8 Suggestions for Further Studies

1. A similar study can be carried out in similar senior secondary schools and institutions in the other parts of the country. Such studies may include undergraduate, polytechnics and colleges of education for students to see if a similar result would be obtained.

2. The study can also be replicated at the junior secondary school level to see what the resultwould be.
3. The study can be replicated to include interest and general attitude ofstudents towards the use of collaborative learning strategy among concrete and formal reasoners.
4. Further studies could involve one that would spread over a longer period. This wouldshow how long the learners have to stay together in order to interact for effectivelearning and achievement.

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APPENDICES

APPENDIX A

ECOLOGY PERFORMANCE TEST (EPT) FOR SENOIR SECONDAY STUDENTS (SS) level

Time Allowed: 30mins

Dear Respondent,

The purpose of the test is purely research and not to test you and your school performance. Your honest response will be a contribution to the improvement of science education. Read the questions carefully. Each question is followed by options A-E one option is correct. You are to tick the correct option on your sheet.

Yemi Oyarole

IMPACT OF COLLABORATIVE STRATAGY ON RETENTION AND PERFORMANCE IN ECOLOGY CONCEPTS AMONG CONCRETE AND FORMAL REASONING ABILITY STUDENTS IN ZARIA, KADUNA STATE.

Ecology Performance Test.

Section A:

Name of school……

Class……

Science or art student……

Sex: male ( ) female ( )

Age:

Section B:

Performance test

ECOLOGY PERFORMANCE TEST (EPT)

Instruction:

Please do not open the answer booklet until you are told to do so. Read the following Instructions carefully.

You must use pencil for the examination.

2. Write your name in the space provided in the answer sheet.

3. Write your class and class number on the in the space provided in the answer sheet.

4. Read each question carefully before answering it.

5. Do not waste time on any question. If you find a question difficult, go on to the other questions and finish them first.

6. After you have selected what you take to be the correct answer, go to you answer sheet and circle the appropriate alphabet in the space that corresponds with your choice.

7. Circle only one letter for your answer.

8. If you change your mind on an answer, completely erase the first circling.

From the multiple choice answers lettered A – D on each question, choose the best option that satisfactorily completes each sentence.

1.)The word 'ecology' is a branch of biology concerned with the study of:

a). Interrelationships between living organisms and their external environment.

b). The study of living organisms only

c).The study of snails and snakes

d). The capillary movement of water in plants

2. In ecology, the total surrounding of an organism is called _____?

a. Surrounding b. Environment c. Temperature d. None of the above.

3. The study of an individual organism or a single species of an organism and its environment is known as?

a. Biosphere b. Synecology c. Autecology d. All of the above

4. The main kinds of habitats are----------

a. Arboreal and ground habitat b. Underground habitats c. Aquatic and terrestrial habitats

c. Salt and fresh water habitats

5. One of the commonest habitats found in the terrestrial habitats is:----------

a. Underground habitats b. Fresh water habitats c. Marine habitats

d. Brackish water habitats

6. The factors which influence living organisms in their habitats and control their survival and distribution are called?

a. Habitat factors b. Ecological factors c. A and B only d. Physical factors.

7. Abiotic factors refer to?

a. Physical factor b. Biotic factors c. Climatic factors d. Edaphic factors

8. An example of topographic factors is?

a. Temperature b. Rainfall c. Elevation d. Soil texture

9. A typical example of an edaphic factor is?

a. Soil texture b. Soil profile c. Soil erosion d. Earth crust

10. Animals that live both in water and on land are referred to as:

a. Aquatic animals b. Sea anemone c. Sea gulls d. Terrestrial animals

11. The ecological unit composed of organisms and their physical environment is:

a. Niche b. Population c. Ecosystem d. community

12. The orderly change from one ecological community to another in an area is called?

a. Converence b. Climax c. Dispersal d. Succession

13. Organisms which breakdown the compounds of dead organisms are called?

a. Phagotrophs b. Parasites c. Saprotrophs d. Producers

14. Which of these must be present in an ecosystem if the ecosystem is to be maintained?

a. Producers and carnivores. b. Producers and decomposers c. Carnivores and decomposers

d. herbivores and carnivores.

15. The relationship between fungi and algae in lichens is known as:

a. Mutualism b. Parasitism c. Commensalisms d. Saprophytism

16. All ecosystems have three basic living components. Which one of the following is not necessarily found in all the ecosystems?

a. "Producer" plants b. Animal "consumers" c. Decomposers d. Parasites and commensalists

17. A sequence of species related to another predator and prey is a (n):

a. Trophic level b. Ecosystem c. Food chain d. Climax

18. Which of the following pairs represents ecological equivalents

a. Squirrel and rattle snake b. House cat and lion c. Sea gull and codfish

d. Wild horse and zebra.

19. Choose the statement that best describes the climax stage of an ecological succession

a. It is usually populated only by plants. b. It remains until there are several changes in the environment.

c. It represents the initial phases of evolution d. It changes rapidly from season to season.

20. Very low rainfall sparse vegetation, high day temperatures and cold nights are the Characteristics of the biome known as?

a. Swamp b. Tropical forest c. Southern guinea savannah d. Desert

21. An association between two organisms in which both benefit is called?

a. Parasitism b. Symbiosis c. Commensalisms d. Predation

22. The following measures are useful for conserving forests except:

a. Preventing and controlling accidental forest fires

b. Encouraging the use of charcoal for industrial and domestic purposes

c. Combating and preventing plants diseases

d. Reforestation of depleted forest.

23. The following practices are aimed at soil conservation except:

a. Contour ridging b. Application of manures c. Strip cropping d. Bush burning

24. Which of the following natural resources is most readily available to all organisms

a. Water b. Air c. Food d. Mineral resources

25. Which of the following is not a structural adaptation of desert plants for water Conservation:

a. Tiny leaves b. Sunken stomata leaves c. Stems and leaves with heavy cuticle

d. Broad leaves with numerous stomata.

26. The burning of farmlands should be discouraged because it:

a. Destroys some plant pests b. Reduces the population of wild animals

c. Makes bush clearing more difficult d. destroys the organic part of the soil.

27. In cold climates or at high altitudes, some small mammals fall asleep in some specially prepared nests or burrows. This process is known as:

a. Hibernation b. Masturbation c. Conservation d. Contraction

28. The role of dead organic matter in the soil is to:

a. Make the soil black b. Increase the mineral salt contents

c. Provide food for all living organisms d. Make the soil more porous.

29. Fewer number of trees is a characteristic of the savannah zones of Nigeria because:

a. There is too much sunlight b. They are usually exposed to grazing animals.

c. There is limited amount of rainfall d. The driest savannahs consist almost entirely of grasses.

30. The number of individuals in a habitat in relation to the unit space available to each organism is referred to as the:

a. Birth rate b. Density c. Mortality d. Frequency

31. In complex food relationships in a community the primary, secondary and tertiary consumers are referred to as:

a. Symbiosis b. Omnivore c. Heterotrophs d. Autotrophs

32. Predator are beneficial in pest control because they:

a. Are natural enemies of small mammals b. Feed on pests of crops c. devour farm animals

d. Compete for food with the pests.

33. Which of the following may not contribute to environmental pollution?

a. Solar energy radiation b. Industrial wastes c. Waste disposal d. Smoke

34. Which of the following limiting resources is competed for by organisms in the desert?

a. Light b. Temperature c. Oxygen d. Water

35. The adaptation for water conservation in organisms include the following except:

a. Scales in fishes

b. Scales in leaves

c. Thick leave

d. Succulent stems

36. Which of the following statements best explains the term aestivation?

a. A device for survival during the period of extreme food and water shortage.

b. A method of survival adopted by plants during the dry season

c. Movements of animals over long distance.

d. A method of survival adapted by animals under favourable condition.

37. Guinea grass, grasshopper, toad, snake, hawk

(Producer) (Primary consumer) (Secondary consumer) (Tertiary consumer)

The above example of a food chain belongs to:

a. Terrestrial habitat

b. Aquatic habitat

c. Ecosystem

d. Food web

38. Diatom Mosquito larvae Tilapia fish Whale

(Producer) (Primary consumer) (Secondary consumers) (Tertiary consumers)

This is a typical example of:

a. Primary succession

b. Secondary succession

c. Decomposers

d. Aquatic habitat

39. A complex feeding relationship among organisms in the same environment with two or more interrelated food chains is an example of a:----------

a. Food web

b. Pyramid of numbers

c. Pyramid of biomass

d. Simplified food chain

40. An interaction between two species in which one species attacks and kills the

others is known as:

a. Inter-specific competition

b. Intra-specific competition

c. Predation

d. A only.

Activity to be used for this study

In this study the research develop a collaborative learning package which contains six activities on Ecology among the group members were developed such as

Activity1: What is ecology?

List 5 ecological concept you know and state what each stands for.

Activity 2: Draw a map of Nigeria showing the following

a) Forest zone (b) Savannah zone (c) Mangrove swamp forest

What are the characteristics of a mangrove swamp forest.

Activity 3: List down any two characteristics that are common to all the types of savannah you have studies. List down two characteristics each that make them differ from one another. Name the animal that are common to the vegetation.

Activity 4: Compare and contrast the vegetation found in swamps and deserts. Explain how their common features will assist a farmer to plan for a successful farming season.

Activity 5: Define the following

a) Natality
b) Mortality
c) Seasonal climatic changes
d) Breeding

Activity 6: Filling in the blank space suitable words that best complete each statement.

1) The process that involves the interactions among two species in which one outgrows the other and survives while the other cannot grow nor survive is referred to as : ----------

2) The association between two organisms living together in which only one benefits from the association while the other neither benefited nor is harmed is known as: -

3) The type of association between two organisms in which the predator kills the _____ other called the prey and feeds directly on it is called: ----------

4) Microorganisms which can cause diseases in plants and animals leading to their reduction through death are called: ----------

Write true or false on the statements that follow:

5) An example of a climatic factor is temperature: ----------

6) Edaphic factors include oxygen, carbon –dioxide and nitrogen: --

7) Topography deals with soil, its water, chemical and physical compositions: --------

8) Dispersal is the spreading of new individuals from their parents to new habitats so to start a new life in the new environment: ----------

9) Light determines seasons in Nigeria: ----------

10) Atmospheric pressure decreases as one goes up from the sea level: ----------

APPENDIX B

MARKING SCHEME FOR ECOLOGY PERFORMANCE TEST (EPT)

(Scoring Key for EAT)

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

APPENDIX C

Table 3.3 Facility Index (F.1) for the Ecology Performance Test (EPT)

Item	Difficulty Index (F.1)
1	0.2
2	0.61
3	0.72
4	0.50
5	0.11
6	0.15
7	0.14
8	0.45
9	0.29
10	0.25
11	0.21
12	0.19
13	0.34
14	0.48
15	0.24
16	0.64
17	0.70
18	0.79
19	0.08
20	0.79
21	0.80
22	0.61
23	0.41
24	0.38
25	0.37
26	0.42
27	0.40
28	0.72
29	0.28
30	0.27
31	0.66
32	0.64
33	0.69
34	0.43
35	0.32
36	0.35
37	0.27
38	0.70
39	0.79
40	
41	
42	0.36

KEY

9 Discarded for being too difficult

R Reframed and accepted

APPENDIX D

Table 3.4 (b) Discrimination Index D.I (P1-P2) for the Ecology Performance Test

Item	Discrimination
Index	Index (p_1-p_2)
1	0.40
2	0.61
3	0.72
4	0.50
5	0.11
6	0.15
7	0.14
8	0.45
9	0.29
10	0.25
11	0.21
12	0.19
13	0.34
14	0.48
15	0.24
16	0.64
17	0.07
18	0.73
19	0.08
20	0.79
21	0.80
22	0.61
23	0.41
24	0.38
25	0.38
26	0.42
27	0.40
28	0.72
29	R 0.28
30	R 0.27
31	0.66
32	0.64
33	0.69
34	0.43
35	0.32
36	0.35
37	R 0.30
38	0.70
39	0.79
40	0.53

KEY

10 Discarded for being too difficult

R Revised and Reframed

APPENDIX E

GROUP ASSESMENT OF LOGICAL THINKING (GALT)

INSTRUCTIONS ***TIME: 40MINS***

The purpose of the questions in this booklet is to find out how logically youthink. Your reasons for choosing an answer is as important as the answer itself.

ANSWER EVERY QUESTION

In answering each question, go through the following steps:

1. Read the question carefully

2. Record your answer in the space provided on the answer sheet

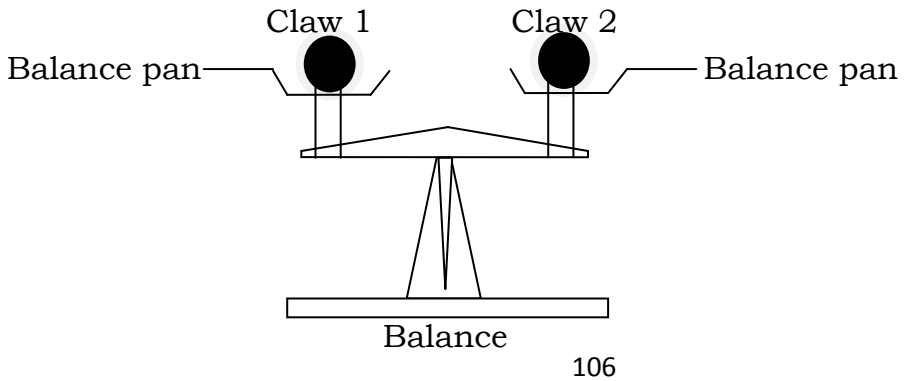
3. Read the set of possible reasons and carefully select the reason which best matches your thinking

GROUP ASSESMENT OF LOGICAL THINKING (GALT)

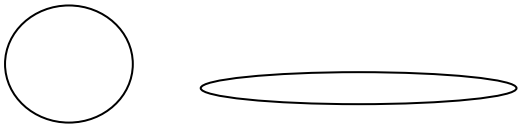
The above instrument is used to group the students as formal or concrete reasoners, the students who score 1 to 4 are formal reasoners while those who score 5-10 are concrete reasonners

PIECE OF CLAY

1. Toms has two balls of clay. They are the same size and shape when he places them on the balance, they weigh the same.



The balls of clay are removed from the balance pans; clay 2 is flattened like a pancake.



Clay 1 Clay 2

WHICH OF THESE STATEMENTS OF TRUE?

a. The pancake-shaped clay weighs more

b. The two pieces weigh the same

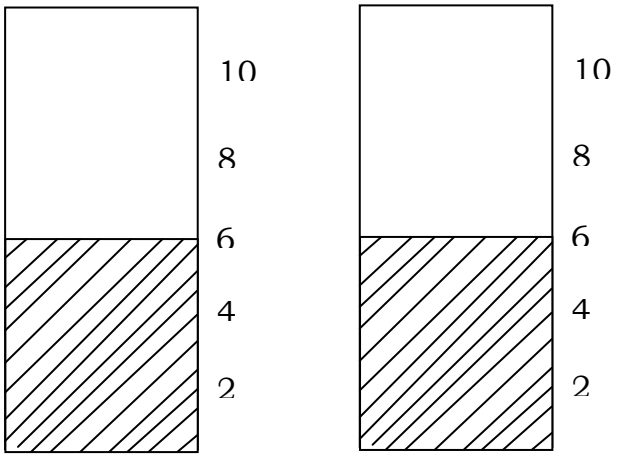
c. The ball weighs more

Reason

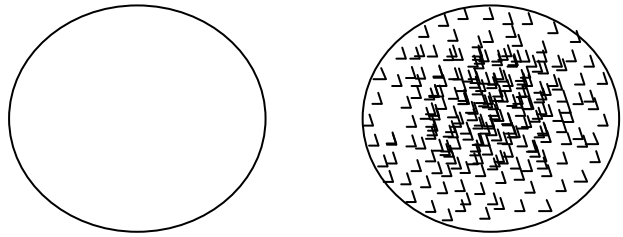
1. You did not add or take away any clay
2. When clay 2 was flattened like an pancake, it had a greater area
3. When something is flattened, it loses weight
4. Because of its density, the round ball had more clay in it.

METAL WEIGHTS

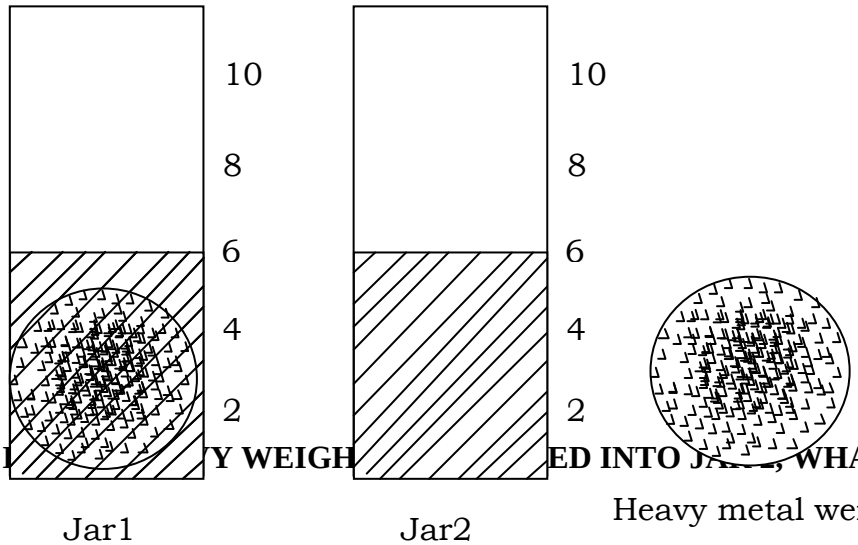
2. Linn has two jars. They are the same size and shape. Each is filled with the same amount of water.



She also has two metal weights of the same volume. One weight is light, the other is heavy.



She lowers the light weight into jar 1. The water level in the jar rises and looks like this:



I[illegible]Y WEIGH[illegible]ED INTO JA[illegible], WHAT WILL HAPPEN?

a. The water will rise to a higher level than in jar 1

b. The water will rise to a lower level than in jar 1

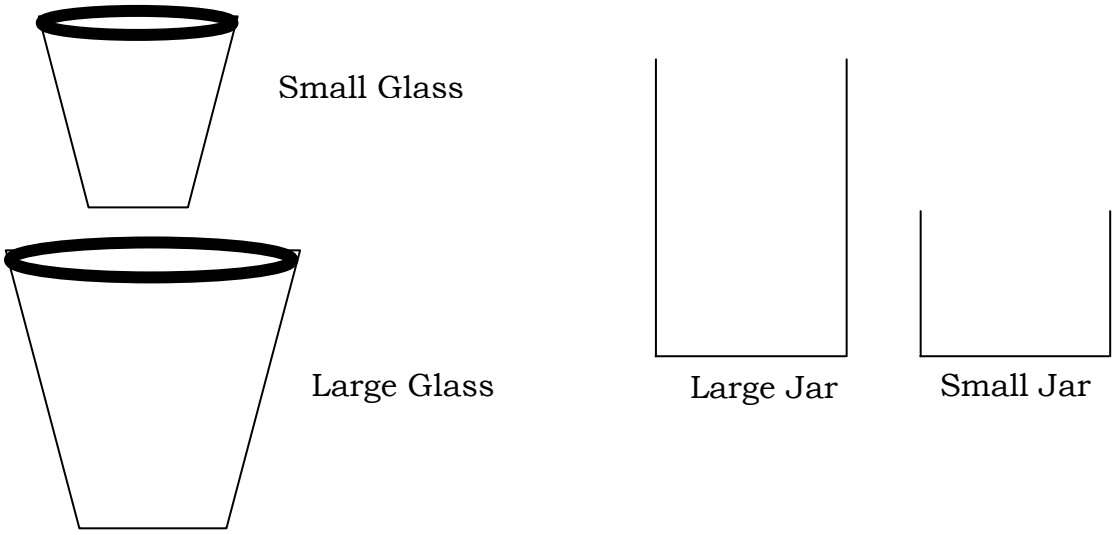
c. The water will rise to the same level as in jar 1

Reason

1. Weights are the same size so they will take up equal amounts of space
2. The heavier the metal weight, the higher the water will rise.
3. The heavy metal weight has more pressure; therefore the water will rise lower.
4. The heavier the metal weight, the lower the water will rise.

Glass size #2

The drawing shows two glasses, a small one and a large one. It also shows two jars, a small and a large one.



It takes 15 small glasses of water or 9 large glasses of water to fill the jar. It takes 10 small glasses of water to fill the small jar.

HOW MANY LARGE GLASSES OF WATER DOES IT TAKE TO FILL THE SAME SMALL JAR?

a. 4

b. 5

c. 6

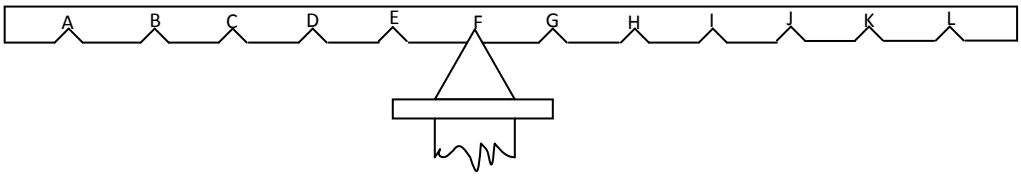
d. Other

Reasons

1. It takes five less small glasses of water to fill the small jar. So it will take five less large glasses of water to fill the small jar.
2. The ratio of small to large glasses will always be 5 to 3.
3. The small glass is half size of the large glass. So it will take about half the number of small glasses of water to fill up the same small jar.
4. There is no way of predicting.

Items 4 Scale #1

Joe has a scale like the one below



When he hangs a 10-unit weight at point D, the scale looks like this

WHERE WOULD HE HANG A-5-UNIT TO MAKE THE SCALE BALANCE AGAIN?

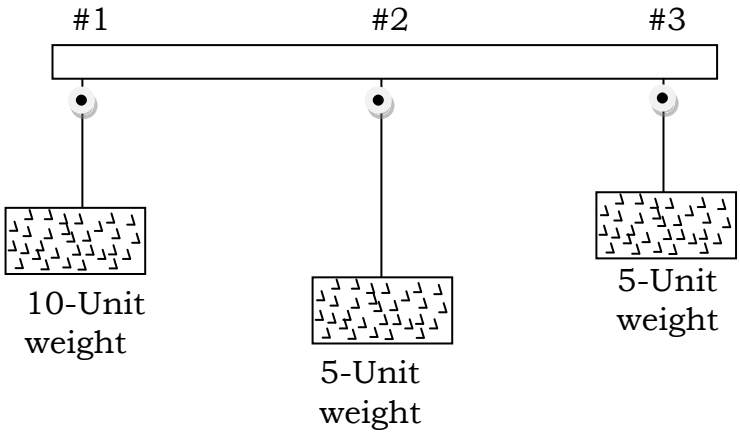
a. At point J
b. Between K and L
c. At point L
d. Between L and M
e. At point M

Reason

1. It is half the weight so it should be put at twice the distance.
2. The same distance as 10-unit weight, but in the opposite direction
3. Hang the 5-unit weight further out to make up its being smaller
4. All the way at the end gives more power to make the scale balance
5. The lighter the weight, the further out it should be hung

Item 5 Pendulum Length

Three strings are hung from a bar. String #1 and #3 are of equal length. String #2 is longer. Charlie attaches a 5-Unit weight at the end of string #2 and at the end of #3. A 10unit weight is attached at the end of string #1. Each string with a weight can be swung.



Charlie wants to find out if the length of the string has an effect on the amount of time it takes the string to swing back and forth.

WHICH STRING AND WEIGHT WOULD HE USE FOR HIS EXPERIMENT?

a. String #1 and #2

b. String #1 and #3

c. String #2 and #3

d. String #1, #2, and #3

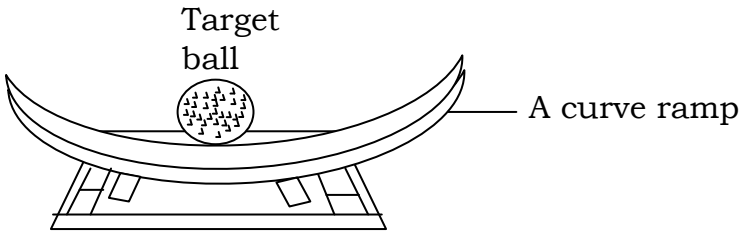
e. String #2 only

Reason

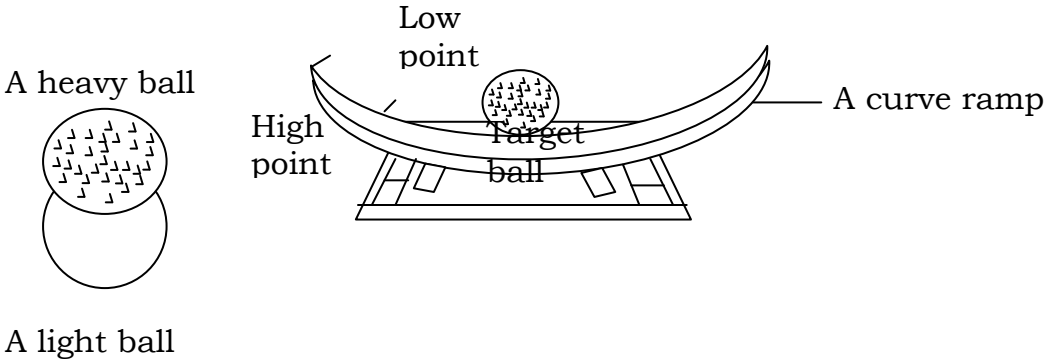
1. The length of the strings should be the same. The weights should be different
2. Different lengths with different weights should be tested
3. All strings and their weights should be tested against all others
4. Only the longest string should be test. The experiment is concerned with length not weight
5. Everything need to be the same except the length so you can tell if length make a difference.

Item Ball #1

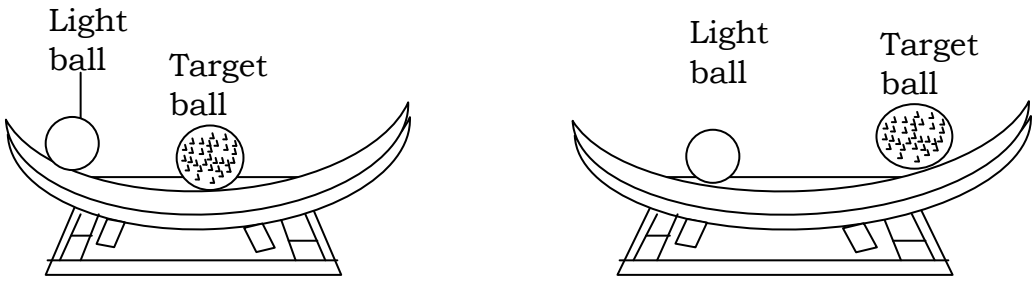
Eddie has a curved ramp. At the bottom of the ramp there is one ball called the target ball.



There are two other balls, a heavy and a light one. He can roll one ball down the ramp and hit the target ball. This causes the target ball to move to up the other side of the ramp. He can roll the balls from two different points, a low point and a high point.



Eddie released the light ball from the low point. It rolled down the ramp. It hit and pushed the target ball up the other side of the ramp.



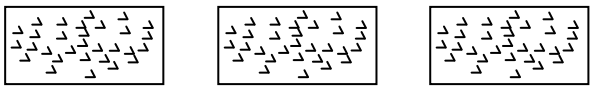
He wants to find out if the point a ball is released from maker, a different in low for the target goes.

TO TEST THIS WHICH BALL WOULD HE NOW RELEASE FROM THE HIGH POINT?

1. He started with the light ball he should finish with it.
2. He used the light ball the first time. The next he should use the heavy ball
3. The heavy ball would have more force to hit the target ball further
4. The light ball would have to be released from the high point in order to make a fair comparison
5. The same ball must be used as the weight of the ball does not count.

Item 7 Square and Diamonds #1

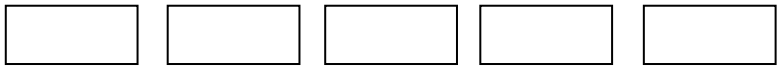
Ina cloth sack, there;



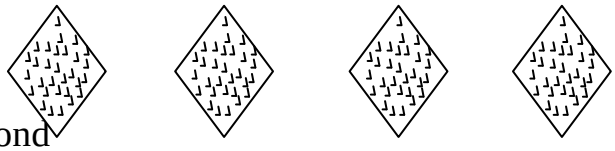
3. Spotted Wooden Squares



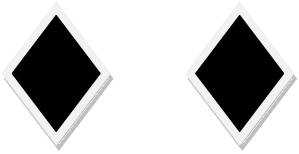
4. Black Wooden Square



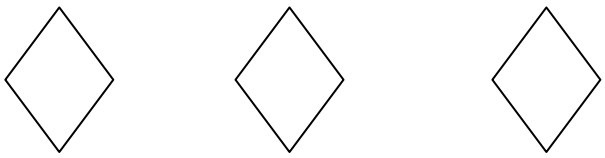
5. White Wooden Square



4. Spotted Wooden Diamond



2. Black Wooden Diamond



3. White Wooden Diamond

All of the square pieces are the same size and shape. The diamond pieces are also the same size and shape. One piece is pulled out of the sack.

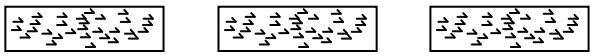
WHAT ARE THE CHANGES THAT IT IS A SPOTTED PIECE?

a. 1 out of 3
b. 1 out of 4
c. 1 out of 7
d. 1 out of 12
e. Other

Reason

1. There twenty-one pieces in the cloth sack. One spotted piece must be chosen from these.
2. One spotted piece needs to be selected from a total of seven spotted pieces
3. Seven of the twenty-one pieces are spotted pieces
4. There are three sets in the cloth sack. One of them is spotted
5. ¼ of the pieces and 4/9 of the diamond pieces are spotted

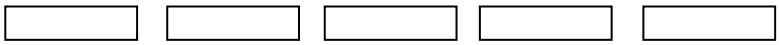
Item 8 Squares and Diamond #2



3. Spotted Wooden Square

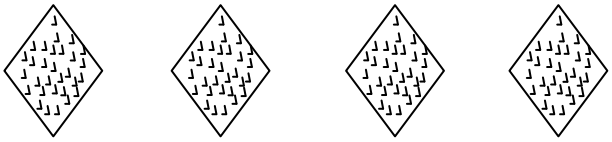


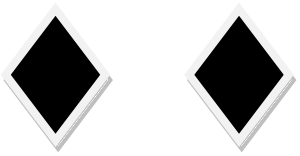
4. Black Wooden Squar



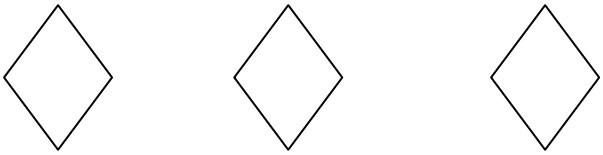
5. White Wooden Square

4. Spotted Wooden

Diamond 



2. Black Wooden Diamond



3. White Wooden Diamond

All of the square pieces are the same size and shape. The diamond pieces are also the same size and shape. Reach in and take the first piece you touch.

WHAT ARE THE CHANCES OF PULLING OUT A SPOTTED DIAMOND OR A WHITE DIAMOND?

a. 1 out of 3
b. 1 out of 9
c. 1 out of 21
d. 1 out of 21

Reason

1. Seven of the twenty-one pieces are spotted or white diamond
2. 4/7 of the spotted and 3/8 of the white are diamonds
3. Nine of the twenty-one piece are diamond
4. One diamond piece needs to be selected from a total of twenty-one pieces in the cloth sack

5. There are 9 diamond pieces in the cloth sack. One piece must be chosen from these.

Item 9 The Mice

A farmer observed the mice that live in his field. He found that the mice were either fat or thin. Also, the mice had either black tails or white tails.

This made him wonder if there might be a relation between the size of a mouse and the colour of its tail. So he decided to capture all of the mice in one part of his field and observe them. The mice that he captured are shown below.

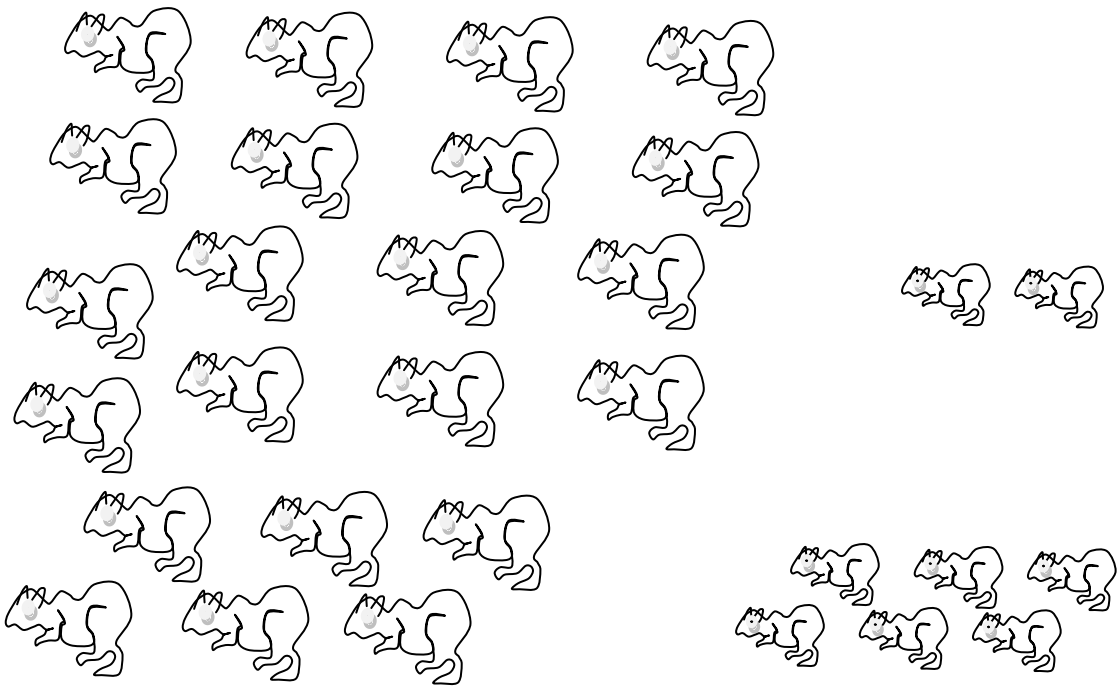
DO YOU THINK THERE IS A RELATION BETWEEN THE SIZE OF THE MOUSE MORE LIKELY TO HAVE A CERTAIN COLOUR AND VICE VERSA?

a. Yes

b. No

Reason

1. 8/11 of the fat mice have black tails and ¾ of the thin mice have white tails.
2. Fat and thin mice can have either a black or a white tails.
3. Not all fat mice have black tails. Not all thin mice have white tails.
4. 18 mice have black tails and 12 have white tails.
5. 22mice are fat and 8 mice are there



Item 10 The Fish

Some of the fish below are big and some are small. Also some of the fish have wide stripers on their sides. Others have narrow stripes.

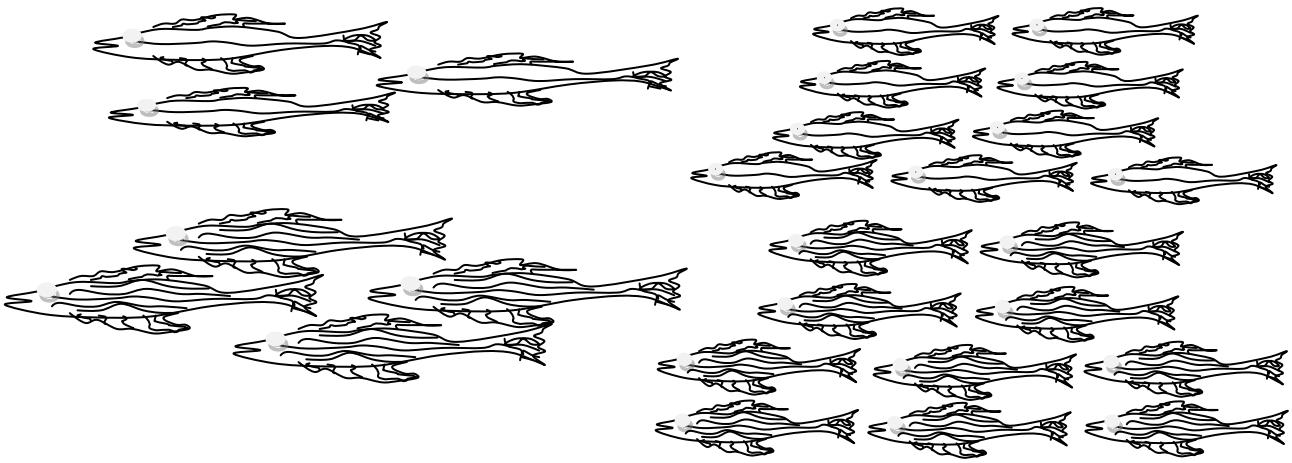
IS THE KIND OF STRIPES IT HAS (THAT IS, ONE SIZE OF FISH MORE LIKELY TO HAVE A CERTAIN TYPE OF STRIPES AND VICE VERSA)?

a. Yes

b. No

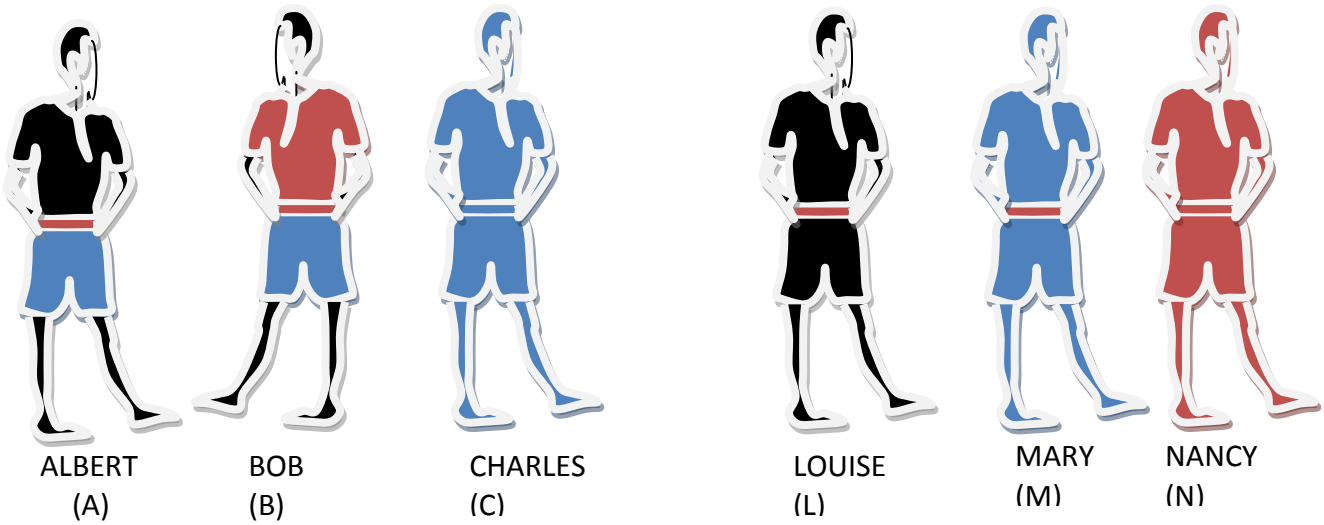
Reasons

1. Big and small fish can have either wide or narrow stripes.
2. 3/7 of the big fish and 9/21 of the small fish have wide stripes.
3. 7 fish are big and 21 are small.
4. Not all big fish have wide stripes and not all small fish have narrow stripes.
5. 12/28 of fish have wide stripes and 16/28 of fish have narrowed.



Item 11 **The Dance**

After supper, some students decide to go dancing. There are three boys: ALBERT (A), BOB (B), and CHARLES (C), and three girls: LOUISE (l), MARY (m), and NANCY (N).

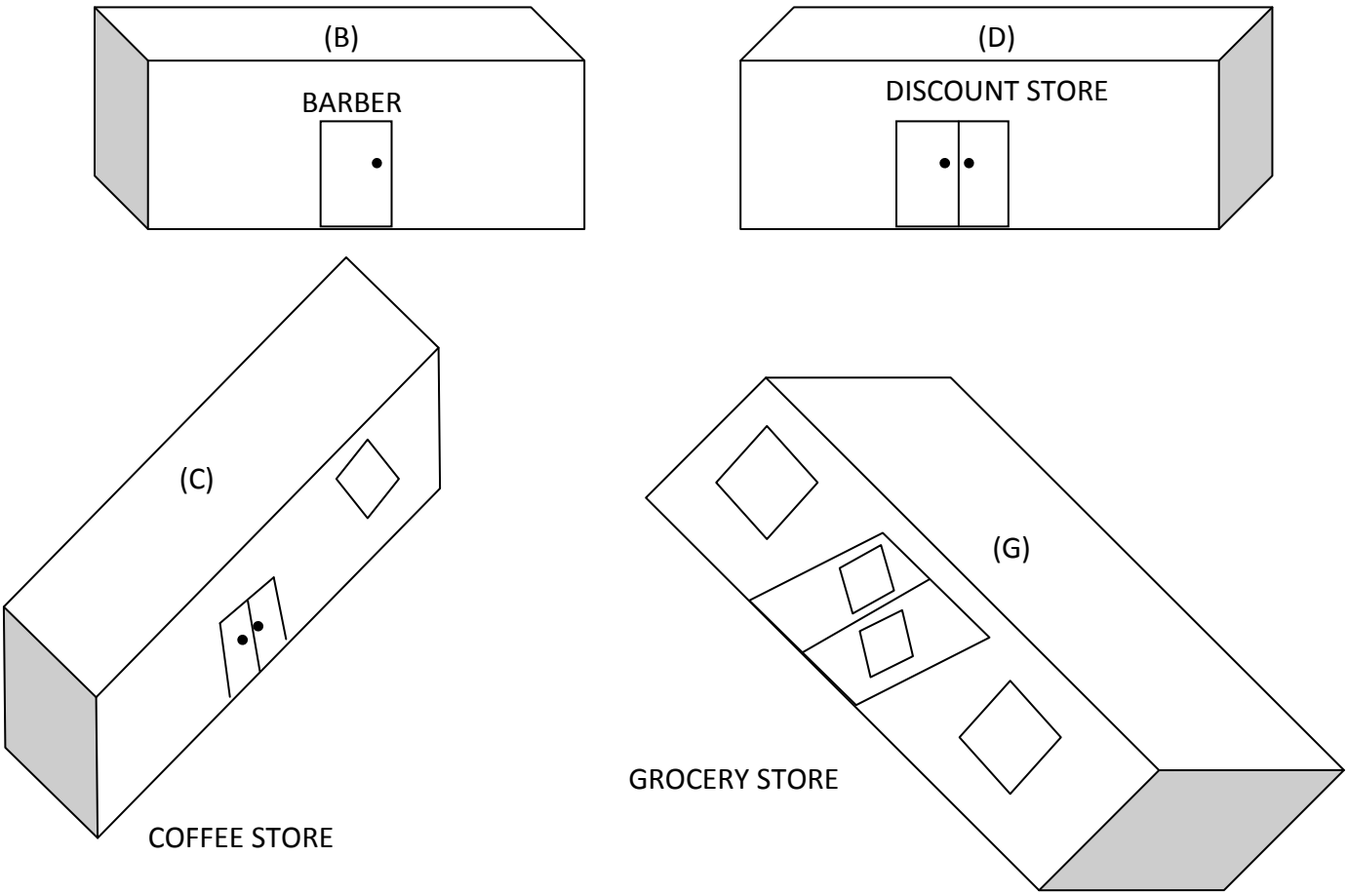


One possible pair of dance partners is A-L, which means ALBERT and LOUISE.

LIST ALL OTHER POSSIBLE COUPLES OF DANCERS. BOYS DO NOT DANCE WITH BOYS; GIRLS DO NOT DANCE WITH GIRLS.

Items 12 The Shopping Center

In a new shopping center, 4 stores are going to be placed on the ground floor. A BARBER SHOP (B), a DISCOUNT STORE (D), a GROCERY STORE (G), and a COFFEE SHOW (C) want to locate there.



One possible way that the stores could be arranged in the 4 locations is BDGC. Which means the BARBER SHOP first, the DISCOUNT STORE next, and then the GROCERY STORE and the COFFEE SHOP last.

LIST ALL THE OTHER POSSIBLE WAYS THAT THE STORE CAN BE LINED UP IN THE FOUR LOCATIONS. Adapted from Mari. 2001

APPENDIX F

GROUP ASSESSMENT OF LOGICAL THINKING (GALT)

Answer sheet

Name:_____

Birth Date:_____
Month Day Year

Sex: _____

School:_____

Directions:
For each item you are to choose the best answer and reason for selecting that answer. Record your answer in the space provided according to the test item from the test booklet.

Item	Best Answer	Reason
1.Piece of clay	_____	_____
2 . Metal weights	_____	_____
3.Glass size	_____	_____
4. Scale	_____	_____
5. Pendulum length	_____	_____
6. Ball	_____	_____
7. Squares and Diamonds 1	_____	
8. Squares and Diamonds 2	_____	_____
9. The mice	_____	_____

Item	Best Answer	Reason
10. The fish	_____	_____

11. The “Dance” _____ _____

Put your answers below:
A-L

_____ _____ _____

APPENDIX G

GROUP ASSESSMENT OF LOGICAL THINKING (GALT) MARKING SCHEME

1. **A (1 Reason)**
2. **C (1 Reason)**
3. **C (2 Reason)**
4. **E (1 Reason)**
5. **C (5 Reason)**
6. **B (4 Reason)**
7. **A (3 Reason)**
8. **A (1 Reason)**
9. **A (1 Reason)**
10. **B (2 Reason)**

TOTAL =10Marks

NOTE:

- **One mark for each correct option and correct reason.**
- **No mark for correct option and wrong reason.**
- **NO mark for wrong option and correct reason.**

11.

AL	**BL**	**CL**
AM	**BM**	**CM**
AN	**BN**	**CN**

NOTE:

- **One mark for the above correct combinations.**
- **One mark for ONY one mistake**

APPENDIX H

LESSON PLAN FOR EXPERIMENTAL GROUP

Topic: Basic Ecological Concepts

Class: SS2

Length of Class Period: 40 mins

Main activity: Describe and explaining the basic ecological concepts**.**

Method of Teaching: Collaborative Learning (Jigsaw) method

Objective:

Cognitive:

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

-Explain in their own words the following ecological concepts:
Autecology
Synecology
Lithosphere etc.

Affective:

The students will learn how to work collaboratively in groups

Materials:

-Worksheet for all students.
-Copies of study notes to all expert students.
-Role cards and social names of groups

Activity outlined for expert groups (EGR)

EGR A. Members of this group were to discuss on the following specific areas:

a) Explain Autecology
b) List and explain ecological concepts
c) Explain synecology

EGR B. Member of this group were to discuss on the following specific areas:

1.Explain environment
2. Explain biosphere

EGR C. Member of this group were to discuss on the following specific areas:

1. Discuss and explain lithosphere
2. Discuss and explain hydrosphere

EGR D. Member of this group were to discuss on the following specific areas:

1. Discuss and explain ecological niche
2. Biotic community.

Roles:

Organizer: Collect group folders containing materials.
Distribute materials to group members

Reader: Read the group task to the group**.**

Timer: Keeps the time
Makes sure everyone contributes to answer the questions.

Encourager: Encourages group members
Decides on the order for the members to read task

Presentation:

a) The teacher will present the lesson by explaining to the students that they are going to learn basic ecological concepts using collaborative strategy where all of them will work collaboratively together, and that the success of the group depends on the success of the individual member of the group.

b) The teacher will then group the students into a collaborative learning group comprising of six students per group. Making sure that the groups are heterogeneous.

c) The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group name, expert's names, timing, asking questions.

Specific Procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to the student. Each expert will be asked to study his/her task for some time. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the card given to them.

Members of the expert groups will after some time be asked to break and go back to their main groups where each expert will explain his/her task to the remaining members of his group. Other members of the group will be encouraged to ask questions.

Evaluation

The students were given tests, which they did individually. They are not to discuss with anyone.

The test is marked individually. The scores are awarded and the total for each group is added.

1) what Lithosphere?

(2) What is environment?

(3) What is population?

WORKSHEET FOR JIGSAW (PENCIL AND PAPER) ACTIVITIES.

Lesson One

Topic - Basic Ecological Concepts
Date - February 2015
Subject - Ecology

EXPERT GROUP ONE

INSTRUCTIONS:
Discuss the activities listed below among members of your group and record your findings in the space provided and in your notebook. You will use these findings during feedback to members of your jigsaw (main) group.

Step I: Members of this group are to discuss the following areas:

The basic ecological concepts:-

Jigsaw group 1:- Students within the group are to discuss the followings among themselves the (i) Autecology; (ii) Synecology
(b) Ecological concepts

Jigsaw group 2:- Members of this group are to discuss the following specific areas:(a) Environment
(b) Biosphere

Jigsaw group3:- Members of this group are to discuss the following specific areas:(a) Lithosphere
(b) Hydrosphere

Jigsaw group4:-Members of this group are to discuss the following specific areas:(a) Atmosphere
(b) Habitat

Jigsaw group5:-Members of thisgroup are to discuss the following specific areas:(a) Biotic community or biome
(b) Ecological niche

Step IV: Teacher askstudents the following questions based on their Jigsaw group:
(a) What is environmental biology?
(b) Define in your own words the following terms:

(i) Autecology
(ii) Synecology
(iii) Environment
(iv) Biosphere
(v) Ecosphere
(vi) Lithosphere

Evaluation

The students were given tests, which they did individually. They are not to discuss with anyone.

The test is marked individually. The scores are awarded and the total for each group is added.

1) What Lithosphere?

(2) What is environment?

(3) What is population?

SUMMARY AND CONCLUSION

Highlight the main points of the lesson along with the students.

WORKSHEET FOR JIGSAW (PENCIL AND PAPER) ACTIVITIES.

Lesson Two

Topic: Local biotic communities

Date - February 2015

EXPERT GROUP TWO

INSTRUCTIONS:
Discuss the activities listed below among members of your group and record your findings in the space provided and in your notebook. You will use these findings during feedback to members of your jigsaw (main) group.

Activity outlined for expert groups, members of this group are to discuss on the following specific areas:
Jigsaw group 1:-Local biotic communities
The local biotic communities in Nigeria are grouped into two major zones. These are:
(a) Forest zone and savannah zones which also consist of:

Jigsaw group 2:-- Members of this group are to discuss the following specific areas:(i) Mangrove swamp forest (salt and fresh water swamp, (ii) tropical rainforest

Jigsaw group 3:-Members of this group re to discuss the following specific areas:(a) Savannah zone:
Savannah is further subdivided into three i) savannah belts and ii) Sahel savannah(iii) mangrove swamp forest.

Each jigsaw group is expected to locate the Local biotics on their cardboard
Characteristics of swamp forest:

Jigsaw group 4: Members of this group are to discuss on the following specific areas:

- **i) Tropical Rainforest**
- ii) Location
- iii) Characteristics of tropical rainforest

Evaluate
The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added.

1. What are the characteristics of a mangrove swamp forest?
(i) Draw a map of Nigeria showing the following

(ii) Forest zone
(iii) Savannah zone
(iv) Mangrove swamp forest

Summary and Conclusion

The group leader highlight the main points of the lesson with the students.

Explain how biotic communities in Nigeria have been formed (discuss within your group)

WORKSHEET FOR JIGSAW (PENCIL AND PAPER) ACTIVITIES.

Lesson Three

Topic : Tropical rainforest

Date– February, 2015.

EXPERT GROUP THREE

INSTRUCTIONS:
Discuss the activities listed below among members of your group and record your findings in the space provided and in your notebook. You will use these findings during feedback to members of your jigsaw (main) group.

Jigsaw group 1-3 will be given the same topic**,**Members of this group are to discuss on the following specific areas:

a)Tropical rainforest and characteristics of tropical rainforest

sStep II
Jigsaw groups 4-6groups Members of this group are to discuss on the following specific areas:

a) Sahel Savannah and their locations.

Evaluation
The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added.

1. What is a savannah?
2. How does a savannah differ from a tropical rainforest?
3. In which parts of Nigeria do you find the following;

(a) Mangrove swamp forest
(b) Desert biome

Summary and conclusion
Highlight the main ideas of the lesson. Provide chalkboard summary for the students to copy.
Home work: Draw a map of Nigeria showing all the biotic communities.

WORKSHEET FOR JIGSAW (PENCIL AND PAPER) ACTIVITIES.

Lesson Four

Topic: Major biomes of the world

Date– February, 2015.

EXPERT GROUP FOUR

INSTRUCTIONS:

Discuss the activities listed below among members of your group and record your findings in the space provided and in your notebook. You will use these findings during feedback to members of your jigsaw (main) group.

Activity outline for expert groups

Step 1:Members of this group are to discuss on the following specific areas:
a) Major biomes of the world
(i) Tropical rainforest
(ii) Savannah
(iii) Desert
(iv) Shrub
(v) Afro-alphine
(vi) Swamp

Jigsaw 1::Members of this group are to discuss on the following specific areas:
(**a) Tropical rainforest,**
Characteristics of tropical rainforest

Jigsaw 2 ::Members of this group are to discuss on the following specific areas:
(**a) Savannah/Grassland**
-Tropical grassland
Characteristics of tropical grassland
Temperate grassland,
Characteristics of temperate grassland

Jigsaw 3: :Members of this group are to discuss on the following specific areas:
(A) Deserts, hot and cold deserts
And also their Characteristics

Jigsaw 4: :Members of this group are to discuss on the following specific areas**:**
- Afro-Alphine

-Characteristics of Afro-Alphine

Jigsaw 5::Members of this group are to discuss on the following specific areas**:**

-Swamp

-Characteristics of swamp

Evaluation The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added and

ask these questions to evaluate:

(1) How do climatic or physical conditions of tropical grassland relate to that of temperate grassland?

(2) In which of the forest areas do you find the following vegetational plants?

a. Creepers (b) climbers and (c) parasitic plants?

(3) Define the following

a. Afro-Alphine

b. Shrub

c. Swamp

d. Mangrove

Summary and conclusion

Highlight the main salient features of the lesson provide a chalk

board for the pupils to copy.

WORKSHEET FOR JIGSAW (PENCIL AND PAPER) ACTIVITIES.

Lesson Five

Topic: Population studies
Date– February, 2015.

EXPERT GROUP FIVE

INSTRUCTIONS:
Discuss the activities listed below among members of your group and record your findings in the space provided and in your notebook. You will use these findings during feedback to members of your jigsaw (main) group.

Activity outline for expert group

Jigsaw 1:Members of this group are to discuss on the following specific areas:

Population

(1) Types of organisms: This involves the listing of the various types of populations that are found in the particular habitat.
(2) Dominance

Dominance could be expressed in terms of (i) their number, (ii) occupation of largest portion of space (iii) possession of the lightest biomass and (iv) the largest contributions to the energy flow in the habitat.

Jigsaw 2: :Members of this group are to discuss on the following specific areas
Population characteristics
These characteristics include:
(a) Population size:
(b)Population density
(c)Population frequency
(f) Population growth rate

Jigsaw 3: :Members of this group are to discuss on the following specific areas**:**
-Factors affecting population
Factors which may affect the population of organisms in a given habitat include:
(1) Natality (birth rate)
(2) Mortality (death rate)
(3) Immigration (dispersal)

Jigsaw 4: Members of this group are to discuss on the following specific areas:
Factors affecting population

(4) Emigration
(5) Availability of food
(6) Natural disasters

Evaluation
Ask the following questions to evaluate:
(i) Population density
(ii) Population size
(iii) Population

Summary and conclusion
Summarize the lesson by highlighting the main points of the lesson

APPENDIX I

LESSON PLAN

LESSON PLAN - CONTROL GROUP

Lesson 1 – Traditional Lecture Method
Date –February, 2015.
Subject - Ecology
Topic - Basic Concepts
Class - SS II
No. of Pupils in Class-30
Average age - 17 years
Instructional Materials - Essential Biology Textbook
Previous knowledge - Students have been introduce to the concepts of ecology

BEHAVIOUR OBJECTIVES

At the end of the lesson, the students should be able to:
1. Explain in their own words the following ecological concepts:
(a) Autecology
(b) Synecology
(c) Lithosphere
(e) Hydrosphere
(f) Biotic community
(g) Ecological niche
(h) Environment
(i) Biosphere/Ecosphere
(j) Atmosphere
(k) Habitat
(l) Population
(m) Ecosystem
2. Describe in their own words the importance of these terms in the study of ecology

Previous Knowledge- Students have been introduced to ecology concept e.g plants, animal and the eviroment they live.

Introduction

Presentation

Class, in the previous lesson held we discussed the relevance of biology to agriculture. Have you ever heard of the word ecology?

In this and other subsequent lessons, we shall be examining the different concepts of ecology. We shall discuss about the meaning of ecology and ecological concepts.

Step I:

(a) The teacher defines ecology

(b) Describes ecology as an environmental biology

(c) Classified ecology into two main branches namely, Autecology and synecology.

Step II

(a) The teacher define and explain the following basic ecological concepts, thus

(i) Autecology

(ii) Synecology

(b) Ecological concepts

(i) Environment

(ii) Biosphere or ecosphere

(iii) Lithosphere

(iv) Hydrosphere

(v) Atmosphere

(vi) Habitat

(vii) Biotic community or biome

(viii) Ecological niche

Step III:

The teacher ask students the following qestions:

(a) What is environmental biology?

(b) Define in your own words the following terms:

(i) Autecology

(ii) Synecology

(iii) Environment

(iv) Biosphere

(v) Ecosphere

(vi) Lithosphere

Evaluation – ask the following questions

(1) Explain the importance of the study of ecology to ,you as a student

(2) What is meant by a biome?

(3) Define the following:

i. Biotic community

ii. Ecological niche

iii. Population

iv. Ecosystem

v. Abiotic components

SUMMARY AND CONCLUSION

Highlight the main points of the lesson along with the students

Lesson 2: Traditional Lecture Method

Date February, 2015.
Subject: Ecology
Topic: Local biotic communities
Class: SS IIB Biology
Duration: 40 minutes
No. of pupils in Class:30
Average age: 17 years
Instructional method: Lecture method
Teaching Aids: no chart.

Previous knowledge: the students have been taught basic ecological concepts Basic ecological concepts.

Behavioural objectives

At the end of the lesson, students would be able to:
(1) Identify the different basic ecological concepts
(2) List the different branches of ecology
(3) State the relationship of living organisms with one another and with the environment in which they live.
(4) Identify the interrelationships between groups or organisms or species of organisms living together in an area.

Introduction

In our last lesson, we learnt about the basic ecological concepts. We also learnt the meanings of different ecological concepts. Explain what is meant by ecology and synecology. What relationship exists between a single species and its environment. What is the importance of studying ecology to you as a student?

Presentation

Teacher explains the Local biotic communities and the two major zone which are

(a) Forest zone which also consist of the following local biotic communities

(i) Mangrove swamp forest (salt and fresh water swamp and tropical rainforest

(b) Savanna zone and is further subdivided into three

i) savanna belts
ii) Sahel savanna
iii) mangrove swamp forest and location.

Step 2:

The teacher explains Tropical Rainforest

Location and Characteristics of tropical rainforest

Evaluation

1. Which are the common areas in Nigeria where the mangrove swamp forest is located?
2. What are the characteristics of a mangrove swamp forest?

(a) Draw a map of Nigeria showing the following

(b) Forest zone

(c) Savannah zones

(d) Mangrove swamp forest

Summary and Conclusion

Highlight the main points of the lesson with the students.

Explain how biotic communities in Nigeria have been formed (discuss with a partner)

Assignment

Show where you can locate mangrove and rainforest swamps in the map of your country.

Lesson 3: Lecture Method
Date: Febuary, 2015.
Subject: Biology
Topic : Tropical rainforest
Class: SS II
Duration: 80 minutes
No. of pupils in Class:30
Average age: 17 years
Instructional method: Lecture Method
Teaching Aids: No chart
Previous knowledge: Mangrove swamp forest

BEHAVIOURAL OBJECTIVES
At the end of the lesson, students should be able to:
(a) Explain fully the characteristics of a swamp forest
(b) Explain the commonest types of woody trees, aerial roots having evergreen trees with broad leaves.

Introduction
Class You could recall our discussion during the last lesson that mangrove swamp forest is found in areas along the coast especially in states Like Delta, Cross River, Rivers, Akwa-Ibom etc. It is divided into major zones. Could you briefly list these zones? What do you think are the similarities and differences that can be found in forest and savannah zones?

Presentation
The teacher explain tropical rainforest,mention the location and the Characteristics of tropical rainforest

Step II
The teacher explain Sahel savannah and the characteristics

Evaluation
The teacher ask students the following questions in the evaluation process.
1. What is a savannah?
2. How does a savannah differ from a tropical rainforest?
3. In which parts of Nigeria do you find the following;
(a) Mangrove swamp forest
(b) Desert biome

Summary and conclusion
Highlight the main ideas of the lesson. Provide chalkboard summary for the students to copy.
Home work: Draw a map of Nigeria showing all the biotic communities

CONTROL GROUP

Lesson 4:

Date Febuary, 2015.

Subject: Ecology

Topic: Major biomes of the world

Class: SS II

Average age: 17 years

Instructional method: lecture Method

Previous knowledge: The students have been taught Local Biotic Communities, for example Forest and Savannah zones.

Behavioural objectives

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

(1) Explain in their own words the meaning of a biome

(2) Describe in their own words the different types of biomes globally

(3) Describe in their own words the types of biotic communities that are found in their country/locality.

(4) Outline and describe the characteristics of each biome.

Introduction

You could recall in our last lesson, we discussed tropical Rain forest and its characteristics.

Presentation

Could you explain briefly what it entails?

Explain what the components of the rainforest are?

How would you differentiate between a tropical rainforest and a mangrove swamp forest?

Step 1:

The teacher explains the followings and some of their location and characteristics:

Major biomes of the world

(i) Tropical rainforest

(ii) Savannah

(iii) Desert

(iv) Shrub

(v) Afro-alphine

(vi) Swamp

-Tropical rainforest

Location

Characteristics

Step 2: The teacher explain Savannah/Grassland

And mention the location

Tropical grassland
Location
Characteristics of tropical grassland

Step 4: The teacher explains Deserts and the characteristics
There are two types of deserts. These are the hot deserts and cold deserts.

Characteristics of cold deserts
Afro-Alphine
Characteristics of Afro-Alphine

Step 4:
The teacher explains Swamp and the characteristics
Characteristics of swamp

Evaluation
The teacher ask these questions to evaluate:
(1) How do climatic or physical conditions of tropical grassland relate to that of temperate grassland?
(2) In which of the forest areas do you find the following vegetational plants?
a. Creepers (b) climbers and (c) parasitic plants?
(3) Define the following
a. Afro-Alphine
b. Shrub
c. Swamp
d. Mangrove
q
Summary and conclusion
Highlight the main salient features of the lesson provide a chalk
board for the pupils to copy.

Home work
(1) Describe in your own words what a biome means
(2) Differentiate between an ecosystem and a biome

Lesson 5: LECTURE
Date: February, 2015.
Subject: Ecology
Topic: Population studies
Class: SS 2
Duration; 80 minutes
No. of pupils in class: 30
Average age: 17 years
Teaching Aids:chalkboard and notebooks

Previous knowledge: Students have been taught Biomes, the different type of Biomes and their characteristics.

Behavioural objectives
At the end of the lesson, students should be able to:
1. Explain in their own words the meaning of population
2. Identify basic concepts of population
3. Identify the different types of species found in particular habitats and relationships that exist between various organisms (plants and animals) in a habitat.
4. List the names of species that exert a greater influence or a major species controlling effect on other members of the community.
5. Enumerate population characteristics
6. Identify factors that affect population

Introduction
Class, who can help us define the word population?
Name the common species that are found in your locality or community. What is meantby population characteristics?

Step I:
The teacher explain the following:
Population
(2) Dominance

Step 2
The teacher explain Population characteristics
These characteristics include:
(a) Population size
Population density
Population frequency
(d) Percentage cover
(e) Population growth rate

Step 3:

The teacher explain

Factors affecting population

Factors which may affect the population of organisms in a given habitat include:

(1) Natality (birth rate)

(2) Mortality (death rate)

(3) Immigration (dispersal)

(4) Emigration

(5) Availability of food

(6) Seasonal climatic changes

(7) Breeding periods

(8) Natural disasters

Evaluation

Ask the following questions to evaluate:

(i) Population density

(ii) Population size

(iii) Percentage cover; and

(iv) Population size

Summary and conclusion

Summarize the lesson by highlighting the main points of the lesson

Lesson 6: Lecture Method
Date February, 2015.
Topic Ecological Factors
Subject: Ecology
Class SS II Ecology
Average age: 17 years
Teaching Aids: Essential Biology Textbook, Chalk and Board
Previous knowledge: Population studies

Behavioural objectives
At the end of the lesson, students would be able to:
1. Define the term ecological factors
2. Explain in their own words the meaning of the following terms under biotic factors
(i) Competition
(ii) Parasitism
(iii) Commensalism
(iv) Predation
(v) Pathogens
(vi) Mortality
(vii) Migration
(viii) Dispersal
(ix) Natality
(x) Food
(xi) Diseases
(xii) Pests

Introduction
Class, who can help us define the term ecology factors? Give the meaning of the following: biotic factors, competition, parasitism, commensalisms, predation, pathogens, mortality, migration, dispersal, natality, food, diseases and pests.

Step 1
The teacher explain the following Ecological factors

-Competition
-Commensalisms
-Predation
-Parasitism
-Pathogens
-Mortality
(immigration)
-Dispersal
-Natality

-Food
-Diseases
-Pests

Step 2: The teacher explain abotic factors
The abiotic factors comprise the following:

(i) Climatic factors
(ii) Chemical factors
(iii) Edaphic factors
IV) Topography

Step 3 The teacher explain
Ecological factors common to all habitats
Factors affecting/common to all habitats (both aquatic and terrestrial habitats) include (i) temperature, (ii) rainfall, (iii) light,(iv) wind, (v) pressure, (vi) hydrogen ion concentration of these factors, temperature and rainfall determine the major biomes of theworld temperature

Evaluation
Ask the following questions to evaluate
1) Name five ecological factors that are found in your locality/community
2) Define the following terms
(i) Mortality (ii) Food (iii) Parasitism (iv) Natality (v) Migration (vi) Pests.

Summary and Conclusion
Highlight the main salient features of the lesson provide a chalk
board for the pupils to copy.