EFFECTS OF SCAFFOLDING INSTRUCTIONAL STRATEGY ON ATTITUDE RETENTION AND PERFORMANCE IN ECOLOGY AMONG SENIOR SECONDARY SCHOOL STUDENTS OF GIWA EDUCATION-ZONE KADUNA STATE, NIGERIA

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MAY, 2019

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A THESIS SUBMITTED TO SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILSOPHY IN SCIENCE EDUCATION

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MAY, 2019

DECLARATION

I declare that this thesis entitled, "Effects of Scaffolding Instructional Strategy on Attitude, Retention and Performance in Ecology Among Senior Secondary School Students of Giwa Education-Zone, Kaduna State, Nigeria" has been carried out in the Department of Science Education, Faculty of Education, Ahmadu Bello University, Zaria, Nigeria. The information derived from the literature have been duly acknowledged in the text and in the list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

_____ _____

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CERTIFICATION

This thesis entitled Effects of Scaffolding Instructional Strategy on Attitude, Retention and Performance in Ecology Among Senior Secondary School Students of Giwa Education-Zone, Kaduna State, Nigeria" by Janet Adesola SANGOWAWA PhD/EDUC/4017/2011-12; P16EDSC9139 meets the regulation governing the award of the degree of Doctor of Philosophy (PhD) Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to the memory of my late beloved husband Dr. B.G. Sangowawa and my late beloved sons Mr. Toyin Tolulope Sangowawa and Mr. Taiwo Oluwadamilola Sangowawa. May their souls rest in perfect peace. Amen.

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ABBREVIATIONS

SIS**:**	Scaffolding Instructional Strategy
LM:	Lecture Method
FME:	Federal Ministry of Education
ECPT:	Ecology Performance Test
AEQ:	Attitude to Ecology Questionnaires
ZPD:	Zone of Proximal Development
AT:	Attitude Questionnaire

OPERATIONAL DEFINITION OF TERMS

Lecture Method: a teaching style in which the teacher does most of the talk.

Scaffolding Instructional Strategy: is an instructional technique that targets the learners' progress with support from actual developmental level to the potential level and as the students' progress, the support is removed.

Zone of Proximal Development: the distance between the actual development level as determined by an independent problem solving and the level of potential development as determined through problem solving under adult guidance or teacher or with a more knowledgeable other (MKO).

Ecology Performance Test (ECPT): the initial test administered to the two groups in the study which served as pre-test, post-test and postpost-test in Ecology.

Attitude to Ecology Questionnaire (AEQ): set of statements given to the students to find the attitude of the students to the concept of Ecology taught.

Attitude to Questionnaire: the Positive or Negative response of the Students to the Teaching of the Ecology concepts.

Ecology Retention: the ability of the students to recall the Ecology concepts taught after a specific interval of time.

ABSTRACT

The study investigates the "Effects of Scaffolding Instructional Strategy on Attitude, Retention and Performance in Ecology among senior secondary school students of Giwa, Education Zone, Kaduna State, Nigeria". The study was carried out as a result of the low performance of students in Biology especially in Ecology concepts as reported by W.A.E.C. Chief Examiner Reports (2008-2017). The research design was quasi-experimental, involving pretest, posttest and postpost-test. A sample of 139 SS II students was drawn from a population of 3092. Two instruments tagged Ecology Performance Test (ECPT) and Attitude to Ecology Questionnaire **(**AEQ) were used for data collection. The reliability coefficient of ECPT was calculated to be 0.88, while that of Attitude to Ecology Questionnaire (AEQ) was found to be 0.75. Six null hypotheses were tested at $P \leq 0.05$ level of significance using t-test, Wilcoxon signed rank test and Kruskalwallis test. The findings among others show that a significant difference existed in the performance and retention scores of the participants in favour of the experimental group. Also there was a significant difference in the attitude of experimental group compared to the control group, with the experimental showing a better attitude score. In addition, there was no significant difference in the performance of male and female student taught in the experimental group. The strategy proved to have a high potential for enhancing academic performance, retention and better attitude to the concept taught on the part of the students. On the basis of this finding a number of recommendations were made among which is the teaching of Ecology should be carried out with tasks that involve using scaffolds and involving interaction among students and teachers.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Biology as the science of life is offered in all Senior Secondary Schools in Nigeria. Nwosu (2003), states that Biology attracts more students in both science-oriented and Arts based students. Nwosu also observes that, Biology provides a platform for teaching students the ability to develop and apply science concepts and principles in solving everyday life problems. It serves as a pre-requisite to the study of other professions like, Medicine, Nursing, Pharmacology, Biochemistry, Agriculture, among others. Akanbi and Kolawole (2014), Agboghoroma and Oyovwi, (2015) opine that the vital role of the study of this discipline in the economic, industrial and public life of the learners and the general humanity cannot be overstressed. According to Agboghoroma and Oyovwi (2015), with knowledge explosion all over the world via the internet, biological knowledge has also expanded immensely. There are advances recorded in fields such as Biochemistry, Physiology, Ecology, Genetics and Molecular Biology that have made the subject a central focus in most human activities. This include problems like food scarcity, pollution, population, radiation, disease, health, hygiene, family life, management and conservation of natural resources as well as Biotechnology and Ethics.

However, over the years, the performance of students have not been very impressive from the West African Examination Council (WAEC) in the Sciences especially Biology (Table 1.1).

Table 1.1: WAEC Examination Result for Biology Students from 2011-2017 Kaduna State

Year	Total sat	No with A_1-C_6	% with A_1-C_6	No. with D_7-F_9	% with $D_7 – F_9$
2011	126,821	59657	47.04	67161	52.96
2012	134,852	56570	41.95	78282	58.05
2013	130,653	56155	42.98	74498	57.02
2014	150,925	72204	47.85	78722	52.17
2015	143,936	62008	43.08	81928	56.92
2016	149,162	61028	40.90	88134	59.10
2017	136,916	58284	42.60	78632	57.40

Source: West African Examination Council Kaduna Office (WAEC) 2017

Accordingly, from the various studies conducted in Nigeria Mbah, (2005); Aina, (2009), Aderogba, (2012) and Orenaiya (2014). A number of factors have been identified to be responsible for low performance in science (of which Biology is one). James (2005) and Aina, (2009) identify poor teaching methods and negative attitude of teachers towards teaching. Also, Braimoh and Okedeji (2001) and Folaranmi (2002) identify lack of motivation for most teachers, lack of teaching skills and competence by science teachers. In addition, Agoha (2005); Agbowuna (2009) and King'Aru (2014) report negative attitude towards science subjects among students. Furthermore, Olaleye (2002), reports the inadequacy of textual/reference materials. Some years ago, Okebukola (2004) describes instructional strategies for teaching science to be gloomy, ineffective and devoid of challenging and creative activities. He called for the use of an instructional strategy that could involve use of concrete activities or scaffold to enhance learning among learners. Etobro and Fabinu (2017), report that ecological management as one of the topics students have difficulty in understanding. Among reasons adduced for the perceived difficulty was

poor teaching strategy. He also reports that the nature of Biology forces students to memorize facts rather than help them learn meaningfully. Çimer, (2004) had reported that memorization is common among secondary school Biology students.

Mari (2001), earlier observes that most students are at the concrete operational stage of development and cannot learn difficult or abstract concepts meaningfully without the use of concrete examples to show relationships among concepts. Kidman, (2008) asserts that memorization of Biology concepts might be due to method of instruction. When texts and classroom activities do not include practical work or experiments, students may consider Biology a science that just requires the memorization of factual knowledge. Memorization leads to students' inability to question phenomena which are not understood since teaching is teacher-centred. Lakpini (2006), states that memorization results in students finding it difficult to see value in the science they learn as applicable to life though they are able to recite masterfully the information/concepts studied. This method encourages rote learning, neglects slow learners who find it difficult to grasp orally presented instruction, discourages interaction among students and teachers incapable of imparting scientific skills and attitudes on students. Lakpini (2010) asserts that teacher-centred learning can be less productive and, in some cases, detrimental to conceptual understanding; teachers' competencies and knowledge in both Biology as a discipline and its teaching are crucial for enhancing students' learning. The most commonly used method of teaching in Nigeria is talk and chalk method generally referred to as the expository method (Baike, 2000 and Lakpini 2006).

Lakpini (2010) reports that the lecture method of teaching emphasizes the overall content rather than conceptual understanding and learning for the students is used principally for testing, hence; retention is short-lived. Danmole and Adeoye (2004) admit that no single method is best for the teaching of science especially Biology of which Ecology is a branch. They agreed also that methods that would involve active students participation such as cooperative learning, guided discovery, scaffolding, use of analogy and problem-solving can go a long way to improve learning. However, Igboegwu, (2012) describes most of the methods used by Biology teachers as inappropriate and uninspiring. Treagust (2002), however, provide evidence that teachers' content knowledge has an effect on both the content and the processes of instruction, thus influencing both what and how they teach. Mari (2001); Lapkini (2006) and Djwantoro's (2010) studies indicate that research efforts have proposed various suggestions and recommendations for improving the quality of science teaching and learning in Nigerian classrooms. Some of these recommendations are: use of learner centred instructional methods that enhances cognitive gains and the acquisition of science proleg-skills (Mari, 2001). Agoha (2005) and Agbowuno (2009) in their independent studies observe that, students have negative attitudes to learning Biological concepts which contribute to low performance. Attitudes determine how an individual thinks, feels or reacts towards an object.

If students have better attitude towards an object or subject, it is easier to lead them towards desirable objectivess. According to an observation by Bansal (2017), bad instructional strategies that do not promote meaningful learning and tend to make students develop negative feeling and behaviour towards learning materials which has negative toil on their performance. This is because as negative attitude is known to affect students' involvement

in learning and performance (John, 2014). As proleg-based instruction provides concrete examples and engages students in learning process, it is expected to have positive influence on students attitude. Çimer (2004), opines that if teachers show weaknesses in their knowledge of the subject, this might create a lack of confidence in students about the teachers' abilities and knowledge. The effect of this among others, is that a student may become less attentive and develop negative attitude towards both Biology as a subject, and the teacher. This leads to the idea of Scaffolding Instructional Strategy to be investigated to find the impact on the attitude retention and performance of students on Ecology.

The idea of scaffolding emerged from socio-constructivist views of learning, especially Vygotsky's (1978) socio-cultural notion of the ("Zone of Proximal Development" ZPD). This zone reflects the "distance between the actual development level of the learner as determined by activities that can be performed without assistance and the potential development level of the learner as determined by performance of tasks under guidance of a more capable person". This person guides the learner through the ZPD towards a new actual development level in a gradual process of scaffolding. The notion of scaffolding is increasingly being used to describe the support provided for students to learn successfully in classroom (Janneke, Volman, Oort and Beishuizen, 2015). Janneke *et al* (2015), emphasize that learning occurs in rich social context marked by interaction, negotiation, articulation and collaboration.

Hartman (2002), identifies a number of important scaffolds like giving approval, probing learner's ideas, structuring task activities and providing general hints or specific suggestions that will help the learner throughout the task. Asking learner's questions and using appropriate written materials are other important scaffolding tools. In researches

carried out, Scaffolding Instructional Strategy was used to teach Ecology. Hartman (2002) reports that Scaffolding Strategy promotes dialogue between teacher and students which provides the students with enough guidance and support to accomplish goals that are impossible without it. This strategy also promotes self-reliance and possibly positive attitude in the students (Alake, 2007a). The present study also investigates if using the scaffolding strategy could result in gender disparity.

Ogunkola and Bilesanmi-Awoderu (2002), opine that the issue of gender is an important one in science education especially with increasing emphasis on ways of boosting manpower for technological development as well as increasing the population of females in science and technology fields. David and Stanley, (2000); Freedman, (2002); Sungur and Tekkaya, (2003); Din, Ming, and Esther (2004); Arigbabu and Mji (2004); have provided reports that there are no distinguishing differences in the cognitive, affective and psychomotive skill performance of students in respect of gender. Arigbabu and Mji (2004), report that in Nigeria and perhaps the whole of Africa, gender bias is still very prevalent. This is a view to which Onyeizugbo (2003) alluded to in pointing out that sex roles are somewhat rigid. It is common place to see gender stereotypes manifested in the day-to-day life of an average Nigerian. However, Billings (2000); Kolawole (2007) in their studies found that male students performed better than female students in the cognitive, affective and psychomotor skill performances. Therefore, there is a strong association between gender and response to science education. The likely influence of gender factors on students academic performance in Ecology when they are taught using Scaffolding Instructional Strategy and Lecture Methods was examined in this study. The research also

considered retention as a variable in determining the students retention ability in the Ecology concept taught.

Bichi (2002) states that retention is the ability to preserve and consequently remember things experienced or learned by an individual at a time It takes place when learning is coded into memory. Thus, appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane (Bichi, 2002). The nature of the material to be coded contributes to the level of retention. Materials are related to the quality of retention in terms of their meaningfulness, familiarity, concreteness and image evolving characteristics (Adeniyi, 1997). Permanent and meaningful learning is the ultimate target of any educational endeavour. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students (Bichi, 2002). Onyegebu (2006), states that retention is the ability of the working memory of an individual to retrieve stored information from the long term memory for processing is attained.

Achimugu (2008), opines that students comprehend and remember better when teaching materials are employed in the teaching-learning process, if carefully and properly planned enhances teaching and learning of science. Retention is the ability of the learner to remember what has been learnt after some reasonable period of time has elapsed. This explains the need to find strategies of teaching that will help the students retain learnt concept longer and apply them when needed. Therefore, the need for the present study on Effects of Scaffolding Instructional Strategy is to ascertain the students' retentive ability in Ecology concept. Bichi (2002), reports that learning should improve retention while things

that lead to confusion or interference among learned materials decrease the speed and efficiency of learning and accelerates forgetting.

Studies on retention and instructional strategy have attracted the attention of many researchers in recent years, Crossgrave and Curran (2008) investigated knowledge retention after four months associated with the use of clickers in introductory Biology class for non-majors and the other genetic course for Biology majors. (Clickers are small hand-held keypads that allow students to answer a multiple choice (MC) question displayed on a projection system. A receiver on the instructor's computer collects the information, and it is displayed as a graph of the students responses). The retention information was compared four months after the course ended and there was increased retention of material taught with clickers for the non-majors course, but not for the Genetics course.

Students' performance was significantly higher in examination questions covering materials taught with clickers, the differences were more dramatic for the non-major Biology course than the Genetic course. This retention study using clickers is relevant to the impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology in the use of scaffold while it differs in the technological device and with tertiary students but the present study used secondary school students to teach Ecology concept. Furthermore, the value of Biology animations on knowledge retention in introductory Biology twenty one days after viewing was investigated (O'Day, 2007) on the effectiveness of animation versus graphics in the long term retention of information involving 393 students responses, three different animations and two graphics – one with one and one lacking a legend were used to determine the long term retention of information. The results

show that students retain more information 21 days after viewing an animation without narration compared with an equivalent graphic whether or not that graphic had a legend, students' comments provided additional insight into the value of animations in the pedagogical process.

The study of O'Day, (2007) on retention is relevant to the present study on Effects of Scaffolding Instructional Strategy in the use of scaffold but differs in using tertiary students and on the technology operations. Custers (2010), provides an excellent review of basic science knowledge retention in general and medical education in medical school students. Examination of these types of knowledge retention studies yields mixed results with some indicating a great deal of knowledge retention and other revealing significance loss of knowledge over time. Scaffolding Instructional Strategy was employed in this study to find its effects on attitude, retention and performance of Ecology concept to Senior Secondary two (II) students of Giwa. The literature shows that performance of students have continued to decline because of the instructional strategies that do not involve meaningful learning through learners active participation in learning (James 2005; Okebukola, 2006; Aina, 2009). Studies show also that the use of instructional strategies that enhance interaction of learners with learning materials, use of scaffolds, problem solving among others can enhance achievement and retention of concepts (Brynes, 2006; Azih and Nwosu, 2011; Janneke, 2015). This study investigates the impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among Senior Secondary II students of Giwa Education-Zone, Kaduna State.

1.1.1 Theoretical Framework

The theoretical framework for this study is hinged on the constructivist theory of social constructivism of Vygotsky (1978) and Cognitive constructivism of Piaget (1964) that attempt to explain how students learn by constructing understanding by themselves. The central idea of Piaget's theory is that knowledge is not a copy of reality, but is the product of a person's interaction with his environment. To Piaget, cognitive development was a progressive reorganization of mental processes resulting from biological maturation and environmental experiences which he termed "equilibrium". He described equilibrium of learning as consisting of two processes, Assimilation and Accommodation. By this two processes students construct new knowledge from their experiences. Assimilation causes an individual to incorporate new experiences into the old experiences. This causes the individual to develop new outlooks, rethink what were once misunderstandings and evaluate what is important, ultimately altering their perceptions. Accommodation, on the other hand, is reframing the world and new experiences into the mental capacity already present. When things do not operate within that context, they must accommodate and reframe the expectations with the outcomes. The implication of this is that teaching and learning at all stages of a child's development should be learner-centred.

In Scaffolding, teachers following Piaget's theory functions as facilitators whose role is to aid the students when it comes to their understanding. This takes away the focus from the teacher and lecturer and puts it upon the students and their learning. Instead of telling, the teacher must begin by asking. Instead of answering questions that only align with their curriculum, the facilitator in this case must make it so that the students come to the conclusion on their own instead of being told. Also, teachers are continually in

conversation with the students creating the learning experience that is open to new directions. Depending upon the needs of the students as the learning progresses.

In addition, teachers following Piaget's theory must challenge the students by making them effective critical thinkers and not being merely a "teacher" but also a mentor, a consultant and a coach. Some strategies for teachers include having students working together and aiding to answer one another's questions. Another strategy includes designating one student as the "Expert" on a subject and having them teach the class.

These strategies are similar to Vygotsky social constructivism, who believes in child's cognitive development progresses by social interaction with others. These strategies are all in the application of Scaffolding Instructional Strategies in the teaching of the Ecology concepts to students. In scaffolding social interaction encourages development through the guidance of skillful adults. The students exercise their will, determination and action to gather selective information, convert it, formulate hypotheses, test suppositions via applications, interactions or experiences and draw verifiable conclusions. (McLeord, 2007). The students are allowed to draw conclusions on their own based on experiences acquired from activities engaged in during studies. Thus, logical and conceptual growth is enhanced by creating the learning experiences that is open to new directions that challenge the learner by making them effective critical thinkers, to develop skills and confidence to analyze the world around them, create solutions or support for developing issues and then justify their words and actions through scientific processes (Zohar, 2004).

Vygotsky's theory is a socio-cultural approach that perceives knowledge as socially constructed. Vygotsky was concerned with the child's mental development and learning

from a psychological point of view within its Zone of Proximal Development (ZPD). Vygotsky suggests that when individuals work together, socio-cognitive conflicts occur which creates cognitive disequilibrium that stimulates perspective thinking and ability reasoning which allows students to learn at their level. Vygotsky's theory assumed that learning arises not through interaction, but in interaction where learners first succeed in performing a new task with the help of another person and then internalize this task so that they can perform it on their own. The groups are heterogeneous faction so that the More Knowledgeable Others (MKO) can help others. The other person's help would be the teacher using explanation, questions, hints, prompts, which are scaffolds to support the student in the performance of the task. In this way, social interaction is advocated to mediate learning. Social interaction plays a fundamental role in the process of cognitive development. Through social interaction with More Knowledgeable Others (MKO) such as more advanced peers and adult learners eventually develop higher mental functions such as language, logic, problem-solving skills, moral reasoning and memory schemas such as retention ability.

Vygotsky emphasized the process of internalization which involves the students actively processing an experience, modifying the experience based on past experience and then integrating this experience into his or her way of thinking in such a manner that the old way of thinking is changed or developed. It is for this theory of cognitive development that Vygotsky has become known as a major contributor to the discussion of constructivism. Central to Vygotsky's theory of social cognitive development, is his construct of the Zone of Proximal Development (ZPD), which was conceptualized as the distance between the actual development level as determined by activities that can be performed without

assistance and the potential development level of the learner as determined by performance of tasks under adult guidance or in collaboration with more capable peers (Vygotsky, 1978).

Therefore the study was also hinged on theory of social constructivism of Vygotsky (1978). This study is related to Vygotsky theory in the following ways:

1. The study encourages social interaction with other students in the group by carrying out the task or skill and they depend on one another in their learning process.
2. There are supporting materials such as partial solutions, questioning. explanations, prompts examples, hints which are scaffolds to enable them to learn from each other which may lead to better performance. Socialization may also promote their positive attitude towards learning of Ecology.
3. The study also recognizes the use of More Knowledgeable Others (MKO). The students worked in groups while the MKO explains the task to others in the group thereby increasing their capacity of working cooperatively together to the individual success.

Ausubel (1968), postulates that meaningful learning occurs when the learners' experience is related to the new materials to be learnt. The underlying basis of Ausubel's theory is that meaningful learning occurs when new knowledge is consciously and purposely linked to an existing framework of prior knowledge which is in the steps of Djwantoro's (2010) model of Scaffolding Instructional Strategy adopted for this study. The learner must also consciously relate the new ideas or verbal propositions to relevant aspects of the learner's knowledge structure. Scaffolding promotes meaningful learning and makes information to be retained longer. This implies that Ecology teachers should be able to

effectively link and bridge the gap between the previous knowledge and the new materials or tasks or concept to be taught.

Therefore, the investigation on the Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology was based on the theories of Vygotsky (1978), Piaget (1964) and Ausubel (1968).

1.2 Statement of the Problem

In spite of the important position of Biology in science and related disciplines, Aderogba (2012), Orenaiya (2014) in their studies report that academic performance of students in Biology (of which Ecology is a branch) at the Senior Secondary School Certificate Examinations (SSCE) has consistently been low. The reports of Chief Examiners of WAEC (2008-2017) supports this point. The Chief Examiner in 2007 reports that the question on Ecology was the least answered by the candidates. This shows the preference of students to other questions probably which they found easier than the Ecology therefore avoiding it because of its degree of difficulty. In 2010, he further reports that even though many candidates attempted the question on Ecology but the performance was just average. In 2011, the Chief Examiner's report shows a poor performance of the candidates on the concepts examined on Ecology too. The 2012 report was that most candidates did not attempt the question. This may also be due to lack of understanding of the concepts in the classroom teaching. The year 2013, also had a report of poor performance. It was reported that many candidates were unable to describe and define certain ecological terms such as ecological succession in the question. This is a topic that with a good teaching strategy like scaffolding if used, the performance could have been better. In 2015, the pattern of performance was nothing different from previous years because majority of the candidates

did not answer the question well with the unambiquous answer the question required. The Chief Examiner's report for 2017 did not differ from the previous years of general poor performance. He comments too that the few candidates that attempted the question performed badly. These reports are evidence of low academic performance of students in Ecology at the Senior Secondary School Certificate Examination (SSCE).

Some of the factors that led to low performance are poor teaching strategies, negative attitudes of teachers towards teaching (Aina, 2009; Usman, 2010), negative attitudes of students towards Biology (Agbowuna, 2009; King'Aru, 2014). Attitude has been found to affect academic performance. Foley and Mcphee (2008), report that students' positive attitude to science correlate highly with their performance. In addition, lack of qualified teachers and teaching facilities are among several factors that lead to poor performance. The quality of learning and knowledge acquired and retained by the students can be determined by the teaching and learning process. Bichi (2002), states that most scientific information is passed to students' via conventional method. Most teachers use Lecture Method that lack active students' participation which brings about low retention. However, efforts are being made to find solutions to the recurring failure rate among Biology students by the researcher. One of such efforts is the use of learners-centred instructional method such as Scaffolding which is a learning strategy designed to promote a deeper level of learning where students learn in groups, interact socially and are supported by mates, teachers and materials.

Therefore, the researcher sought to address the problem of low performance through the use of Scaffolding Instructional Strategy which has the potential improving their

performance by helping students to construct knowledge bringing about better attitude and retention. This support given during the process of learning is tailored to the need of the students with the intention of helping the student achieve his or her learning goals (Hartman, 2002). This study therefore investigates the effects of scaffolding instructional strategy on attitude, retention and performance with gender in Ecology among senior secondary students of Giwa.

1.3 Objectives of the Study

The main objective of the study is to determine the "Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among Senior Secondary (II) students of Giwa. The specific objectives were to:

i. determine whether the academic performance of Senior Secondary School (II) students' taught Ecology using Scaffolding Instructional Strategy differs from those taught using Lecture Method;

ii. determine whether the mean performance scores of male and female secondary school (II) students taught Ecology using Scaffolding Instructional Strategy differs;

iii. investigate whether the retention scores of Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy differs from those taught using Lecture Method;

iv. assess whether the retention scores of male and female Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy differs;

v. investigate whether the attitude of Senior Secondary School (II) students taught Ecology with Scaffolding Instructional Strategy differs from those taught using Lecture Method; and

vi. determine whether the attitude of Senior Secondary School (II) male and female students taught Ecology using Scaffolding Instructional Strategy differs.

1.4 Research Questions

The following research questions were addressed by this study:

i. What is the mean difference between the mean performance of Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method?

ii. What is the difference between the mean performance scores of male and female students taught Ecology using Scaffolding Instructional Strategy?

iii. What is the difference between the mean retention scores of students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method?

iv. What is the difference between the mean retention score of male and female students taught Ecology using Scaffolding Instructional Strategy?

v. What is the mean difference between the attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method?

vi. What is the mean difference between the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy?

1.5 Null Hypotheses

The following hypotheses were tested at $P < 0.05$ level of significance.

H_{01}: There is no significant difference between the mean performance scores of Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method.

H_{02}: There is no significant difference between the mean performance scores of male and female senior secondary students taught Ecology using the Scaffolding Instructional Strategy.

H_{03}: There is no significant difference between the mean retention scores of Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method

H_{04}: There is no significant difference in the mean retention score of male and female Senior Secondary School (II) participants taught using Scaffolding Instructional Strategy.

H_{05}: There is no significant difference between the attitude of Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method

H_{06}: There is no significant difference between the attitude of male and female Senior Secondary School (II) students taught Ecology using Scaffolding Instructional Strategy.

1.6 Significance of the Study

The study determines the use of Scaffolding Instructional Strategy to teach Ecology concept in attitude, retention and performance of students among secondary school students in Giwa, Kaduna State. The findings of this study would hopefully uplift the standard of learning, teaching and performance of students in Biology with emphasis on Ecology in the following ways.

Biology Students: will have the opportunity to participate fully in the classroom discussion since scaffolding strategies promote interactive support, that leverages what students already know to help them meaningfully participate in and gain skill at tasks that are beyond their unassisted abilities.

The social interactions that teachers and students have using Scaffolding Instructional Strategy will assist them learn to work in groups and increase their capacity of working cooperatively together.

Biology Teachers: Scaffolding would build off of what students already know and be tied to ongoing assessment of student abilities which enhances performance. The suitability of this strategy can make the teachers to adopt it in instruction and also learn to develop scaffolding lesson plan. Teachers are engaged in professional tasks such as curriculum evaluation, curriculum revision and curriculum development.

Textbook Writers in Ecology would be encouraged to write and publish books on Scaffolding Instructional Strategy using the Nigerian context. In this process, the use of Scaffolding Instructional Strategy may be gradually recognized, accepted and implemented in the Nigerian school system.

Professional Bodies like Science Teachers Association of Nigeria (STAN) that carry out seminars, workshops and research activities might find the results of the study useful and incorporate them also into their instructional packages. They will also disseminate research findings and recommendations that can benefit them from this study.

Curriculum Experts can benefit from the study based on the suitability of the method which will encourage teachers' to use it in teaching. This study will also contribute to current information on the existing literature in Biology. The findings are expected to throw more light on how Ecology lessons should be taught using the lesson plan model developed.

Researchers: The findings will provide new information to the existing literature and serve as foundation for further studies in similar areas.

The Institution of Higher learning where Biology teachers are trained could make use of Scaffolding Instructional Strategy so as to equip them to produce more effective teachers who would in turn help students to learn from a "more knowledgeable one'' (MKO) interactively.

1.7 Scope of the Study

The study investigated the Effects of Scaffolding Instructional Strategy on Attitude, Retention and Performance in Ecology among Senior Secondary School (II) Students. The study was conducted in two senior secondary II schools located in Giwa. These secondary schools are Government Day Secondary Schools Jama'a and Government Day Secondary School Kwangila. It was carried out for six weeks. The justification for choosing SSII is that they have studied Biology for one year and have gotten some background of Biology and are more stable in school. The concept chosen is in SS II syllabus (Ecology) which is

one of the areas that have been identified as difficult (Okebukola and Jegede, 2006) and also having low performance in West African School Certificate Examination (WASCE) according to WAEC Chief External Examiner's Reports (2008-2017). The concepts are basic ecological concepts, functioning ecosystem, ecological management and Ecology of population. The average age of the students is 16-18 years. The model used is Djwantoro (2010) Scaffolding Instructional Strategy to teach Ecology to Senior Secondary School (II) students of Giwa

1.8 Basic Assumptions

The study has the following basic assumptions.

i. The selected topics or concepts are appropriate for the level of the students for this study according to the syllabus.

ii. The students and teachers are not well acquainted of Scaffolding Instructional Strategy.

iii. The students have the same attitude toward Ecology.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This study investigates the Effects of Scaffolding Instructional Strategy on Attitude, Retention and Performance in Ecology among senior secondary schools of Giwa, Kaduna State, Nigeria. In this chapter, a review of related literature was made that are relevant to this study and are discussed under the following sub-headings:

2.2 The Teaching and Learning of Biology at SSCE

2.2.1 Importance of the Study of Ecology at SSCE

2.3 Science Teaching Methods

2.3.1 Academic Performance in Biology

2.4 Historical Perspective of Scaffolding

2.4.1 Concept of Scaffolding

2.4.2 Types of Scaffolding

2.4.3 Types of Scaffolding Models

2.5 Instructional Strategy and Academic Performance in Science

2.6 Concept of Attitude

2.6.1 Attitude and Academic Performance in Biology

2.7 Instructional Strategy and Retention Ability in Biology

2.7.1 Instructional Strategy and Performance by Gender in Science

2.8 Overview of Similar Studies

2.9 Implications of Literature Reviewed for the Present Study

2.2 The Teaching and Learning of Biology

Teaching is defined as the provision of experience and guidance of activities to promote learning on the part of those engaged in the activities (Okafor, 2008). These descriptions refer to the level at which content and concepts are understood as a result of the pieces of learning. The purpose of all teaching is to make the students learn or know what they are taught. Teachers teach to impact knowledge and skills on the students. For teaching to be effective, it has to be rooted in an understanding of how students learn.

According to Ayeni (2011) teaching is a continuous process that involves bringing about desirable changes in learners through the use of appropriate methods. Effective teaching reported by (Orji and Orji (2007); Adeoye and Alayande (2009)) is characterized by maximum students involvement, goal oriented, conducive learning environment, effective awareness, democratic attitudes and personal concern for students. Adunola (2011) indicates that in order to bring favourable changes in students, teaching methods used by educators should be best for the subject matter. It is in the light of this that the researcher is investigating the Impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among Senior Secondary II students.

Furthermore, teaching methods work effectively if they suit learners' needs since every learner interprets and responds to questions in a unique way (Chang, 2009; Bharadway of Pal, 2011). The need for reform in the teaching and learning of Biology cannot be over-emphasized. The National Policy on Education (FME, 2014), states some measures that should be taken to ensure qualitative education. It observes that educational activities should be learner-centred for maximum self-development and self-fulfillments; modern

educational techniques shall be increasingly used and improved upon at all levels of the educational system–inspire its students with a desire for self improvement and achievement of excellence. In addition, the Federal Government stated some objectives in the core curriculum for the Senior Secondary Biology (FME, 2014). They include the preparation of pupils to acquire:

i. adequate laboratory and field skills in Biology;
ii. meaningful and relevant knowledge in Biology;
iii. the ability to apply scientific knowledge to everyday life in matter of personal and community health and Agriculture; and
iv. reasonable and functional scientific attitude

From the above, a close look at this policy shows a need to investigate the process of teaching and learning that is going on in Nigerian schools in relation to methods and strategies that are used in the delivery of the content. This calls for a teaching technique that will help the learner to maximize self development, to develop the habit of self learning; create in the learner ability to think for himself. Consequently, the researcher feels it is necessary to investigate the impact of scaffolding on attitude, retention and performance in Ecology among senior secondary II students. This means that teaching and learning in Biology classes should be child-centred so that the activities of the child would have the most important educative influence on the child. Omolade (2008), reports that students learn best by doing and getting actively involved in the learning process.

The importance attached to science especially Biology by the Federal Government could be due to the general belief that science is capable of improving and changing skills, attitudes

and cognition by increasing pupils' store of knowledge about themselves, their environment and their world. Omolade (2008), opines that meaningful learning occurs when learners comprehend concepts and are able to connect them with previous knowledge. Warburton (2007), states that when students learn Biology meaningfully, their ability to reflect on their own learning and make adjustments accordingly fosters deeper learning. Warburton further adds that deeper learning is the key strategy through which students find meaning and understanding from course material and experiences. This in turn may result in competence of knowledge transfer to other domains and how to apply the knowledge in answering questions and resolving problems (Pellegrins and Hilton, 2012).

2.2.1 Importance of the Study of Ecology

Biology is a natural science subject which studies living organisms and how they interact with each other and their environment. It examines the structure, function, growth, origin evolution and distribution of things. Also, it classifies and describes organisms, their functions and how species come into existence. Ecology is one of the branches of Biology that study the interrelationship among plants, animals and their non-living environment. It seeks to understand the vital connections between plants and animals and the world around them. It also provides information about the benefits of ecosystems and how we can use earth's resources in ways that leave the environment healthy for future generations. Ecologists study the relationships among organisms and habitats of many different sizes, ranging from the study of microscopic bacteria growing in a fish tank, to the complex interactions between the thousands of plant, animal and other communities found in a desert.

Ecology provides knowledge and understanding of the mechanism of change brought about by the interaction of the living things and its effects on their external environment (Ige, 2001; Nwagbo and Obiekwe, 2010). Ecology gives the students an opportunity to meet with some of the most important ecological issues affecting the environment. These include the influence of human activity in altering the ecological set up such as burning, deforestation, radioactive substances and difficulties arising from the stress of modern day life (Nwagbo and Obiekwe, 2010). In secondary school Biology Curriculum, it was observed that ecological concepts play very important role in scientific advancement that affects the lives of mankind such as genetic experimentation and engineering, manufacturing of food and drugs, ecological impact of modern technology and global warming (Alsop and Hicks, 2001; Minishi, Muni, Kumu, Mutai, Mwangasha, Omoko and Munyeke, 2004).

Teaching of Ecology involves field trips which could help students to understand and appreciate application of learning concepts in real life as described by the school curriculum. It encompasses searching for insects in the school garden, excursion to National parks, game reserves, zoos, visiting museum, lagoons as well as indoor activities. The many specialities within Ecology, such as marine, vegetation, and statistical Ecology, provide us with information to better understand the world around us. This information also can help us improve our environment, manage our natural resources, and protect human health. The following examples illustrate just a few of the ways that ecological knowledge has positively influence our lives. Public Health: Ecologists have discovered that marshes and wetlands filter toxins and other impurities from water. Communities can reap the benefit of this ecological service. Leaving some of these filtering ecosystems intact can

reduce the burden on water treatment plants that have been built to perform the same service. By using natural filtering systems, we have the option to build fewer new treatment plants.

Ecologists have discovered that many plants and animals produce chemicals that protect them from predators and diseases. Some of these same chemicals have been synthesized by scientists or harvested from the organism and used to treat human diseases. For example, the pacific Yew tree produces a substance which is used in cancer treatments. Another example is a substance found in horse shoe, crabs and hemolymph, that is used in leukemia treatments. Lyme disease is a potentially serious bacterial infection that is transmitted to humans by certain ticks. Ecological studies have found that people are more likely to get lyme disease when acorns are plentiful. Why? Because mice and deer, which carry the disease and the ticks, feed on acorns. More acorns usually mean more mice and deer, thereby providing a favourable environment for large populations of ticks to flourish. Knowing the connections between acorns, deer, mice and ticks, ecologists are able to predict the likelihood of infection and let people know when they need to be more careful when outdoors. These are lessons that can be taught to enlighten the knowledge of the students in Ecology.

Ecological concepts have been applied to forest management and are slowly being integrated into traditional forest sciences. For example ecological studies have shown that fire plays a key role in maintaining healthy forest ecosystems in certain types of forests. This knowledge has encouraged more research to find ways to use controlled fires to prevent unpredictable and costly wildfires. Biological control is a technique that uses the

natural enemies and predators of pests to control damage to crops. It is based in part on knowing the Ecology of pests, which is used to understand when and where they are the most vulnerable to their enemies. Biological control alleviates crop damage by insects, saves money, and decreases insects, saves money and decreases problem associated with pesticides.

Ecological research has shown that estuaries are nursery grounds for fish populations that live in coastal waters, an important reason to protect these areas. Ecological research has also identified obstacles, such as dams, that fish encounter when returning to their breeding areas. This information has been used to help design structures for fish so they can move around these obstacles to reach their breeding areas. These importance of the study of Ecology when carefully integrated into the teaching will increase the attitude of students to the study of Ecology leading to retention and performance especially when taught with scaffolding strategy.

2.3 Lecture Method and Academic Performance in Biology

Lecture method is a teacher centred, student peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials (Nwagbo, 1999). According to Awotua-Efibo (2001), the teacher comes to the class fully armed with a mass of facts, probably gathered from books and would start to pour out the fact. The teacher presents ideas or concepts, develops and evaluates them and summarizes the main points at the end, while the students listen and take down notes. The students are passive instead of active and so it does not encourage learning through active involvement which is a very important principle of learning. It does not encourage the

students to practice oral communication skills. Nacino-Brown (2002) and Maduewesk (2010) have the following as the advantages of lecture methods

i. It has high inspirational and motivational value. It is therefore, an effective method of creating interest and appreciation.

ii. It supplements and enriches materials found in students' textbooks.

iii. The teacher has complete control over choice of the knowledge the students learn.

iv. He can present exactly what he wants in the way he wants.

v. It results in economy of time and effort (Nacino, 2002).

vi. It is very useful in teaching a large class

As observed by Mari (2001), the teacher-centred method of teaching is best suited for abstract learners and does not suit concrete learners. Academic performance according to Obeka (2009), is the quality of results produced by students which reflects in the quality of their examination scores. Obeka, Bichi and Yusuf (2012) define academic performance as the display of knowledge attained or skill developed in school subjects designed by test and examination scores or marks assigned by subject teacher. Oghenerwede (2010), reports that teaching is effective when the approach used brings about a desirable change in the behaviour of the learner.). If learning strategies and students performance have to improve, then the students have to be introduced to a more efficient and appropriate teaching approach. The research reported by Azubuike (2005) and Nwagbo (2008) indicate that students perform low in secondary school science subjects especially Biology. Lioyd (2009), states that low achievers performance could be improved when instructions is based on clear demonstration guided practice, active involvement of the students in goal directed

activities with immediate feedback and reinforcement. All these are made use of in Scaffolding Instructional Strategy.

A number of factors were identified as militating against students' attainment of the objectives of science instruction. The isolated factors among researchers are the inappropriate and uninspiring teaching approaches adopted by science teachers. (Aina, 2009; Igboegwu, 2012). These researchers express the view that teachers shy away from activity oriented teaching approaches which are known to be more effective (Okebukola, 2006). They rely most on teaching approaches that are easy but most times inadequate and inappropriate. The study carried out by Ibrahim (2008) investigates the effects of levels of teacher-student verbal interaction on academic performance of Senior Secondary School Biology students found that students taught Biology using high level of teacher-students verbal interaction performed significantly better than those in the medium and low level of interaction in some Biology concepts. Ketim and Olowo (2013), in a study on the academic performance of direct and pre-NCE students in Federal Colleges of Education (Special Oyo) found that students that entered Federal Colleges of Education through pre-NCE and Direct entry did not differ in their performance. This is why this study investigates to find out the impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among the SS II students. This was done to find if there is any signficiant difference in the performance of those taught with Scaffolding Instructional Strategy and those taught with Lecture Method.

2.4 Historical Perspective of Scaffolding

The notion of scaffolding was initially presented and analyzed in the learning theories of the Russian Lawyer, Philologist and psychologist Lev. S. Vygotsky (1896-1936). Although, he did not use the exact word 'scaffolding' in the description of the support that a child may receive from others as he grows up mentally and psychologically. Vygotsky's theories concerning the cultural and social dimension of learning were met and supported by the American psychologist J. Bruner. The term 'scaffolding' was initially introduced by Wood, Bruner and Ross (1976) as tutoring or other assistance provided in a learning setting to assist students with attaining levels of understanding impossible for them to achieve without assistance. They viewed scaffolds as personal in nature; that is aid provided by teacher or peer to help in the learning process. Scaffolding is a multi-faceted and, many times, misunderstood term that is related to second language teaching and learning and has been subjected to intensive research by scholars and educators (Bruner, 1985; Hammond, 2001; Walqui, 2006; Walqui and Van Lier, 2010). Its literal meaning refers to the constructions (Scaffolds) that workers make little by little in order to be helped when they raise a building and which they dismantle when the building is ready to stand on its own. Metaphorically, the term has been borrowed from the fields of children's psychology and pedagogy and seems to be part of a more modern view of second language teaching and learning which posits the child into learner-centred and task-based approaches and theories, and where the learner is seen as a social being who acquires knowledge in general and language more specifically through interaction with the teacher and his/her peers and not as individual units.

Wood, Bruner, and Ross, (1976), introduce scaffolding in the context of adults assisting children in acquiring knowledge or solving problems in informal learning environments. Early research and practice on scaffolding focused on parents helping children in informal learning environments was done by (Wood, Bruner: and Ross, 1976; Lepper, Drake and O'Donnell-Johnson, 1997; Coltman, Petyaeva, and Anghilera, 2002). Because of its effectiveness in informal learning, it was adopted to formal education which under natural settings is not based on one-on-one interaction but includes multiple learners (Hogan and Pressley, 1997; Roehler and Cantlon, 1997). Later, it was adjusted to include a wider range of learners with diverse learning goals in formal education (Kao, 1996; Sharma, 2001, Dennen, 2004).

With the advance of technologies and their application in education, there are considerable interests in scaffolding students learning in technology-based environments (Sharma, 2001; Bean and Stephens, 2002; Azevedo, Cromley, Thomas, Seibert, Tron, 2003 and Ge and Land, 2003). In addition, many studies have been conducted to use technological means, especially computer-based tools (Chang, *et al.,* 2001) rather than human beings to assist students (scaffold) with instructional activities in learning. These tools can be embedded within multi-media and hypermedia software to provide students with support while they are using the software (Chang *et al*, 2001). Today, the definition of scaffolding has expanded to include a broad range of formal structure, including conversational devices (For example guiding questions), curriculum design (e.g. direct instructions for students), and features of computer software Pea, (2004); Ouitana, *et al*., 2004; Tabak, (2004). There are increasing interests in the use of scaffolding in distance learning environment with the boom of internet-based distance education.

More recently, research has focused on tools, in particular technological tools that can assist students (Reiser, 2011), such tools can reduce the effort required of learners and allow them to focus on specific parts of tasks, instance, word processors with spell checkers allow students to focus on the content and structure of their writing without taking time to check spelling. Software can also focus students' attention on parts of the problems or the process that they might have missed. In this way, scaffolds not only allow learners to solve problems but also increase what is learned from their problem solving whereas the original intent of scaffolds was to temporarily provide assistance in a task, to be removed as learners have more expertise in it. Today, many of the technological and visualization scaffolds are intended to be intellectual partners to be continually tapped. This is in line with the assertion of Resta and Laferriere (2012) as they enumerated some modern scaffolds tools available that can support the students in learning: "Generic tools such as e-mail, file attachments, electronic bulletin boarders, chat blogs, wikis, digital audio and video conferencing system, asynchronous communication tools of web-based Instructional Management Systems and visual learning environments. These tools are not only widely used for business or educational delivery of information purposes, but are also used to support online collaborations, scaffolded learning.

There are an increasing number of tools and on line environments emerging that are especially designed with affordances to support scaffolding learning or knowledge building".

Vygotsky (1978) was concerned with the child's mental development and learning from a psychological point of view within its zone of Proximal Development (ZPD). Bruner focused more on the language taught in the classroom and the importance of the role of the

teacher who scaffolds. He connected it with the cognitive and social development of a child that learns from a tutor, who transmits culture and as understanding of the world. Both scholars developed their theories based on the cultural influence and the social interaction as essential features of learning. This study was used to to find the impact of scaffolding strategy on attitude, retention and performance in Ecology in Senior Secondary 11 school students.

2.4.1 Concept of Scaffolding

Scaffolding evolved in the interaction between tutor (either adult or peer) and students who design tools to support students' learning material or skill in the classrooms (Puntambekar and Hubscher, 2005). Scaffolding is the interaction between child and adult or more competent peer who provides just the right support based on the progress made by the child in an on going basis. The concepts behind the teaching technique of scaffolding emerged from Vygotsky's studies of learning and development. Vygotsky (1978), wanted to understand the relationship between learning and development. He views the previously developed theories of learning and development as inadequate and began his research by breaking down his investigation into two parts: the general relationship between the two and the specific relationship that emerges when children reach school age. Vygotsky asserts that children's learning begins before school. Vygotsky zones of proximal development looks at the potential development of children by understanding what they are attempting to master at the present time.

A child's inability to solve a problem independently today does not indicate that he will not be able to solve it independently tomorrow. Vygotsky continued by saying "The actual development level characterizes mental development retrospectively, while the zone of

proximal development characterizes mental development prospectively". Vygotsky argues that this method of observing learning and development allows psychologists, educators and researchers to examine not only the skills and mental abilities a child has mastered, but also the independent problem solving that is maturing inside the child.

Vygotsky (1978), describes two types of cognitive entities: concepts and functions. According to his theory young children comprehend primarily spontaneous concepts, or pseudo concepts. They might understand the name of a concept, but the criteria by which they understand it are concrete and context specific (Brynes, 2006). For example, a young child might identify the correct label for the concept of "dog", but his defining criteria of 'brown with white spots" are specific to his environment and experience. Older children, Vygotsky theorized, are capable of understanding scientific or 'true" concepts, which include both a correct label and generalized defining criteria. Like the young child, an older child understands the concept of "dog". However, the older child understands generalized, context-independent defining criteria like "has four paws and sharp canine teeth, parts to keep cool" (Brynes 2006).

In order to learn concepts, Vygotsky theorized that both young children and older children utilize five main cognitive functions: language, thinking, perspective, attention, and memory. He proposed that the integration of several or all of these cognitive functions in problem solving makes a learner successful, as compared to the unsuccessful learners who utilize only one or two cognitive functions in problem solving (Brynes, 2006). Vygotsky believed that the primary goal of instruction is to lead children from their naïve understandings of spontaneous concepts to mature understandings of true concepts, through

social interaction with both adults and other children (Brynes, 2001). Unlike true constructivists, he insists that social agents, such as adult tutors or more skilled peers, are absolutely essential to a child's cognitive maturation (Vygotsky and Social Cognition). He theorized that a child's thinking would forever remain on the level of spontaneous concepts without the influence of social agents (Brynes, 2006).

According to Vygotsky, academic tasks fall into one of three categories; those that the students can perform independently, those that the students cannot perform even with help from others, and those that the students can perform with help from others (Dodge, nd). A child is in the ideal cognitive state for learning when he is working on skills in the last category. Vygotsky called this state the Zone of Proximal Development or ZPD. Scaffolding plans must be written carefully, such that each new skill or bit of information that the students learn serves as a logical next step, based upon what they already know or are able to do. The instructor must prepare both to continuously assess students learning and to connect new information to the students' prior knowledge. The second major step of instructional scaffolding is execution of the plans, within the instructor provides support to the students at every step of the learning process e.g. models, cues, prompts, hints, partial solutions (Hartman, 2002).

At the beginning of the process, the instructor models the task in its entirety. Having observed their instructor's model, the students begin guided practice by performing parts of the task independently. The instructor assists his or her students with their early practice and continuously assesses their learning. As the students gain experience and understanding of new information or tasks, the instructor increases the complexity of

guided practice activities and gradually reduces his or her support. By the end of a well-executed scaffolding plan, the students perform the entire task with little or no support from their instructor (Ellis, Larkin and Worthington, 2002). There are actually five different instructional scaffolding techniques: modeling of desired behaviours, offering explanations, inviting students' participation, verifying and clarifying students' understanding and inviting students to contribute clues (Sawyer, (2006). These techniques may either be integrated or used individually, depending on the material being taught. The instructor's goal in employing scaffolding techniques is offering just enough assistance to guide the students toward independence and self-regulation.

Vygotsky identified four phases of instructional scaffolding (Brynes, 2006). The first phase is modeling, with verbal commentary. The second phase is students imitation of the skill they have seen modeled by their instructor, including the commentary. During this phase, the instructor must constantly assess students' understanding and offers frequent assistance and feedback. The third phase is the period when the instructor begins to remove her scaffolding. The instructor/teacher offers progressively less assistance and feedback to her students as they begin to master new contents and/or process. In phase four, the students have achieved an expert level of mastery. They can perform the new task without any help from their instructor (Brynes, 2001). Modeling is generally the first step in instructional scaffolding. It is defined as "teaching behaviour that shows how one should feel, think or act within a given situation (Sawyer, 2006).

There are three types of modeling. Think aloud modeling, talk-aloud modeling and performance modeling. Think-aloud modeling is verbalization of the thought process used

to solve a particular problem. For example, an instructor might verbalize his or her strategies for finding the main idea of a paragraph. By contrast, talk-aloud modeling is a demonstration of task completion accompanied by verbalization of the thought process or problem solving strategy that brought the modeler to her conclusion. For example, an instructor might verbally describe her strategies as she demonstrates the written solution to a word problem. Finally, performance modeling is simply demonstration of the task to be completed. For example, an instructor might model sustained silent reading by reading a book and either moving her lips, smiling at a funny part of the story, running her finger along the lines of text as she reads, etc. Performance modeling does not involve any verbal explanation (Sawyer, 2006). In addition to modeling, it is extremely important for the instructor to offer explanations, which should be "explicit statements adjusted to fit the learners' emerging understanding about what is being learned (declarative or prepositional knowledge) why and when it is used (conditional or situational knowledge), how it is used (procedural knowledge) (Sawyer, 2006).

At the beginning of instruction, explanations are thorough and may be repeated. As the learners gain experience, explanations consist of only hints or key words, which prompt the learners to recall important information. Eventually, explanations are removed altogether (Sawyer, 2006). For example, an instructor might begin a unit on dividing fractions with a thorough explanation of compound fractions, reciprocals and inverse operations. The instructor might have to rephrase or repeat this thorough explanation several times during guided practice. As the students gain experiences, their instructor might limit her explanations to single words like "reciprocal" and "operation" to prompt the students when they occasionally forget the next step in the process.

To avoid low performance particularly in the early stages of scaffolding, an instructor must invite students participation in the task at hand. This practice engages the students in learning and provides her with ownership of the learning experience (Sawyer, 2006). For example, a teacher might write the decimal point on the chalkboard and then ask a student to identify the next step in converting a fraction to a decimal.

The student might be invited to participate verbally or she might be asked to come to the chalkboard and contribute her ideas or strategies in writing. Rather than asking a student for direct participation, an instructor might scaffold learning by asking students to contribute clues or ideas (Sawyer, 2006). When students contribute their ideas about a topic or skill, the instructor can add her own ideas to guide the discussion. If the students' understandings are incorrect or only partially correct, the teacher can correct them and tailor her explanation based upon whatever the students have brought to the discussion (Sawyer, 2006). As the students gain experience with new material, it is important for the instructor to continuously assess their understanding and offer feedback. Verifying and clarifying students' understanding" is essentially offering affirmative feedback to reasonable understandings, or connective feedback (Hogan and Pressley, 1997). For example, an instructor might affirm a student's understanding of inverse operations as opposites she might then clarify the understanding of a student who has identified addition and multiplication as inverse operations.

With the right techniques and materials, an instructor can provide the temporary support that learners need to grow intellectually. This instructional scaffolding allows learners to reach levels of understanding and task mastery that would have been unattainable without

it. Just as scaffolds help workers to complete difficult jobs, instructional scaffolding helps learners to build solid understandings of challenging academic topics. Hartman (2002) explored the challenges of scaffolding in the classroom setting. He offered several solutions for scaffolding with large classes. Students may be organized in groups so the groups are scaffolded rather than individuals. Another suggestion is providing groups with cue cards, question cards or question stems. Self-regulated learning must be encouraged as much as possible. Gullies and Boyle (2005), explore the relationship between cooperative learning and scaffolding. Their study found the type of scaffolding interactions used by teachers in cooperative learning included probing and clarifying to extent students' thinking, acknowledging and validating students' understandings, focusing on key issues; challenging discrepancies in students' thinking and cautiously offering suggestions.

They also found that teachers spend less time disciplining when the framework of the lesson was organized as small group discussions rather than a whole classroom discourse. Interactions among the whole community of learners are more practical for the reality of the classroom. Sawyer, (2006) refers to Vygotsky's approach as individual's thinking which is "profoundly influenced by participating in forms of social practice". The teacher sets the stage for didactic dialogue by organizing a learning environment that focuses on thinking together with students. Scaffolding students' participation results in a community of scientific discourse. In this interactive setting, students can articulate their own understanding and other students may benefit from this. The social environment of the classroom becomes the setting for the scaffolding of values while it supports and fosters the development of students' competency.

The dialogue for individual students do not only give new insights to subject matter, but also provides ways of thinking strategically and reflectively. Sharpe (2006), differentiates between "designed-in" scaffolding defined as the overall design of the lesson and "contingent scaffolding" that is delivered at the point of need. Objectives, prior knowledge, procedures and outcomes are included in both. Contingent scaffolding requires on the spot reaction to opportunities for dialogue, questionnaire, and interactions among students and teachers and/or other students. Sharpe (2005), concludes that a combination of the two, along with both dialogue and visual cues, provide a strong learning environment.

Wolf and Brush (2000), carried out an experiment in which students were taught by the use of scaffolds and others without scaffolds. The scaffolded group conducted research and wrote their findings with the metacognitive scaffold skill (Metacognitive is the ability to plan, implement, and evaluate strategic approaches to learning and problem solving). The non-scaffolded group relied on the teacher for direction in a traditional setting. The scaffolded group performed significantly better on the performance measure, but the teacher-managed group reported more positive attitudes. Authors concluded that providing a scaffold for research skills can be effective when certain conditions are met. These conditions include strong team-based planning and implementation activities, students engagement, and a collaborative learning environment. McKenzie (2000), provided a guide to instructional designers that includes eight characteristics of scaffolding to incorporate in a project-based instructional plan that is appropriate both in an electronic context and classroom environment.

i. Scaffolding provides clear directions instructional designers try to anticipate any student confusion so step-by-step directions are provided for a successful conclusion to the learning activity.

ii. Scaffolding clarifies purpose. “Why are we doing this?” is an important students’ question that needs to be defined before students begin their research projects. Rather than simply “collecting information, the students focus on the objective and categorize the information according to the purpose.

iii. Scaffolding offers assessment to clarify expectations. In other words, rubrics and standards of performance are defined from the beginning and examples of quality work are provided.

iv. Scaffolding points students to worthy resources and thus reduces wasted time. Rather than having students wander aimlessly through the Internet, best sources are identified so students focus on the assigned task.

v. Scaffolding reduces uncertainty, surprise and disappointment. Instructional designers are expected to test the lesson before implementation. This eliminates problems that may arise such as lack of clarification.

vi. Scaffolding delivers efficiency by eliminating boredom and non relevant materials.

vii. Scaffolding creates momentum by channeling energy

Sawyer, (2006), gave benefits of instructional scaffolding that it challenges students through deep learning and discovery, engages students in meaningful and dynamic discussions in small and large classes, motivates learners to become better students (learning how to learn), increases the likelihood for students to meet instructional objectives, affords the opportunity for peer-teaching and learning. Scaffolds can be “re-

cycled" for other learning situations and provides a welcoming and caring environment. Scaffolding also delivers efficiency since the work is structured, focused, glitches have been reduced or eliminated prior to initiation, time on task is increased and efficiency in completing the activity is increased. It minimizes the level of frustration for the learner.

2.4.2 Types of Scaffolding

There are four types of Scaffolding that has been put forward by Hannafin, Land and Oliver (1999). This classification into four categories was based on their functions as follows:

i. conceptual scaffolding;

ii. metacognitive;

iii. procedural; and

iv. strategic.

Conceptual Scaffolding

This provides learners guidance about what to consider. Learners are shown pictures that depict concepts. For example, Bean and Steven (2002) used prompts to guide pre-service teachers to reflect the instructional content. It provides hints and prompts about the content (Hannafin et al 1999) and it helps to structure and problematize tasks (Reizer, 2004). Conceptual Scaffolding often incorporates, such strategies as concept mapping and other visualization strategies. Conceptual Scaffolding guides learners regarding what to consider and helps them reason through complex problems.

ii. Metacognitive Scaffolding

It refers to temporary support provided by the teacher, more capable peers, or computer tutors to help students solve a problem or carry out a task that they accomplish

independently. Metacongnitive Scaffolding facilitates metacognitive thinking and supports metacognitive processes including planning, monitoring, evaluating and facilitate problem-solving processes. Metacognition plays a crucial role in effective scaffolding without metacognitive awareness, attempts at scaffolding may only create over-confidence in students without any learning. As an example, Ge and Land (2003), provide the general process of problem solving to help students solve computer programming problem.

iii. Procedural Scaffolding

It helps learners on how to use resources and tools provided by the learning environment before, during and after instruction. Students need access to the content of the text, but it is equally important that students feel safe enough to make academic risk as they collaborate within a classroom community even when they make mistakes. The combination of this low-effective-filter environment and these scaffolds accelerate students learning and acquisition of task. Some examples of procedural scaffolds within collaborative literary lessons that support both academic and social goals in support of language acquisition include:

i. asking open-ended questions with support; and

ii. explicit pre-teaching and modeling.

The Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among Senior Secondary School (II) in Giwa was in line with the procedural Scaffolding by the learning environment provided before and during instruction. The scaffolding administration of treatment in steps (i–v) fig. 3.3 also depicts the procedural Scaffolding

iv. Strategic Scaffolding

It provides guidance on how to approach learning tasks or problems. Strategic scaffolding offers a repertory of alternative techniques and tips. For example in (Azevedo, Gromley, Thomas, Seibert and Tron's (2003) study, the tutor gave a student on how to illustrate his idea mere clearly by saying "it will be easier to undertand if you make a drawing". Teacher guides the students on how they will organize or plan and how a task can be executed. Students are directed until they learn how to plan and execute any project given to them.

Scaffolding techniques are used in conjunction with scaffolding instructional materials. These materials fit into one of the following categories: reception scaffolds, transformation scaffolds or production scaffold Dodge (1998).

Reception scaffolds help learners to effectively gather information from available sources. They are designed to direct the learners' attention to what is important, and to help them organize and record information. They include tools such as anticipation guides, glossaries, graphical guides, project guides, reading and research guides, reference resources, study guides, thinking strategy guides, tutorial guides, vocabulary guides, writing guides. For example, a web-like graphic organizer called a concept map might be provided to students who are learning about the metric system (A scaffolding strategy, n.d.) the concept map prompts the students with focus questions and provide them with a framework for organizing their answers. Whereas reception scaffolds help the students to identify structure already present in a given sources (file:///C:/users/Isaac/Downloads/receptionscaffoldings.htm). Transformation scaffolds are helps provided to assist learners in transforming the information they have received into some other form. They involve imposing structure

on information, while reception scaffold helps learners perceive structure already in the information. It helps students complete an activity. It gives guidance on applying specific transformation (Dodge, 1998).

The student might need to compare, select, organize, analyse, synthesize and review. Many tools can be used to help students with their thinking such as: chronologies, timelines, cause/effects charts, compare/contrast tables, classification webs, what if and trend spread sheets and problem solving activities. For example, a child who is studying the metric system might be asked to classify metric units of length, mass and volume in different columns as a chart. The transformation scaffold is the blank chart, which prompts the students to categorize information logically.

Production scaffolds are helps provided to assist learners in actually producing something observable that conveys what they have learned. It helps students complete a project. They are useful when the form of what is to be produced follows the conventions of some publication or presentation format (file:///C:/users/Isaac/Downloads/productionscaffolds .htm). These helpers to learners include prompts and starters, samples and models templates, guidelines, tutorials, how-tos, and planning tools. Production scaffolds include: presentation templates and outlines, prompted writing template, play structure, play mechanics, multimedia templates (Dodge, 1998). For example, an instructor might prepare an outline or template to help students organize their book reports (Dodge, 1998). The three different kinds of scaffolds may either be integrated or use individually to support students learning.

According to Saye and Brush (2002) there are two levels of scaffolding soft and Hard. An example of soft scaffolding in the classroom would be when a teacher circulates the room and converses with his or her students (Simon and Klen, 2007). The teacher may question their approach to a different problem and provides constructive feedback. According to Vanlier, (2010), this type of scaffolding can also be referred to as contingent scaffolding. The type and amount of support needed is dependent on the needs of the students during the time of instruction (Vanlier, 2010). In contrast with contigent or soft scaffolding, embedded or hard scaffolding is planned in advance to help students with a learning task that is known in advance to be difficult (Saye and Brush, 2002). For example, when students are discovering the formula for the Pythagorean Theorem in maths class, the teacher may identify hints or cues to help the students reach an even higher level of thinking. In both situations, the idea of "expert scaffolding" is being implemented (Holton and Clarke, 2006). The teacher in the classroom is considered the expert and is responsible for providing scaffolding for the students. Reciprocal scaffolding, a method first coined by Holton and Clarke (2006) is a method that involves a group of two or more collaboratively working together. In this situation, the group can learn from each other's experiences and knowledge. The scaffolding is shared by each member and changes constantly as the group works on a task (Holton and Clarke, 2006).

According to Vygotsky (1978), students develop higher level thinking skills when scaffolding occurs with an adult expert or with a peer or higher capabilities (Stone, 1998). Conversely, Piaget believes that students discard their ideas when paired with an adult or student of more expertise (Piaget, 1926). Vygotsky in his opinion said that students should be paired with others who have different perspectives. Conflicts would then take place

between students allowing them to think constructively at a higher level. Technical scaffolding is a later approach in which computers replace the teachers as the experts or guides, and students can be guided with web links, online tutorials, or help pages (Yellard and Masters, 2007). Educational software can help students follow a clear structure and allow students to plan properly (Lai and Law, 2006). Saxena (2010) develops these two notions theoretically by incorporating. VanLier's (2010) works. Within the Initiate Response Evaluate (IRE) pattern, teachers provide 'directive scaffolding' on the assumption that their job is to transmit knowledge and then assess its appropriation by the learners. The question-answer-evaluation sequences creates a predetermined standard for acceptable participation and induces passive learning. In this type of interaction, the teacher holds the right to evaluate and asks 'known- information' questions which emphasize the reproduction of information.

In managing the talk, teachers apply 'constructive power' (Saxena, 2010) and exploit students' responses as occasions for joint exploration, rather than simply evaluating them, then the classroom talk becomes dialogic. The discourse opens up the roles for students as the 'primary knower' and the 'sequence initiator' (Wells, 2000), which allows them to be the negotiator and co-constructor of meaning. The suspension of asymmetry in the talk represents a shift in the teacher's ideological stance and therefore, demonstrates that supportive scaffolding is more than simply a model of instruction (Saxena, 2010).

Front-ends scaffolding according to Saxena (2010) are the actions teachers take to prepare students to better understanding on how to access complex text before they read it. Traditionally, front end scaffolding has included information to build greater context for the text, front loading vocabulary, summarizing the text, and/or making predictions about

what is to be read. Close analytical reduces the amount of front-end scaffolding to offer students the opportunity to read independently and create meaning and questions first. It also offers students the opportunity to own their own learning and build stamina (expeditionary learning, NY).

Back-end scaffolding, on the other hand, according to Saxena (2010) are what teachers, plan to do after students read complex text to help deepen understanding of the text. When teachers provide back-end scaffolds, they follow the "release-catch-release model", allowing students to grapple with hand text. First, and then helping students as needed. It can be concluded that scaffolding literacy enhances the students' self confidence, self regulation, improves critical thinking and higher order skills and has an impact on the students' progress and teaching practices. (Lioyd, 2009).

Scaffolds and Uses

Scaffolding has been used in many ways: Albali, (2006) suggests that as students progress through a task, the faculty can use a variety of scaffolds to accommodate students' different levels of knowledge. More complex content might require a number of scaffolds given at different times to help students master the content. The Table 2.1 below presents scaffolds and ways they could be used in an instructional setting.

Table 2.1: Scaffolds Instructional Model

Scaffold	Ways to Use Scaffolds in an Instructional Setting
Examples	Samples, specimens, illustrations, problems: Real objects; illustrative problems used to represent something
Explanations	More detailed information to move students along on a task or in the thinking of a concept: Written instruction for a task; verbal explanation of how a process works.
Handouts	Prepared handouts that contain task-and content-related information, but with less detail and room for student note taking
Hints	Suggestions and clues to move students along for example "Place your foot in front of the other", "use the escape key," "find the subject of the verb, "add the water first and then the acid".
Prompts	A physical or verbal cue to remind-to aid in recall of prior or assumed knowledge. Physical: Body movements such as pointing, nodding the head, eye blinking, foot tapping. Verbal: Words, statements and questions such as "Go", "Stop", "It's is right there", "tell me now", "What toolbar menu item would you press to insert an image". "Tell me why the character acted that way".
Question Cards	Prepared cards with content-and task-specific questions given to individuals or groups of students to ask each other pertinent questions about a particular topic or content area.

Source: Northern Illinois University, Faculty Development and Instructional Design Centre facdev@niu.edu.www.niu.edu/faedev. 815.753.0595

Guidelines for Instructional Scaffolds

A number of general guidelines have been developed. Applebee and Langer (1985) identified five features necessary to scaffold students' understanding such as:

1. Intentionality: The task has a clear overall purpose driving any separate activity that may contribute to the whole.
2. Appropriateness: Instructional tasks pose problems that can be solved with help but which students could not successfully complete on their own.
3. Structure: Modeling and questioning activities are structured around a model of appropriate approaches to the task and lead to a natural sequence of thought and language.

4. Collaboration: The teacher's response to students work recasts and expands upon the students efforts without rejecting what they have accomplished on their own. The teacher's primary role is collaborative rather than evaluative.
5. Internalization External Scaffolding for the activity is gradually withdrawn as the patterns are internalized by the students (Applebee and Langer, 1983 as cited in Zao and Orey, 1999).

These five guidelines, are useful in a description of good teaching in general and can help in planning instruction for students.

Puntambekar and Hiibscher (2005) took a different tack in their analysis of the key features of instructional scaffolds. They analyzed the key features as a theoretical construct and identified four features which sharp the guided instruction, regardless of whether it is used for whole class instruction, small-group teaching, or individualized tutoring.

1. Intersubjectivity: The first component necessary for instructional scaffolds to be effective involves the joint ownership of the task between the student(s) and teacher. This requires that the task be defined and redefined by the student(s) and teacher such that the student(s) begin to understand the task from the perspective of the More Knowledgeable Other. As Wood, Bruner and Ross (1976) note, this involves "making it worthwhile for the learner to risk the next step".
2. Ongoing Diagnosis: The teacher must continually be aware of what the learner understands and still needs to learn. This requires a deep understanding of the task at hand, including the subtasks required for mastery, and a keen level of knowledge about the individual learner.

3. Dialogue and Interactive. A third feature of learning scaffolds relates to the conversation that the student(s) and teacher have as part of the learning situation. This is not a time for a monologue, but rather a dialogue in which the teacher monitors the students' understanding and progress. It requires a fairly sophisticated feedback system in which the teacher is regularly checking for understanding and collecting assessment information.

4. Fading: The final theoretical feature requires that the teacher fade the support provided to the learner(s). In Vygotskian terms, this occurs when the learner has reached internalization. Vygotsky (1978), hypothesizes that cognition first occurs between people (interpsychological before moving to intrapsychological (within one's own self). Without fading, this process of internalization cannot happen; students become "prompt-dependent, not independent"

The Puntambekar and Hiibscher (2005) agree that the Instructional Scaffold and found it to be in line with Applebee and Langer (1983) but for the fact that it was broken into five.

2.4.3 Types of Scaffolding Models

These are different types of Scaffolding models to help learners to process tasks as follows:

1. Djwantoro (2010) Scaffolding Model
2. Rochler and Cartlon (1997)
3. Soloway's TILT Model
4. Gilly Salman's Five Stage Model

i. Djwantoro (2010) Scaffolding Model: Djwantoro (2010) used Scaffolding Approach to enhance students engagement in learning Structural Analysis in Petra Christian University, Surabaya, Indonesia. The application of the method to analyze

various problems is learned by students themselves by doing the series of problems engineered with gradually-reduced supports. Students' engagement is greatly enhanced, as they are so much involved in the learning process.

The two steps described by Lange in 2002 as mentioned by Lipscomb *et al* (2004) were followed by the author in the application of the Scaffolding Approach in teaching Structural Analysis. The first step is "Development of Instructional plans to lead the students from what they know to a deep understanding of new material".

This step involves the introductory part to raise students' interest on the topic, as well as to help them to connect with the previous knowledge. It is then followed by the delivery of the history and the theoretical background of the method. The delivery is normally performed in traditional lecture format within a set time frame which is normally kept minimal. After providing one or two examples on the use of the method to analyze structures, it will be followed by distributing worksheet equipped with procedures or steps, formulas, hints, tables and arrows (for Moment Distribution Method) which serve as scaffolds. The scaffolds are carefully selected and prepared to make sure the activities are within the students' ZPD.

A series of worksheets are prepared in advance with gradual removal of supports provided. Students will then work either in groups or alone to carry out the tasks in the worksheet. At this stage, lecturer turns role to become coach, providing additional help or clarification to those in need and to progress in their own pace. If a common mistake is found, further clarification for the whole groups will be given. Students who finish earlier will be given the next worksheet, which might be similar to the previous one to reinforce the skill or from a different case. Sessions are intermittent with discussion to reflect the case they are

doing or on the usefulness, benefit and limitation, and the connection of the method with students' previous knowledge.

The second step is the Execution of the plans, wherein the instructor provides support to the students at every step of the learning process. As students are busy with their worksheets, the author took time to move around to see how they progress. In most cases, the students were allowed to make mistakes. It is believed that students learn from their mistakes. However, before going too far in the wrong direction, additional help or hints or clarification will be given to the whole group. The development of students confidence in using and understanding the new tool to analyze structure and its behaviour is the main learning outcome. Thus, it is imperative to keep the level of students' frustration minimal in every step of the process by providing just enough support. The lecturer plays the role of a coach for students in carrying out the task given.

The most convincing evidence of success on the use of Scaffolding Approach in learning Structural Analysis is students engagement. All students actively participate in their learning, not only listening passively, but engage in different activities. As lecturer role is turned to be more like coach, and personal attention is given to every group or individual, the learning environment naturally becomes more relaxed and the learner-students relationship becomes more informal and thus invites more questions and discussions to happen. Students capability are identified early, and extra attention was able to be given to weak students. A sense of accomplishment is normally shown by a student who completes the task. Using this approach, students are encouraged to discover the knowledge and to gain the skills by themselves. Every student participates actively with the stronger students

given the opportunity to progress faster and weak students are given better attention together with the opportunity to progress in slower pace.

The description above can be represented in the following steps below:

Step 1: Introduction

This step involves raising students' interest on the topic as well as to connect with the prior knowledge.

Step II: Then followed by the delivery of the topic in traditional lecture format within a set time frame which is normally kept minimal.

Step III: The teacher distributes the students' activities equipped with procedures or steps and tables which serve as scaffolds.

Step IV: Whole class discussion of students findings while the lecturer's role is becoming a coach or facilitator providing additional help or clarification to those in need. As students gain competence, the scaffolds are withdrawn (fading).

Step V: Evaluation of the students' performance by the teacher asking questions and getting feedback from the students.

This model (Djwantoro, 2010) was chosen to teach Ecology to SS2 students because of the simplicity and step by step process on the application which was easier to adapt for this study. This makes the lesson more interesting and gives the students a sense of accomplishment.

ii. Roehler and Cantlon (1997): identify five different strategies in instructional scaffolding: the modeling of desired behaviours, the offering of explanations, inviting students to participate, verifying and clarifying students understanding and inviting

students to contribute clues. This model was used by Bikmaz et al (2010) in Scaffolding Strategies Applied by Student Teachers to teach Mathematics. In this research, the aim was to analyze student teachers' scaffolding strategies as they have been applied to the teaching of Mathematics. The research was conducted with thirteen student teachers in their fourth year in Bachelor of Education (Classroom Teacher) programs. Nine student teachers worked with two fifth grader learners, while the other four worked with three. The student teachers worked on a one-to-one basis with students who were having difficulty in Geometry. According to the results; inviting student participation was found to be the most commonly used scaffolding strategy. The least common were inviting students to contribute clues and the modeling of desired behaviours.

The model involved the use of more teachers to few students. This model will not be suitable for the researcher's study which involves a whole classroom of students with only one teacher. The model is time consuming and labour intensive.

iii. Soloway's TILT Model of Scaffolding: is provided to help students with a task they do not know how to do, and it gradually becomes less important as the students become more competent. In educational terms, scaffolding is operating in Vygotsky's ZPD. The ZPD is defined as an area of domain knowledge beyond a students' current comprehension, but which they can successfully navigate their way through with the assistance of their peers or an expert (such as a teacher). Soloway's Tools/Interfaces Learner's needs/Tools (TILT) model is a classification of different types of scaffolding and their roles in the learning environment (Fig. 2.1). To scaffold learning tasks, software can coach a learner by providing helpful advice at appropriate points in the learning process. To support a learner's growing competence the tools is a model that must be adaptable to

the task in question. To support the learner at a communication level, the interface must provide different means of expression appropriate to the learners' competency.

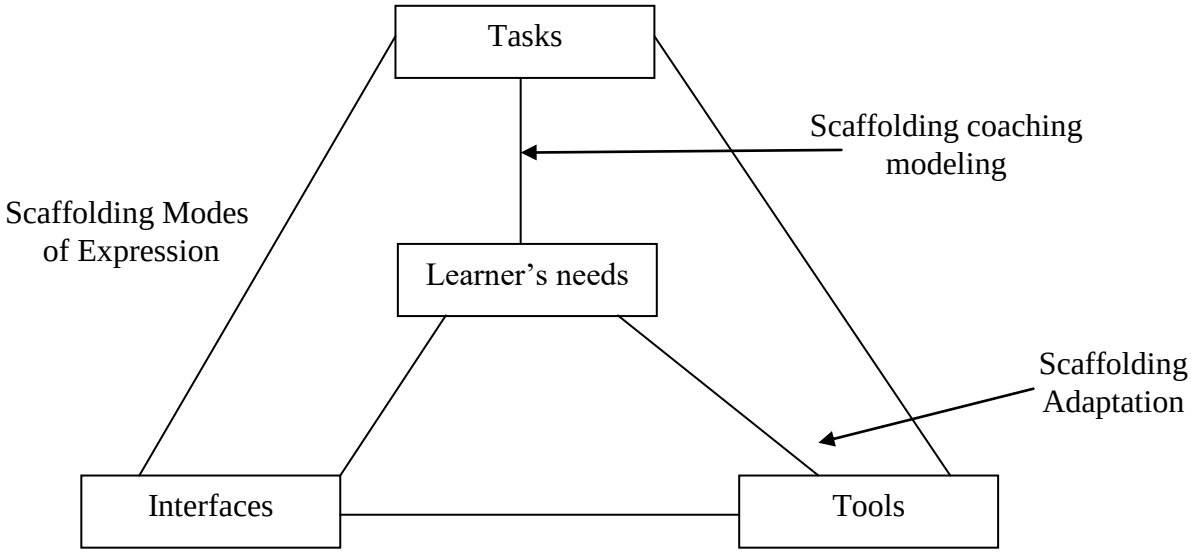


Fig. 2.1: Soloway TILT Model
Source: Soloway (2000)

This model does not have a step by step flow of the strategy. The detail of this model is not explicit in the literature. There is also software device embedded in the process to coach students. All these made this model inapplicable for the researcher's use.

iv. Gilly Salman's Five Stage Model of E-Learning can be used to identify the typical activities tutors may be involved at different stages of the students' learning processes.

Access and Motivation

Stage 1: Individual access and the induction of participants into online learning are essential prerequisites for online conference participation.

Stage 2: Socialization

Involves individual participants establishing their online identities and then finding others with whom they interact.

Stage 3: Information Exchange

Participants engage in mutual exchange of information. Up to and including stage 3, a form of co-operation occurs whereby each person supports the other participants' goals.

Stage 4: Knowledge Construction

Course-related group discussions develop and the interaction becomes more collaborative. Knowledge construction and working towards a group goal. Collaboration requires an active sharing of information and intellectual resources amongst the participants.

(The term 'collaborative learning' refers to an instruction method in which students at various performance levels work together in small-groups towards a common goal. The students are responsible for one another's learning as well as their own. Thus the success of one student helps other students to be successful).

Stage 5: Development

Participants look for more benefits from the system to help them achieve personal goals and reflect on the learning processes. This model is not suitable for the researcher's classroom study because it is on-line. The researcher's study has physical, social interaction with the students, where the researcher could observe all the various group activities on the tasks, and can give hints and prompts to each group as the tasks or activities are on going. The online model involves a computer system with internet connection which is not available in the selected schools of the study.

2.5 Instructional Strategy and Academic Performance in Science

Scaffolding refers to the support that helps students finish a complex task or achieve a goal that they could not accomplish on their own (Wood, Bruner and Ross (1976). The provider of scaffolding is a scaffolder. The tools designed to scaffold learning are called scaffolding

tools. The techniques used for the purpose of scaffolding are named as scaffolding strategies. From its definition, we can see that the nature of scaffolding is instructional intervention. Furthermore, scaffolding is not just any form of support that is offered to students. It has to be the support that helps learners construct knowledge and thinking rather than remembering simple facts (Hammond and Gibbons, 2001). However, Habor Peters (2002), points out that students will be able to do better if the required instructional techniques and materials are appropriately and effectively used. Based on the metaphor, instructional scaffolding has several characteristics: it supports learners; it functions as a tool; it allows learners to accomplish a task that they cannot complete on their own; and it is used selectively to aid learners when needed (Driscoll, 2000). Early practice in scaffolding was between a learner and another more capable individual. This, to some extent, made many researchers believe that scaffolding can only be applied to one-on-one situations. However, some researchers pointed out that the scope of scaffolding can be expanded beyond pair interactions.

Sawyers (2006), suggests using weaving as a metaphor to expand the use of scaffolding to a whole classroom community, in which not only the teacher supports each individual student, students also support each other. More importantly, Palinscar (1998) recommends expanding the scaffolding metaphor to include contexts and activities as means of scaffolding in addition to human beings, be they instructors, parents or more capable peers. Scaffolding is an instructional technique, associated with the Zone of Proximal Development (ZPD), in which a teacher provides support by incrementally improving a learner's ability to build on prior knowledge (Olson and Platt, 2000). In scaffolding learning, the scaffold of a group cannot be withdrawn unless the entire members of the

group have reached a zone of Proximal Development (ZPD). In addition, when the high level students work with low ability ones, in heterogeneous learning groups, they explain their ideas to the low ability level ones, and the high levels ones, and the high level students themselves learn when they remember it longer. This is contrary to the research finding of Maduewesi (2010) and Ezeani (2012) who report that group method of learning does not encourage the habit of listening and it also does not make students develop the habit of writing fast as found in a large class size.

But to Lioyd (2009), poor achiever's performance could be improved when instructions is based on clear demonstration, guided practice, active involvement of the students in goal directed activities with immediate feedback and reinforcement. All these are made use of in scaffolding instructional strategy. Lioyd suggests that instructions should be delivered to students in small heterogeneous groups for individual attention and practice opportunities to be provided for successful acquisition of knowledge and skills by low performance students. This might be responsible for why it is important to investigate the scaffolding teaching strategy to determine the performance of science students.

Some researchers attributed low performance by students in science to the methods adopted by science teachers in teaching the subjects Mbah, (2005), remarks that performance is dependent upon several factors among which are instructional techniques; the learning environment, motivation for stimulating students' interest in learning and the learners. He added that the degree of understanding by students depends on several interacting variables. He observes that, the students' readiness to learn while the teacher is teaching can be superfluxed by other variables such as lack of learning materials, lack of interest, school environment, teaching techniques and other factors. He therefore emphasizes that

teachers should endeavour to adopt instructional techniques that are capable of reducing divergences on the part of students. One of these instructional techniques is scaffolding teaching strategy. When a teacher takes care of the students by adopting good instructional techniques, the academic performance of the students will improve significantly. Scaffolds can promote different types of knowledge like metacognitive expertise, inquiry abilities and content knowledge (McNeill, Lizotte and Krejick, 2006).

Metacognition refers to knowledge and control of factors that affect learning, such as knowledge of self, the task at hand, and the strategies to be employed (Baker and Brown, 2002). To evaluate the effectiveness of the metacognition prompts, White and Fredericksen (2000) compared two versions of the curriculum, one with reflections prompts and one without reflection prompts. They found that students who received the reflection prompts resulted in greater understanding of the inquiry practices. Davies (2003), also examines the role of scaffolds or directed prompts in supporting students' reflection. In this case, Davies (2003) integrated the scaffolds into the Knowledge Integration Environment (KIE) software. She investigates the role of two different types of reflection prompts, generic prompts and directed prompts. She found that generic prompts were more productive for students' reflection than directed prompts.

A variety of technology tools have been created to scaffold students learning, such as Computer Supported Intentional Learning Environments (CSILE) (Marx and Soloway, 2000; Reiser, Tabak, Sandoval, Smith, Steinmuller, and Leone, 2001). Providing students with prompts or contextualized scaffolding can encourage a deep learning approach in students where they are more apt to articulate their reasoning about how and why something occurs. Reiser et al added that if students do not initially provide their

reasoning, prompting can result in students articulating their thoughts. In scaffolding students explanation construction, it attempted to make explanation framework clear to students in order to facilitate their understanding of what an explanation is and how to create one. Making scientific thinking strategies explicit to students can facilitate their use and understanding of these strategies (Herrenkohl, Palincsar, Dewater, and Kawasaki, 1999).

More specifically, revealing the tacit framework of scientific explanation through scaffolds can facilitate students' explanation construction (Reiser *et al*., 2001). It is hoped that by providing students with explanation framework, would encourage deeper thinking and promote students translation of their thinking into written text. (Reiser *et al*., 2001). The importance of teacher-student communication in learner's performances is strongly emphasized in the socio-cultural educational theory, originated by Vygotsky (1978) and further developed in modern research (Daniels 2001). This theory describes the process of teaching and learning as "much more than face-to-face interaction or the simple transmission of prescribed knowledge and skills" (Daniels, 2001) but rather places stress on dialogue and co-construction of knowledge (Wells 1999). It describes teaching as strongly influenced by, and embedded in its social and cultural context and points to the meaning of teaching as the transformation of socially constructed knowledge into that which is individually owned by the learner. This type of teaching assumes a specific paradigm of teacher-student interaction where the role of the adult is that of collaborator and co-constructor. A strong emphasis is on the active position of the learner, which is essential for the development of the life long learning skills.

2.6 Concept of Attitude

Attitude as one of the variables been considered in this study, will focus on their affective, behavioural and cognitive components. Affective component involves a person's feelings/emotions about the attitude object. Behavioural is about the way the attitude we have influences how we act or behave while cognitive component involves a person's believe or knowledge about an attitude object. One of the underlying assumptions about the link between attitude and behaviour is that of consistency. This means that we often or usually expect the behaviour of a person to be consistent with the attitude that they hold.

Attitude according to Rosemand (2006), opines that it implies a favourable or disfavourable evaluation reactions towards something, events, programmes etc exhibited in an individual's beliefs, feelings, emotions or intended behaviours. Olatoye and Aderogba (2012), report that attitude is a psychological construct, or latent variable, inferred from observable responses to stimuli which are assumed to mediate consistency and coherence among those responses and went further to explain that attitude is related to thinking, feeling, perceiving and behaving toward a cognitive object. Or attitude is a tendency to react favourably or unfavourably towards a designated class of stimuli. Thurstone (1928), who was the first to undertake measurement of attitude defines it as "The degree of positive or negative effect associated with some psychological object". The definition of attitude offered by Karlinger, that is "the tendency to react favourably or unfavourably toward designated class of stimuli is called attitude", however, Olatoye and Aderogba (2012) add that if this reaction is in accordance with the ethics of science, then it is scientific attitude.

Scientific attitudes, according to Kolawole (2007), are a composite of a number of a mental habits, or tendencies to react consistently in certain ways to a novel or problematic

situation, these include: rationality, curiosity, open-mindedness, aversion to superstition, objectivity, intellectual, honesty, humility and suspended judgement. Some scholars opine that a person with positive scientific attitude is free from superstition, unverified assumption and many times from popular opinion that has no empirical basis (Olatoye, 2002; Olatoye and Aderogba, 2012). Scientific attitudes are set of attributes that an individual should possess in the pursuance of scientific knowledge and some researchers acknowledge that activity based teaching approaches can enhance scientific attitude along with academic performance in science (Obeka, 2010). It has been argued that lack of practical activities which make learning last longer was instrumental to negative scientific attitude among students (Nwosu, 2008). To develop scientific attitude in students, they should be provided with hands on experiences (Nzewi and Nwosu, 2008).

Festus (2007), contended that performance appears generally to be the fundamental goal behind every life struggle, but the positive platform has consequential effects of improving the worth of the students and can only be achieved through acquisition of positive learning attitudes. The attitudes of a student trigger his behavior. Attitudes are antecedents which serve as inputs or stimuli that trigger actions. Attitudes can distort the perception of information and affect the degree of their retention. Olatoye and Aderogba (2012) determine the relationship between scientific attitude, attitude towards science and academic performance of secondary school students and found that scientific attitude, attitude towards science do not significantly predict academic performance. Attitude and attitude towards science has positive but no significant relationship with science performance mean score by gender.

Funke (2012), conducted a study in Nigeria, and her finding reveals that there is no significant relationship between students' academic performance and scientific attitude. Yenice and Saydam (2010) investigate 8th grade students' science attitudes and views about nature of scientific knowledge in Turkey. The results indicated that students have high positive attitudes towards science, but was found that students generally hold double-minded and unsatisfactory views on the nature of scientific knowledge. Pillai (2012) conducts an analytical study on scientific attitude of higher secondary school students in virud hunager district India. His findings reveal that male and female students had no significant difference in respect of their scientific attitude. Government and private school students show significant difference in respect of their scientific attitudes.

2.6.1 Attitude and Academic Performance in Biology

The knowledge aspect of attitude strength covers how much a person knows about the attitude object. People are generally more knowledgeable about topics that interest them and are likely to hold strong attitudes (positive or negative) as a consequence. So the various studies below tell the attitude of students as it affects their academic performance in Biology. Sola and Ojo (2007) and Akinbobola and Ikitde (2008) define attitude as beliefs and opinions that can predispose an individual to behave in certain ways. Thompson in Peni (2008) and Foley and Mcphee (2008) see attitude as opinion or way of thinking, or the behaviour reflecting the way of thinking. Attitude associated with science affects students' performance in science as a subject. Azure (2009) studied the effect of self-image and attitude as predictors of students' performance in Basic science at the tertiary level. Results show that there was statistically significant relationships between performance and high self-image, perceived importance of science, and dislike for the subject.

Adesoji (2008), Foley and Mcphee (2008) also report that students' positive attitudes to science correlate highly with their performance in science. Adesoji (2008) laments that in general, the attitude of Nigerian students towards the Basic Sciences tend to decrease in the order, Biology, Chemistry, Physics and Maths. Eze in Bunkure (2008), on the other hand observe that students show lukewarm attitude towards science. Some students have preconditioned their minds on their incapability to learn science and even propagated some beliefs of its difficulty thereby discouraging others (Sola and Ojo, 2007). These beliefs have affected the attitudes of students towards learning science. He also stressed that certain science concepts are perceived difficult by most students; this affects their performance (Akinbobola and Ikitde, 2008). Cracker (2006) and Akinbobola and Ikitde (2008) concerned that research has shown that a person's attitudes are learned; as opposed to being inherited thus it can be changed through persuasion using a variety of techniques. Cracker (2006), reports a steady decline in students' interest to science in the United States due to the instructional strategy employed by their teachers.

Akinbobola and Folashade (2009), compared the effectiveness of constructivists teaching method and the conventional method with reference to attitude, performance, and retention. They found that students exposed to constructivist teaching method have higher cognitive performance, more positive attitudes and higher retention level than their counterparts taught using the conventional teaching method. Similarly, Muhammad (2012), studied the impact of inquiry teaching method on academic performance, retention and attitudes towards Chemistry among diploma students of Kano State Polytechnic and recorded a significant effect on students' academic performance in both male and female students.

Several studies in science education have investigated the relationship between students' attitudes toward learning of science and their academic performance in science (Cukrowska, Staskun, and Schoeman, (1999); Papanastadiou and Zembylas, 2004). In general, these investigations have found conflicting correlations between attitude and performance in science. Cukrowska *et al* (1999) report a positive relationship between attitudes and academic performance in first-year Chemistry. In the study above, it was found that students in central board schools have significantly greater interest in science when compared to their counterparts in matriculation and state board schools. The syllabus of central board schools is very interesting and application oriented and this enables teachers to plan for more application oriented assignments and projects during their classroom activities. Learning of science for these students is more effective, because of the interest developed in the subject. Thus, these students at the secondary level in central board schools are able to perform significantly better when compared to the secondary level students in the other two categories of schools namely matriculation and state board. It is also found that the girls are better than boys in both attitude towards learning of science and academic performance in science in all three categories of schools following different systems of education.

Peni (2008), stresses that certain science concepts are perceived difficult by most students; this affects their performance. Home background is another factor that may influence attitude. Ogunsola–Bandele (2001), opine that the choice of subject has some relationships with the social background of the parents i.e. if the parents are educated they will encourage their wards to take up science subjects. Thus, it is expected that the home a child comes from, influences his/her attitude towards science. Another societal influence

that affects attitude and enrolment into science subject is the gender stereotyping of science (Ogunsola–Bandele, 2000). In most Nigerian societies; science is seen as a male's activity and a 'no go area' for the females. Some activities are considered 'abnormal' for females but normal for males. These societal perceptions of "normal" and "abnormal" sex roles influences female participation. Issues of gender role, stereotyping gender, division of labour, discrimination (Akanbi, 2004) are factors that immensely affect female participation in science.

Similarly, lack of self-esteem, poor self image and non-assertive behaviour are among the factors that make the girl child shy away or perform poorly in school and in particular; science (Ogunsola-Bandele, 2000); According to Yara (2009), attitude has serious implication for teaching and learning processes in science. That is, it has both the potential to facilitate or inhibit learning. Attitudes are formed as a result of some kind of learning experience which affects the outcomes in teaching and learning of science. Bunkure (2012), posits that attitudes are important in influencing students acceptance or rejection of situations. He went on to say that the kind of attitude a child has, affects his school work and learning. If a child has positive attitude about teachers and school work, he will experience some success and will work more effectively.

Many factors have been identified in many researches influencing students' attitudes towards sciences. Yara (2009) identified gender, personality, environmental factors and curriculum variables as factors influencing students' attitude to science. The quality of teaching of science is a significant determinant of attitude towards science (Sjoberg, 2002). Okebukola (2002), opines that the way students perceive science is another significant

factor affecting their attitude towards science. There are several studies established that students have negative attitudes towards science and science-related subjects. And some even preconditioned their minds on their incapability to learn science and have the belief of it been difficult (Peni, 2008). He went on to stress that certain science concepts are perceived difficult by most students and in turn, affects their performance.

Nachi (2002), states that attitude seems to account for some significant percentage of the differences in academic performance in science. Okebukola (2002), also stresses that students' attitudes to science have significant direct effect on academic performance in science. Therefore, higher academic performance in science is linked to positive attitudes towards science learning. Katcha (2005), investigates that the effect of Vee-diagram instructional strategy on senior secondary school academic performance in an attitude change to Biology. He found out that students taught Biology concept using vee-diagram instructional strategy performed better in Niger State than students taught using lecture method and they also show a positive attitude towards Biology.

In a study carried out by Lakpini (2006), on the effect of a conceptual change instructional strategy on academic performance, retention and attitudes of secondary school Biology students in Zaria, Giwa Educational Zone, Kaduna State, Nigeria, it reveals a positive attitude to conceptual change instructional strategy than their counterparts in the control group. Bunkure (2012), in a study on effects of constructivist teaching strategy on academic performance, retention and attitude of senior secondary school Physics students of Kano State found that students in the experimental group show more positive attitudes than the control group taught with lecture method.

Akinbobola (2009), conducted a study to find out the attitude of students towards the use of cooperative, competitive and individualistic learning strategies in Nigerian Senior Secondary School Physics. He used a quasi-experimental design. A total of 140 students consisting of 66 males and 77 female were selected by a random sampling technique from a population of 680 senior secondary two (SS II) physics students drawn from all the 13 co-educational secondary schools in Ife South Local Government Area of Osun State, Nigeria. The data collected was analyzed using analysis of Variance (ANOVA) and the result of the findings showed that cooperative learning strategy was the most effective in facilitating students attitude toward physics.

Bitrus (2012), in a research on effects of science process skills approach on academic performance and attitude of integrated science students with varied abilities in Potiskum Educational Zone found no significant attitude change among students of varied abilities in both the experimental and control group. This study investigates attitudes towards science and technology, school science and environmental issues among middle school students. The population included all 3rd grade students in Isfahan and a total of 250 students (120 female and 130 male) were selected through stratified random sampling method. Research instrument was the Persian translation of the Relevance of Science Education (ROSE) Questionnaire. After a pilot study, data were analyzed by SPSS. Cronbach's alpha coefficient for this scale was set to be 0.75. For data analysis, descriptive statistics and one sample t-test and independent t-test were used. Results indicate that there is a positive attitude towards science and technology, school science and environmental issues among students in three components of study. According to this result, males have higher averages than the females. The results of this research provide important information about Iranian

students' attitudes towards science and could be used by science educators for development of science curricula and science text books. It will also be used as a guide for this study on impact of scaffolding instructional strategy on attitude, retention and performance in Ecology among senior secondary 11 students of Zaria metropolis Kaduna State.

2.7 Instructional Strategy and Retention Ability in Science

Learners construct knowledge by making connections between new information and their existing conceptual network. The mind acquires the materials of knowledge through sensation and perception. The acquired materials in the mind need to be preserved in form of images for knowledge to be developed whenever a stimulating situation occurs, retained images are revived or reproduced to make memorization possible. Knowledge retention is defined as the proportion of knowledge acquired by an individual after a specific retention interval. A retention interval is defined as the time that elapses between a test of original learning and a retention test. (Bruno, Ongaro, Frazer (2007). People get faster and make less noticeable errors as they repeatedly perform the same task. This is what most mean when they refer to learning. Kimble's (1961) description of learning as the relatively permanent change in response potentiality that take place as a result of extended practice. Several factors are known to influence retention.

Bichi (2002), reports that anything that aids learning should improve retention while things that lead to confusion or interference among learned materials decrease the speed and efficiency of learning and accelerate forgetting. Retention level in relation to age has been investigated by several researchers. Bichi (2002), reports that retention increase from infancy throughout the teenage years followed by a slow recession in middle age. Studies on retention and instructional strategy have attracted the attention of many researchers in

recent years. Three studies comparing the effect the different class formats have on retention rates demonstrate conflicting results. Silverberg, Tailor Vaisey, Szalai, Tipping (1995) examined differences between lecture-based and small group-based teaching methods in a continuing medical education course. Their results demonstrated that, although both groups had a significant decline on a three-month follow-up exam, the group who attended lecture classes performed better than the group who attended small group classes. In another study, Kolars Gruppen, Traber, Paine, Davis, Woolliscrolf (2007), separated second-year gastro-intestinal medical students into two groups: one group which attended "teacher-centred" lecture-based classes, and another which attended "student centred" small group-based classes. They conclude that small group-based classes lead to greater learning and retention compared to lecture-based classes.

Finally, a study by Harrison testing medical students compared knowledge retention after a one year interval between groups assigned to attend either lectures or self-study classes. On both the original final examination, there were no statistically significant differences between the two groups' performance. In this reviewed study, university students were separated into two groups; one group which were given two midterms during the year, and another which were given frequent quizzes. Performances on both "rote" and "meaningful" questions was compared between the two groups via a final examination at the end of the year, as well as via a retention examination given after a two year interval. On the final examination, the "quiz" group performed better than the "midterm" group on both the 'rote" and "meaningful" questions. On the retention examination, the "quiz" group performed better on the "meaningful:" questions, although there was no difference between the two groups on the "rote" questions.

Onion and Slade (2005), separated their subjects into groups who either studied using "superficial processing" or "deep processing". The results demonstrated that the students in the "deep processing" group performed better on the retention examination than those in the "superficial processing" group. This suggests that the type of information processing used whilst studying is important when learning new material if one is to retain the knowledge. Several authors have indicated a number of inherent weaknesses and limitations in the study of learning and knowledge retention. These include the multifactorial nature of this topic area (Onion and Slade, 2005); the difficulties in controlling for the quality and or quantity of individual studying methods.

Onion and Slade (2005), Akinbobola and Folashade (2009) compared the effectiveness of constructivist teaching methods and the conventional method with reference to performance retention and attitude. They found that students exposed to constructivist teaching method had higher cognitive performance, more positive attitude and higher retention level than those taught using the conventional teaching method. Jiya (2011) found that NCE I Biology students taught Biology using teaching with Analogy Strategy retain evolution concepts better than those taught with lecture method. From the literature reviewed, it has been shown that improved instruction could enhance retention. In this study, the Ecology concepts will be taught for six weeks and tested after two weeks to know the retention ability. The teaching will be done both with Scaffolding Instructional Strategy and Lecture Method to SS II students of Zaria.

2.7.1 Instructional Strategy and Performance by Gender in Science

Gender, a biological distinction as well as a social label by which two groups are distinguished as males and females, has engaged the attention of scholars and the general

public in recent times. Otagburuagu (2001) notes that "since the Beijing conference held in China in 1996, scholars have found added impetus to investigate the gender variables in all spheres of human endeavours". One of such human endeavours is performance in school subjects between males and females. Bichi (2006), reports that many studies in Singapore suggests that boys achieve better than girls in Mathematics but Oluwatoyin (2010) in her findings on the effect of gender on students found out that female subject were significantly better than their male counterparts and that there was a significant difference between the male and female subject in their ability to solve quantitative problems while Azih and Nwosu (2011) did not find either gender performing better.

Okwo and Otubah (2007) in their studies on gender and cognitive styles found out that gender and cognitive styles are individually and jointly significant factors influencing students' performance in physics essay facts. It is often claimed that very few girls choose science in school and apart from Biology very few of them are keen on science subjects. International studies have confirmed such a view by showing that girls are more interested and perform better in Biology than boys (Bell, 2011). Researches on gender and academic performance such as that of Usman (2008), Ibrahim (2012) and Umar (2013) observe that boys achieved better than girls, but studies by Bichi (2002), Lawal (2009) and Bunkure (2012) point out that girls achieved better than boys. Aigbomian (2002) and Njoku (2004) report that boys perform better than girls in science, technical and mathematical subjects. Other researcher like Dahiru *et al.,* (2013) show that sex plays no significant role in performance in science and technology.

Ogunboyede (2003) in a study of sex difference and students performance at the primary school level indicates that boys are not better than girls in terms of educational

performance. A study carried out by Philip (2004), reveals that girls show greater participation in science than boys. It is also observed by Oluwatoyin (2010), that when women are exposed to science, they performed better. Lawal (2009), found no significant difference in gender when taught using conceptual change instructional strategy, but she found significant gender difference when exposed to traditional instructional strategy. Lakpini (2006) in her study of gender and different ability levels found out that gender difference existed when students were exposed to conceptual change instructional strategy in Zaria – Giwa Educational Zone. Bunkure (2012) also found same result when he carried out similar study in Kano State.

Drzewiecki and Westberg (1997) carried out a survey on high school students to better understand how students' attitudes towards Mathematics differ by gender and by grouping technique used for Mathematics instruction. More specifically, the survey examined the impact of cooperative grouping as an alternative to traditional Mathematics instruction for improving female attitude toward mathematics. The result indicates that there was no significant main effect for gender and instructional methods. ViAnn (2004), investigates differences and the effects of cooperative learning in Mathematics classroom setting. The results reveal no significant gender-related differences, but female achieved slightly higher grades than males.

Pandian (2004), investigates the effects of cooperative computer-assisted learning method on male and female students' performance in Biology. The students were randomly grouped into cooperative computer-assisted learning and traditional method groups. The results indicate that gender did not express any significant influence on Biology performance. However, male and female students in the cooperative computer-assisted

instruction group show remarkable post-test mean differences over their respective counterparts who learned the same Biology concepts through traditional method.

Samuel and John (2004), examined how the Cooperative Class Experiment (CCE) teaching methods affect students' performance in chemistry. They found that there was no significant difference in gender performance between the experimental and control groups, but girls had a slightly higher mean score than boys did. Moreso, the girls taught through CCE method performed better than girls taught through the conventional teaching method in the post-test scores. Similarly, boys who were taught using CCE method performed significantly better than the boys in the control groups in the post-test scores. The researchers also pointed out that there was no significant difference in performance between boys and girls exposed to CCE method, both performed significantly better than those taught through conventional lecture method.

Kolawole (2007) found that boys performed better than girls in both cooperative and competitive learning strategies when he conducted a research on the effects of competitive and cooperative learning strategies on Nigerian students' academic performance in Mathematics. Billings (2000); Aguele and Uhumniah (2007); found in their studies at various times, that male students achieved significantly better than female students in science education. Other researches carried out on gender issues in science education, Bilesanmi-Awoderu, (2002); Erinosho, (2005). Ogunkoya and Bilesanmi-Awoderu (2000) carried out a research on the effectiveness of laboratory-based and lecture methods on students' performance in Biology while Erinosho (2005) carried out studies on gender as it affects performance. They found that students' performance in Biology was not sensitive to the sex of students. Bilesanmi-Awoderu (2002) carried out a study on the concept-

mapping, students' locus of control and gender as determinants of Nigerian High School Students' performance in Biology. She found that there was no significant main effect of gender on students' performance in Biology.

Another study on impact of scaffolding as a strategy for teaching reading and to investigate the possible impact of gender as a moderator variable between scaffolding and reading development by Mohammad (2012), reveals that scaffolding has a positive effect on learners reading comprehension and motivation scores. The findings also point to a positive relationship between female learners' performances in comparison with males in terms of their reading and motivation. Maduewusi (2010), remarks that well documented research in Nigeria has shown that children might lack male role models in primary and secondary schools, female learners definitely lack female role models in science education.

In a study conducted by Ugwu (2005) on the Influence of Cultural Practice on the studying of science by women the result reveals that there were a low percentage of female students in Mathematics and related courses than the male students. The researcher maintained that it is generally believed that science and Mathematics courses are masculine subjects. Olagunju (2001), investigates sex, age and performance in Mathematics. The study used a sample size of 240 students considered of 120 males and 120 females. The mean, standard deviation and percentage of passes were used for answering the research questions, while T-test was used for testing the research hypotheses. The result shows that there is no significant difference in the performance of male and female counterparts.

Aiyedun (2000), carried out a study to determine the influence of sex difference of students on the performance in secondary school Mathematics. The result shows that performance

does not depend on sex. From the above research studies, it would appear that there is no significant difference in science performance as a result of gender (BiIesanmi-Awoderu, 2002). In line with this, Betiku (2002), observes sex difference in favour of males in school certificate set and probability theories. Boys performed better than girls while students in the urban centers performed better than students in the rural areas. Jahun and Momoh (2001), carried out a research on the "Effects of Environment and Sex on the Mathematics performance of JS III students in Kwara State". The findings of the study show that the male students performed significantly better than their female counterparts. Mandor (2002), also observes sex differences in favour of males in grade expectancies and actual performance as a function of WAEC 'O' level grade in Biology. It is therefore, worth finding out if gender has any effect on students' performance if they are taught Ecology concept using Scaffolding Instructional Strategy in relation to the conventional lecture method.

2.8 Overview of Similar Studies

To date, quite a number of reports are available on the use of scaffolding practice in many different areas of learning. For example, Ogunseemi (2013) on Effects of Scaffolding Strategy on Learners Academic Achievement in Integrated Science at the Junior secondary level in Ekiti State. 450 students in JS 2 that were randomly selected from four Junior Secondary Schools in two Local Government Areas of Ekiti State respectively. The sample was divided into two groups, two schools serving as a group. The first group was taught using scaffolding strategy (SCS), while the second group was taught using the traditional (chalk and talk) method (TRM). The research design was quasi- experimental control group. Two research questions were raised; correspondingly two hypotheses were

formulated and tested using t-test analysis. Results show that students exposed to scaffolding strategy performed significantly better than their counterparts who were exposed to traditional method. Also, students of schools in urban locations had better academic achievement than their counterparts in rural locations.

Ogunseemi (2013), carried out the study using JS 2 students and in Integrated Science (now Basic Science) in Ekiti State. It did not specify any strategy or model of scaffolding used, and concept taught. However, no report is available on the researcher's approach of Impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among Senior Secondary School which this study will fill the gap by employing Djwantoro (2010) scaffolding model to teach Ecology and to find the impact of attitude, retention, performance, and gender in senior secondary II students in Zaria, Kaduna State. Djwantoro (2010) studied the use of Scaffolding Approach to Enhance Students Engagement in Learning Structural Analysis in Surabaya, Indonesia.

The study of Remalyn (2013), on Scaffolding Strategy in Teaching Mathematics aims to Determine the Level of Effectiveness of the use of Scaffolding and Traditional Strategies. The selected topics in Mathematics III was based on the mathematics performance and attitudes of the third year high school students of La Union National High School city of San Fernando, La Union, Philippines for the school year 2007-2008. The study made use of the true experimental design specifically, the pretest-posttest, descriptive and correlational research designs. Two sections of the 3rd year high school students were the participants of the study. There were 12 participants for each group with first and second grading averages ranging from 78-90. The experimental group was exposed to scaffolding strategy and they were handled one hour from Monday to Friday (11.00–12.00pm).

Combinations of several techniques such as modeling, offering explanations, clarifying students responses, use of scaffolding questions use of visual organizers, cooperative learning (think pair-share technique), guided practice, and computer technology integration were employed to the experimental group. The control group was exposed to traditional strategy which utilized board work, worksheets, lecture method, and the like with an hour of lecture from Monday to Friday (12.00 – 1.00pm). The control and experimental groups both completed the selected topics in Mathematics III which were classifying quadrilaterals, properties of parallelograms proving quadrilaterals as parallelograms. Special parallelograms, trapezoids and kites and Congruent Quadrilaterals. There were two instruments used to gather data, the 45–item pretest–posttest and the Modified Fenn ema-Sherman Attitudes Scale which had four subscales, namely, confidence in learning Mathematics, attitude toward success in Mathematics, Mathematics anxiety and perception of teacher's attitude which were twelve items each. The study reveals the following findings:

*. Based on the pretest, the two groups were comparable. The posttest reveals significant difference with mean performance of the experimental group higher than the control group.

* There was no significant difference on the level of attitude of the two groups of participants before and after the conduct of the study in terms of confidence in learning Mathematics, attitude towards success in Mathematics, Mathematics anxiety and perception of teacher's attitudes;

*. A positive high relationship existed between performance and attitudes of the experimental group. There was a significant relationship between the level of performance and level of attitude of the experimental groups;

*. The scaffolding strategy was found to be effective in improving the performance and had an impact on the attitudes of the participants toward Mathematics.

The study of Remalyn (2013) is relevant to the present study in using scaffolding and traditional methods and the design of the experiment. The researcher's instrument was not only attitude but retention with gender inclusive. The study serves as a guide to the present study in the various steps of the techniques of scaffolding used and recommendations for further studies. It is different from the researchers' study which is in Biology with Ecology concepts taught and also location of study which is Zaria in Kaduna State.

Deyu Hu (2006), studied the Effects of Scaffolding on the Performance of students in computer-based concept linking and retention of comprehension. The purpose of the study was to examine two scaffolding methods on the performance of students in computer based concept linking and retention of comprehension in Virginian Tech. University, United State. After training and practice in concept mapping and cmap Tools – a computer – based concept mapping program, 116 undergraduate students were randomly assigned to one of four treatment groups to work on a computer-based concept mapping task. Students in the no scaffolding (NS) group did not receive any scaffolding. Students in the linking phrase scaffolding (PS) group received linking words or phrases as scaffolding. Students in the articulation hint scaffolding (AS) group received a hint question as scaffolding, which asked them to elaborate on relationships between concepts in full sentences. Students in the

linking phrase and articulation hint scaffolding (PAS) group received both scaffolding while working on the computer-based concept mapping task. One week after the treatment, students took a concept linking posttest in which they constructed a concept map in Cmap Tools based on a web-based instruction on the human heart.

After another week, they took another posttest on retention of comprehension about the heart. Two 2 x 2 factorial Analysis of Variance (ANOVA) were conducted to examine the main effects of linking phrase scaffolding and articulation hint scaffolding and any interaction effect between them on the performance of students in computer-based concept linking and retention of comprehension. The results show no significant difference in the performance of students in both tests. However, the Pearson's correlation analysis shows that there was a positive correlation between students' performance in computer-based concept linking and retention of comprehension.

The study of Deyu Hu (2006) was on concept linking and retention of comprehension while the researcher is on Ecology concept using senior secondary II of Zaria, Kaduna State. Deyu Hu (2006) used undergraduate students who worked on computer based mapping task. It is similar to the researcher's study on methodology used.

The study by Bansal (2017) on the Effect of Instructional Scaffolding on High school students' Academic Achievement and Attitude towards Science in India was another relevant study. It was a true experimental research and was conducted on 100 high school students (50 male and 50 female) studying in two reputed Central Board of Secondary Education (C.B.S.E. under the Union of Government of India) schools located in district Bathinda. One school was made control group while the other was considered as

experimental group. Control group was taught by using traditional method while the experimental group was taught by using various scaffolding strategies for two weeks. For data collection regarding the Academic Achievement, two worksheets given by C.B.S.E. were used both for pre-test and post-test and attitudinarian was used to study the students' attitude towards science after the implementation of scaffolding strategies for experimental group, t-test was used to find out the significant difference in the students academic achievement of the two groups both for pre-test and posttest, it was also employed to find the significant difference in the students' attitude towards science before and after scaffolding strategies are used in the experimental group.

The results clearly reveal a significant difference in the mean scores in students academic achievement of the two groups with students taught by scaffolding strategies performed much better than those taught by traditional methods. In addition, students developed a positive attitude towards science when they were taught using various scaffolding strategies. This study by Bansal (2017), used students in class 10 and the study was not specific on which branch of science and scaffold used. The study took place in Chandigarh, India while the study under investigation was carried out in Zaria, Kaduna State, Nigeria on Ecology using SS II students and Djwantoro (2010), strategy of scaffolding model. The design of the reviewed study and analysis were similar to the researcher's study. Bansal was not specific on the scaffolds used. The researcher used partial solutions, explanations questions, hints and feedback as scaffolds Djwantoro, (2010). These scaffolds were used because they made the tasks for the students easier to understand, relax and exciting for them to gain mastery or competence in the task or skill.

Another interesting study carried out by Simons and Klein (2007) is also relevant to the study being investigated. The study is on the Impact of Scaffolding and Student Achievement Levels in a Problem-based learning environment in United State of America. The study examines how scaffolds and students' achievement levels influence inquiry and performance in a Problem-based learning environment. The scaffolds were embedded within a hyper media program that placed students at the centre of a problem in which they were trying to become the youngest person to fly around the world in a balloon. One-hundred and eleven seventh grade students enrolled in a science and technology course worked in collaborative groups for a duration of 3 weeks to complete a project that included designing a balloon and a travel plan. Students' groups used one of three problem-based hypermedia programs: (1) a no scaffolding condition that did not provide access to scaffolds (2) a scaffolding optional condition that provided access to scaffolds, but gave students the choice to whether or not to use them, and (3) a scaffolding required condition require students to complete all available scaffolds. Results reveal that students in the scaffolding optional and scaffolding required conditions performed significantly better, than students in the no scaffolding condition on one of the two components of the group project. Results also show that students achievement levels were significantly related to individual post-test scores; higher achieving students scored better on the post-test than lower achieving students.

In addition, analyses of group notebooks confirmed qualitative differences between students in the various conditions. Specifically, those in the scaffolding required condition produced more highly organized project notebooks containing a higher percentage of entries directly relevant to the problem. These findings suggest that scaffolds may enhance

inquiry and performance, especially when students are required to access and use them. This study of Simons and Klein (2007) is different from the researcher's study because it used a hypermedia program that placed students at the centre of a problem in which they were trying to become the youngest person to fly around the world in a balloon. The scaffolds were embedded within a hypermedia program. The specific scaffolds were not mentioned while the researcher's study is on Ecology not using any technologically based or software programme, it also differs in location but relevant in the use of having groups of scaffolding and non-scaffolding method. The researcher's study used Djwantoro's (2010) model of scaffolding.

A study of great interest is the one titled "Effect of instructional scaffolding on academic achievement and interest of students' in Chemistry in Senior Secondary Schools'" in Mbaitoli by Chukwuagu (2016). This study was carried out to investigate the effect of instructional scaffolding on the academic achievement and interest of students in Chemistry in Mbaitoli Local Government Area of Imo State. In other to effectively carry out the study, it adopted the quasi experimental design particularly the pre-test post-test non-equivalent control group. The sample for the reviewed study consisted of SS1 and SS II students from 2 selected public schools out of the 18 public schools (population) in the area using purposive sampling. Out of the schools sampled one was randomly assigned to scaffolding treatment group while the other to the conventional expository group.

A total of 81 students made up the sample for the study. Two instruments were used to collect data for the study, Chemistry Achievement Test (CAT) and Chemistry Interest Scale (CIS). The reliability of the instruments were established using Cronbach Alpha for

Chemistry Interest Scale (CIS) and test retest method for CAT with the reliability index of 0.81 and 0.78 respectively. Four research questions and four hypotheses guided the study which was tested at 0.05 level of significance using ANCOVA. Research questions were answered using mean and standard deviation for CAT and CIS. Findings revealed that instructional scaffolding improved the achievement and interest of Chemistry students significantly. Also, gender was not significant in interest and achievement of the students exposed to instructional scaffolding. This study is similar to the researcher's study on Impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology in investigating the academic performance, design and methodology used. It differs in location, the study was done in Imo state and the present study was done in Zaria, Kaduna State. The study was also carried out in Chemistry while the present research was in Ecology.

The research on Scaffolding Strategies Applied by Student Teachers to teach Mathematics by Bikmaz, Celebi, Afa, Ozer, Soyak and Recber (2010) of Ankara University Turkey was conducted with thirteen student teachers in their fourth year of study in Bachelor of Education (Classroom teacher) programs. Nine student teachers worked with two fifth grader learners, while the other four worked with three. In order to determine the participant students, a geometry test relating to the first unit of the fifth grade mathematics curriculum was administered. The student teachers worked on a one-to-one basis with students who were having difficulty in geometry and the scaffolding strategies of Rochler and Cartlon (1997) were used–modeling of desired behaviours, the offering of explanations, inviting students to participate, verifying and clarifying students' understanding and inviting students to contribute clues.

In the research the aim was to analyze student teacher scaffolding strategies as they have been applied to the teaching of Mathematics. The research used two groups of participants. The first group consisted a fifth grade students, whereas the second consisted of senior-year student teachers. The first group consisted of 30 students attending the 5^{th} grade of the elementary school where the student teachers were doing their teaching practice. These students were selected by implementing a pretest. The second group consisted of 13 senior–year student teachers at Ankara University, Faculty of Educational Science, Department of Elementary Education who were taking the teaching practice course. Of the student teachers, 3 were male and 10 were female. The test consisted of 17 questions. Three methods of data collection were utilized; the geometry test, an audio recording of the student teachers and student interactions and interviews with student teachers and students. The most common scaffolding strategy used by the student teachers was inviting students' participation (46.2%) followed by verifying and clarifying students' understanding (19.6%), offering explanation (16.9%) inviting students to contribute clues (9.3%) and modeling of desired behaviours (8%).

According to the results; inviting student participation was found to be the most commonly used scaffolding strategy. The reasons given by the student teachers for using these strategies were to enable students to be aware of their performance and place them in the centre of the learning process. This may be the one reason for using inviting students' participation strategies more than other strategies. The least common were inviting students to contribute clues and the modeling of desired behaviour. The study of Bikmaz *et al*. is relevant to the researcher's investigation on Scaffolding Instructional Strategy in attitudes, retention and performance in Ecology among SS II students. The various steps mentioned

in the study will serve as a guide in the classroom which makes the learner to be at the centre of the learning process. It is different because it is in Mathematics while the researcher is on Ecology. Bikmaz *et al*., used Rochler and Cartlon (1997) model of scaffolding while the researcher used Djwantoro (2010) model of scaffolding.

Azih and Nwosu (2011), investigates the effects of instructional scaffolding on the performance of male and female students in Financial Accounting in Abakaliki Urban of Ebonyi state, a pretest, posttest, control group, non randomized quasi experimental design was used in this study. The population of the study comprised all SSII students in all the secondary schools in Abakaliki urban financial accounting. Four secondary schools were selected out of the fourteen secondary schools in Abakaliki offering financial accounting. A total of one hundred and sixty-three (163) students offering financial accounting were used for the study. The financial accounting performance test was used for data collection. The data were analyzed using mean and standard deviation while the analysis of covariance was used to test the hypothesis. Summary of result reveals that instructional scaffolding method was superior to the conventional method in improving the performance of male and female students in financial accounting. The test of interaction shows that gender had no significant interaction with teaching approach on students mean performance. It was concluded that instructional scaffolding is a good teaching method for teaching financial accounting. Azih and Nwosu's study is similar in the research design, methodology approach but differs in subject studied, location, model adopted by the researcher and variables (attitude and retention).

Another relevant study to the present researcher's investigation is the Effects of Scaffolding in the Classroom: support contingency and student independent working time in relation to student achievement, task effort and appreciation of support by Janneke, Volman, Oort and Beishuizen (2015). The study investigates whether scaffolding affects students' achievement, task effort, and appreciation of teacher support, when students work in small groups. They investigated both the effects of support quality (i.e. contingency) and the duration of the independent working time of the groups. Thirty social studies teachers from 20 Dutch schools of pre-vocational education and 768 students (age 12-15) participated. There were 17 teachers of 11 schools in the scaffolding condition and 13 teachers of 9 schools in the non-scaffolding condition. Of the participating teachers, 20 were men and 10 were women. The teachers taught social studies in the 8^{th} grade of pre-vocational education. The average teaching experience of the teachers was 10.4 years. Each teacher participated with one class, so a total of 30 classes participated.

During the project lessons that all teachers taught during the experiment, students worked in small groups. The total number of groups was 184 and the average number of students per group was 4.15. From the total of 768 students participated, 455 students in the scaffolding condition and 313 students in the non-scaffolding condition. Of the 768 students, 385 were boys and 383 were girls. All teachers taught a five–lesson project on the European Union and the teachers in the scaffolding condition additionally took part in a scaffolding intervention. t-tests for independent samples show that the schools and teachers of the scaffolding and non-scaffolding condition were comparable with regards to teachers years of experience. The design used was Between–Subjects Design (to determine whether

differences exists between two or more treatment conditions, to compare two teaching methods, to determine whether one is more effective than the other).

It investigated the separate and joint effects of supports contingency and independent working time on students' achievement, task effort and appreciation of support using a pre-measurement and a post-measurement. The study contributed the understanding of the circumstances in which low and high contingent support is beneficial. If teachers have the opportunity to provide frequent support, low contingent support appeared more effective in promoting students' achievement and task effort than high contingent support. Yet, if teachers do not have the opportunity to provide support often, e.g. due to a full classroom, high contingent support appeared more effective than low contingent support in fostering students' achievement (when correcting for task effort).

The study reveals that when teachers are taught how to scaffold, their degree of contingency increased but the independent working time for students increased as well. Scaffolding effectiveness depends, among other things, on the independent working time and students' task effort. The studies show that such factors are important to include in scaffolding studies that take place in authentic classroom settings. This study is relevant to the researcher's study on impact of scaffolding instructional strategy on attitude retention and performance in Ecology among senior secondary school students in Zaria in that the amount of supports and the task determine performance of students which serves as a guide to the researcher for the investigation.

The study investigated whether scaffolding affect performance among pre-vocational education students in a classroom setting. The reviewed study differed in the level of students used (8 grade pre-vocational education students – JS II) the subjects taught was

social studies and also differ in concept taught and location of the study. The researcher's study was not just on performance as reviewed, attitude towards the subjects and retention were also considered. The researcher used a higher level of students (SS II) and the location was in Zaria, Kaduna State Nigeria while the reviewed was in Netherlands. The design of the researcher was similar to the reviewed study. The reviewed study investigated task effort and appreciation of support while the present researcher's considered gender.

The study of Akani (2015) on the impact of instructional scaffolding on students' achievement in chemistry in secondary schools in Ebonyi state also studied the interactive effects of scaffolding and gender on achievement of senior secondary school students in Chemistry. Three research questions and two hypotheses guided the study. The method of data collection was experimental, simple random sampling techniques was applied to select a total of ninety (90) students from the ten secondary schools used for the study. The instruments for data collection were Chemistry Scaffolding Achievement Test (SCAT) for the treatment group and conventional Instructional Package (CIP) for the control group. Mean and standard deviation were used for the analysis of the data. The hypotheses were tested using ANCOVA at the level of significance of 0.05. The reliability of the instrument was calculated using Kuder- Richardson ($K–R_{20}$) procedure, from which a reliability coefficient of 0.85 was obtained.

The result on the effect of gender proved that the male students performed better than the female students. The result on interactive effects of scaffolding and gender reveals that there is no significant interaction, as both performed well. This reviewed study is similar to the study at hand in methodology and design, and it also investigated the effects of

instructional scaffolding on achievement of Senior Secondary students while the study at hand is investigating the impact on Ecology concepts and also looking at the attitude of students to Ecology while the reviewed was in Chemistry with specific Senior Secondary school level mentioned. This study was carried out in Kaduna State of Nigeria while the reviewed was done in Ebonyi state of Nigeria.

Bhutto, Khalid, Muhammed; Majeeb (2013) used quasi-experimental to find out the Effect of teaching algebra through social constructivism on the students learning outcomes of 7^{th} graders in public schools of District Jamshoro Sindh Pakistan. For this purpose two existing in-tact sections of grade 7(7^{th} A, and 7^{th} B) of a government high school of district Jamshoro were selected as quasi control and treatment groups. The pre and posttest analyses were carried out. The first pattern t-test analysis reveals that both groups were parallel, however, the latter posttest analysis reveals that treatment group that was taught through social constructivist approach excelled in achieving statistically significant learning outcomes than that of control group that was taught through traditional one-way teaching. All public sector male seventh grader of District Jamshoro comprised the target population of the study; and two existing in-tact classes (section A and B) of 7^{th} graders (2010-2011) of a Government Boys High School of District Jamshoro were selected as sample for control and treatment groups respectively for quasi-experimental study.

The quantitative data were collected from both groups through pre and posttest and were analyzed using t-test to find out statistical difference between control and treatment groups. Online t-test calculator was used from Graph Pad Quick Calcs Website (Graph Pad Quick Calcs, 2011). Two patterns of analyses were carried out: pretest scores analyses of both

control and treatment group to find out and ensure homogeneity between the selected in-tact groups in terms of previous knowledge and understanding and posttest scores analysis of both group to determine the effect of treatment on learning outcomes of the students. It yielded better learning outcomes also provided opportunities for students to interact with others, to share one's ideas and listen to others' (peer or teacher) point of view, to develop social interaction and communication skills and to learn collaboratively in a free and friendly environment. Bhutto *et al* study was relevant to the researcher's study in methodology and design but differend in the subject of study, level of students' used and teaching strategy (i.e. constructivism) and location. The researcher's study was based on scaffolding strategy, with variables in attitude, retention and gender. It also used Senior Secondary School (II) students of Giwa, Kaduna State. While the reviewed study was in Jamshoro Sindh, Pakistan.

Enhancing Academic Achievement and Retention in senior secondary school Chemistry through Discussion and lecture methods; A Case study of selected secondary schools in Gboko, Benue State, Nigeria was investigated by Omwirhiren (2015). The study was initiated to determine how academic achievement and retention in chemistry is enhanced using two instructional methods among SSII students and ascertained the differential performance of male and female students in Chemistry with a view of improving students' performance in Chemistry. The study adopted a non-equivalent pretest, post-test control quasi-experimental design. A total of one hundred and eighteen senior secondary school II students in intact classes were chosen from three schools in Gboko Local Government Area of Benue State using purposive random sampling. Data were collected using a 30-item multiple choice Chemistry Achievement Test (CAT), in Organic Chemistry. Student were

assigned to a treatment and a control group. Three hypotheses were generated and tested which were tested at 0.05 level of significance.

The data obtained were analyzed using descriptive statistics, t-test, spearman's correlation coefficient and analysis of variance (ANOVA). There was significant difference in students performance when discussion and lecture strategies were used to teach chemistry (F_{cal}= 4.65> F_{crit}=3.85 at{<0.05). The result shows significant difference in the retention ability of students exposed to discussion and lecture method (F_{cal} = 0.97867> 0.2353 at P<0.05). There was significant difference in the performance of male and female students in the two groups (t_{cal}=3.621? t_{crit}=2.000 at P<0.05). The overall results shows that discussion instructional strategy significantly improved students performance in chemistry better than the lecture instructional strategy. The study concluded that discussion enhanced better achievement and productivity than the lecture method. It was recommended that discussion method should be used to teach organic chemistry in Nigeria senior secondary schools. This study is relevant to the researcher's investigation in having the same variables, design and the statistical tool used but differ in the instructional strategies. The researcher's study was on scaffolding while the reviewed is on discussion which were all compared with lecture method. The location also differed.

The study on Effects of Lecture and Demonstration Methods on the Academic Achievement of students in chemistry was carried out by Ameh and Dantani (2012). This is to determine the effect of lecture and demonstration methods on academic achievement of students in Chemistry in the Nassarawa Local Government Area of Kano State. Fifty–eight (58) chemistry students (boys and girls) in the Senior Secondary School one (SS1) from

two randomly selected schools were involved in the study. Necessary data were collected and the validated reliable data were analyzed using the t-test at a significant level of 0.05.

Results obtained reveal that students perform better in Chemistry when taught using the demonstration method as compared to the lecture method. The boys and girls are better in academic achievement when taught using demonstration method than when lecture method was used. The demonstration method shows equality in the performance of boys and girls. Hence, the adoption of demonstration methods in the teaching and learning of chemistry and science is recommended. The research on Scaffolding Instructional Strategy was different to the reviewed study in which lecture method was studied with Demonstration to know the effectiveness on the academic performance of Chemistry. It differs from the researcher's study which determines the impact of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among SS 2 students of Zaria. It was also different in subject, level of student and location. It is similar in using lecture method, research design and statistical tool. Therefore, serves as a basis for the researcher's study.

The study of Chen and Chen (2012), examine the Effects of an Inquiry-Based Learning (IBL) approach compared to that of a Problem-Based Learning (PBL) approach on learner performance, attitude towards science and inquiry ability. Ninety-six (96) students from three 7^{th} – grade classes at a public school in Taiwan were randomly assigned to two experimental groups and one control group. All groups received the same web-based curriculum on the scientific topic of the greenhouse effect. These IBL groups, though were asked to actively participate in the processes of predicting, hypothesizing and testing, while the PBL groups were instructed to follow a specific problem-solving process.

The results reveal that all students performed equally in science performance despite of the treatment groups. In terms of attitude towards science, the finding indicates that students participated in IBL or PBL groups reported more positive attitudes toward learning science and resulted in higher inquiry abilities than those who were in the control group. PBL booklet was the instructional manual that taught students how to solve problems step-by-step following the processes of problem-solving which involve constructing problem space, choosing and generating solutions, monitoring and evaluating (Ge and Land, 2004; Chen, 2012). Booklet included external scaffolds aligned with the processes of problem-solving were designed by the researchers and content experts. Scaffolds included thirteen questions, and the sample questions were "what has caused the greenhouse effect"? Pretest and posttest.

A 20-item multiple-choice question test was developed to assess students' performance. The test was developed by the teachers who taught earth science class for more than 5 years. The study of Chen and Chen (2012) is similar to the researcher's impact of Scaffolding Instructional Strategy in having the same instrument, design, performance and attitude as independent variables and also the use of questions as scaffolds. The reviewed study differs from the researcher's investigation on impact of Scaffolding Instructional Strategy on attitude, retention and performance on target population, location, concept and also the strategies. The reviewed study was on Inquiry-Based Learning Approach (IBL) compared with Problem-Based Learning Approach (PBL), used 7^{th} grade (equivalent of JSS 1) and was carried out in Taiwan and also used web-based programme while the researcher used Djwantoro (2010) model of scaffolding to teach Ecology concepts to SS II students of Zaria, Kaduna State, Nigeria. Therefore serve as guide to the investigation.

The study of Dike, Mumuni, Chinda, Worokwu (2017), was undertaken to examine the effect of metacognitive teaching strategies on secondary school students performance in Chemistry. The study adopted pretest posttest quasi experimental design. Three hundred and sixty senior secondary school II (SSII) Chemistry students were drawn from three secondary school in Obio/Akpor Local Government of Rivers State Nigeria. Three research questions and three hypotheses were passed for the study. The instrument for data collection was a twenty five – item multiple choice Chemistry achievement test (CAT) developed by the researcher. Students were divided into two experimental groups and one control group, students in the experimental groups were subjected to treatment using thinking-aloud and self assessment metacognitive teaching strategies while students in the control group were taught with conventional method. Mean, standard deviation, t-test and ANCOVA were used for data analysis.

The results show that students taught with thinking-aloud metacognitive strategies performed better in Chemistry achievement test followed by self assessment metacognitive strategy than the conventional strategy. It was concluded that metacognitive teaching strategy such as think-aloud and self assessment if effectively utilized and applied by teachers in the instructional delivery in chemistry could significantly improve the performance of students'. This study of metacognitive teaching strategies is different from the impact of Scaffolding Instructional Strategy, from the location, it was done in Port Harcourt, the subject taught was Chemistry no specific model of metacognitive strategy used, data analysis used ANCOVA and no gender investigated. The study is similar in the experimental design adopted which is pretest posttest quasi experimental design target

population (SS II), and statistical tool used in analysis of population. The study serve as a guide to construct a reliable instrument for measuring students' performance.

Bukunola and Idowu (2012) investigated the effectiveness of cooperative learning strategies on Nigerian Junior Secondary School students' academic achievement in Basic Science in Omu-Ijebu South West Nigeria. The design of the study was quasi experimental specifically the non-equivalent control group design. The treatments were at two levels: cooperative learning strategies (learning together and Jigsaw II) and conventional lecture method, which was the control group. The moderating variable was anxiety (high and low). Total number of one hundred and twenty students (120) obtained from the intact classes of the three selected junior secondary schools in South-West Nigeria participated in the study. Achievement Test for Basic Science Students (ATBSS) and Basic Science Anxiety Scale (BSAS) were the main instruments used to collect data from students. Descriptive statistics and Analysis of covariance (ANCOVA) were used to analyze the data collected. Also, multiple classification Analysis (MCA) was used to determine the magnitude of the mean achievement scores of students exposed to the different treatment conditions.

The results of Bukunola and Idowu (2012), indicate that there were significant main effects of treatment on all the dependent measures. There were also significant main effects of anxiety on the students' post and delayed – post academic achievement scores in Basic science. Furthermore, there were significant interaction effects of treatments and anxiety on the academic achievement of students at the post-test and delayed – post-test levels. This study reveals that students in the two cooperative learning strategy (Learning together and Jigsaw II) groups had higher immediate and delayed academic achievement mean

scores than the students in the conventional lecture group. Learning together and Jigsaw II cooperative teaching strategies were found to be more effective in enhancing students' academic achievement and retention in Basic Science than the conventional – lecture. When friendliness is established, students are more confident to ask questions from one another for better understanding of the tasks being learnt. This reviewed study is related to the researcher's investigation in the aspect of students' achievement variable in basic science. However, the present study investigates not only students' achievement but also attitude, retention with gender bias under scaffolding on Ecology on Senior Secondary school II students of Zaria, Kaduna State.

The effect of five phase Constructivist Instructional Model (CIM) on upper basic 2 students cognitive achievement and interest in Basic Science and Mathematics in Cross River State of Nigeria was investigated by Ekon, Ekwueme and Meremikwu (2014). To achieve this, two research questions guided the study. Conceptual and theoretical studies were reviewed. A non-equivalent pretest post-test quasi-experimental design was used. Two hundred and sixty–eight (268) students participated in the study out of a total population of about 4,280 upper basic 2 students in state governments – owned schools using a simple random sampling technique. Three schools were randomly assigned to experimental and control groups respectively. The 130 experimental group students were exposed to the use of the five phases constructivist Instructional Model (CIM) while conventional method was used for the 138 control group students.

Two instruments: Cognitive Achievement Test (CAT) and Basic Science and Mathematics Interest Inventory (BSMII) were developed and administered to the students. Mean scores

and standard deviations were used to answer the research questions. The result reveals significant difference in mean achievement and interest scores of the students in the experimental group. The study at hand investigated the impact of scaffolding strategy on attitude, retention and performance in Ecology among senior secondary II while the reviewed study is on upper basic 2 students interest and achievement in Taraba State while the researcher's study is in Zaria Kaduna State. The present study will use two intact classes not 3 as reported in the reviewed study. Furthermore, the reviewed study was carried out using three (3) schools, and two subjects (Maths and Basic Science) but this study will use 2 schools in Giwa, Kaduna State and on Ecology.

Ndirika (2012), investigates the effects of teacher-centred, teacher/student-centred and student-centred instructions on the academic achievement of basic science students at the upper basic level in relation to class-size and gender. A quasi-experimental pretest posttest research design was used for the study which featured nine comparable groups of basic science students. Four hundred and eight basic II students randomly selected from nine schools in Giwa Zone, of Kaduna State formed the study sample. They were taught basic science concepts using the three types of instruction. Performances of the nine groups were compared using their post-test mean scores. Four null hypotheses were tested using one way Analysis of Variance and t-test at a significance level of $P \leq 0.05$ Integrated Science Achievement Test (ISAT) with reliability coefficients of 0.85 was used to collect data for the study.

The findings were (i) students in three different class-sizes taught with student-centred instruction achieved significantly higher than those taught with teacher/student-centred and

teacher centred (ii) There was no significant difference in performance of male and female students when taught with teacher-centred and teacher/student-centred instruction (iii) A significant difference was found in the performance of male and female students taught with student-centred instruction with the males performing better than the females. This study investigated the impact of scaffolding strategy on attitude, retention and performance in Ecology among Senior Secondary School II in Zaria, Kaduna State. This study was similar in having groups of teacher-centred and student centred instruction and having performance and gender as variable but differs in not been specific on reference to any model of instruction/strategy used in carrying out the study. The researchers method is on scaffolding with attitude and retention variables considered and Djwantoro (2010) model of scaffolding used. The design, methodology and statistical tool used were similar. Consequently, it served as a guide to the researcher's investigation. The result study was similar to the research in methodology, analysis and variables adopted.

Another interesting study carried out by Nwagbo (2006) investigated the relative efficacy of guided inquiry and the expository teaching methods on the achievement and attitude to Biology students of different levels of scientific literacy. Four research questions and four null hypotheses were posed and formulated respectively to guide the work. It was hypothesized that effects due to teaching methods and their interactions with scientific literacy levels were not significant ($P<0.05$) relative to students' mean achievement and attitudinal scores in Biology. A pretest, posttest, non-equivalent control group design was adopted for the study. One hundred and forty-seven Senior Secondary two (SSII) Biology students from eight intact classes randomly selected from four secondary schools in Nsukka Enugu state, Nigeria constituted the sample. Three instruments namely: scientific

literacy test (SLT), Biology Achievement Test (BAT) and Attitude to Biology Scale (ABS) were used for data collection. The research questions were answered using mean and standard deviation scores, while the hypotheses were tested ($p \leq 0.05$) using analysis of covariance (ANCOVA).

The results show that the guided inquiry method was significantly better than the expository method in enhancing cognitive achievement in Biology for students of all levels of scientific literacy. Students of different levels of scientific literacy showed positive attitude to Biology when the two methods were used. The interactive effects of teaching methods and scientific literacy levels on both achievement in and attitude to Biology were not significant ($p<0.05$). The reviewed study was on guided inquiry, with no specific area of Biology concepts concentrated on and no attitudinal study of the students to the concepts taught. Unlike the reported study, the present study will investigate the effects of scaffolding instructional strategy on attitude retention and performance in Ecology and gender among senior secondary II school students in Giwa, Kaduna State.

In another study, Abu and Flowers (1997) examined the effects of cooperative learning methods on achievement, retention and attitude of Home Economics students in North Carolina. Cooperative learning was compared to competitive learning classroom structure using a quasi-experimental design. An achievement test, consisting of items from the state, competency test item bank for the course and an attitude questionnaire were administered immediately following instruction on the unit of special nutritional needs. A retention test was administered three weeks following the achievement test. California achievement test scores and first semester grades in Home Economics classes were used as covariates to

adjust for possible preexisting differences between the groups. Multi-variate analysis of covariance showed no significant difference among the dependent variables (achievement and retention) between the two teaching methods used. There was no significant difference in students' attitudes towards the teaching methods. This reported study is similar to the present study since both have the same variables. However, the present study is using the senior secondary II student and teaching Ecology concepts while the reviewed used Home Economics students taught special nutritional need. In addition, the researcher had Ecology Performance Test (ECPT) and Attitude to Ecology Questionniare (AEQ) for the study while the reviewed used items from item bank and was done in North Carolina, the researcher study was done in Giwa Kaduna State, Nigeria.

In a study to determine the effects of cooperative learning strategy in Junior Secondary school students achievement in integrated science, Ajaja (2010), carried out a study to determine how the adoption of cooperative learning as an instructional strategy for teaching integrated science influences students' achievement and attitude toward science studies. They also determined how moderating variables like sex and ability, affect students' achievement in integrated science when cooperative learning is used as an instructional strategy. To guide this study, five hypotheses were stated and tested at 0.05 level of significance. The design of the study was a 2 x 2 x 2 x 2 factorial, pretest, post test control group design. This includes two instructional groups (cooperative and traditional classroom groups), sex (male and females), ability (high and low), and repeated testing pretest and posttest). The population of the study was made up of 205 JS III students from which a sample of 120 students was randomly selected. The instruments used for the collection of data include a Scholastic Ability Test in Integrated Science (SATIS), students attitude scale

(SAS), and Integrated Science Achievement Test (ISAT). All the data collected were analyzed with analysis of covariance.

The major findings of the study include: a significant higher achievement scores of students in cooperative learning group than those in traditional classroom; a significant higher attitude scores of students in cooperative learning group than those in traditional classroom; a non-significant difference in achievement test scores between the male and female students in the cooperative learning groups; and non-significant interaction effect between sex and ability; sex and ability on achievement. The present study is considering the effects of scaffolding strategy on attitude, retention and performance in Ecology among senior secondary II students of Giwa, Kaduna State in the achievement and attitude variable. The population of the reviewed study comprised of JS III students and the learning strategy was co-operative with sex and ability as moderating variables.

Another research conducted by Abdullahi (2009) investigated the effect of cooperative learning on the academic achievement and retention of Mathematics concept at the primary school in Holly Makah. The study sample was (59) students divided into two groups, the control group (29) students been taught traditional strategy and experimental group (30) students been taught Mathematics concepts using the strategy of cooperative learning. An achievement test was used as an instrument to collect information and study data, frequencies, percentages, means, standard deviation as well as t-test were used for the analysis of the data. The results of the study show that there is a statistic significance difference at the level 0.05 between the means of performance of experimental and control group on the achievement and retention test to the advantage of experimental group. The

study differed from the researchers study in location (Makah) and level of education which is primary school, but the literature supports using multiple intelligences, incorporating group work and using positive reinforcement to increase student academic performance in Mathematics. The study is relevant to the researcher's study with all that were incorporated in the literature similar to the use of scaffolds to enhance performance and retention. The reviewed study was a guide to the researcher's study.

2.9 Implication of Literature Reviewed on the Present Study

The literature reviewed the Effects of Scaffolding Instructional Strategy on attitude, retention and performance which explained it as an Instructional Strategy that aids teaching of science and arts. It also highlighted many studies carried out by several researchers such as the study of Bansal (2017) on the Effect of Instructional Scaffolding on High School Students' Academic Achievement and Attitude towards science in Chandigarh India. Chukwuagu (2016), also investigated the effect of Instructional Scaffolding on the academic achievement and interest of students in Chemistry in Imo State. The study of Ogunseemi (2013) on Effects of Scaffolding Strategy on Learner's Academic Achievement in Integrated Science was at the Junior Secondary Level in Ekiti State.

Furthermore, the research investigated by Remalyn (2013) on scaffolding strategy in Teaching Mathematics aimed to determine the level of effectiveness of the use of scaffolding and Traditional strategies. In another dimension Djwantoro carried out a study in the use of Scaffolding Approach to enhance students' engagement in learning structural analysis. From all the studies, however, the researchers compared the effect of Scaffolding Instructional Strategy with a teaching method (Lecture Method). The researcher used Djwantoro (2010) model of scaffolding in carrying out this study. The model designed to

promote a deeper level of learning, in which students learn in groups, interact socially, and are supported by mates, teachers and materials. This model was chosen for its simplicity in application in the classroom. The aspect of using a model was not considered by other reviewed studies. Other variables like retention and attitude were limited. Also from literature reviewed, the study of Scaffolding focused mainly in Science, Mathematics, Chemistry and Basic Science while in the area of Biology especially Ecology concept information is limited. Therefore, this research aims at filling this gaps by investigating the Impact of Scaffolding Instructional Strategy on attitudes, retention and performance in Ecology among senior secondary school students in Giwa, Kaduna State, Nigeria.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The main purpose of this study was to determine the Effects of Scaffolding Instructional Strategy on attitude, retention and performance of students in Ecology among senior secondary II students in Giwa Educational Zone Kaduna State, Nigeria. In this chapter, the methods and procedures employed in conducting the research are described under the following headings:

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Procedure

3.5 Instrumentation

3.5.1 Description of Instrument

3.5.2 Validation of the Instruments

3.5.3 Validation of Ecology Performance Test (ECPT)

3.5.4 Validation of Attitude to Ecology Scale Questionnaire (AEQ)

3.6 Pilot Testing

3.6.1 Reliability Coefficient of the Instrument

3.6.2 Item Analysis

3.7 Administration of Instrument

3.8 Data Collection Procedure

3.9 Procedure for Data Analysis

3.2 Research Design

The research design for this study was non randomized quasi-experimental control group design described by Sambo (2008). The design consists of two groups. The experimental and control groups. To ensure the similarity of the two groups pretest (O_1) was administered to the participants before carrying out the treatment in order to find out if the two groups were similar in their ability levels of academic achievement. The Experimental Group (EG) was taught using Scaffolding Instructional Strategy and the Control Group (CG) using Lecture Method to see if there is a significant difference in their attitude and performance at the end of 6 weeks treatment period. The posttest (O_2) was administered to both groups (experimental and control) to evaluate the effectiveness or otherwise of the treatment. The same instrument (ECPT) was used as pretest (O_1), posttest (O_2) and post-posttest (O_3). The post-posttest test was to determine the retention level in Ecology concepts taught to both groups of students. The research design is presented on Figure 3.1.

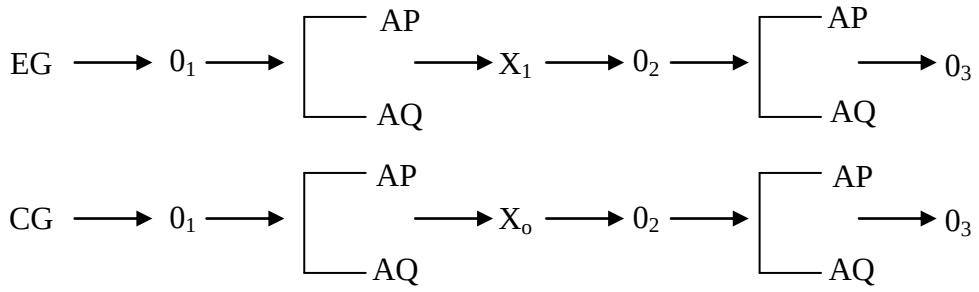


Figure 3.1 Research Design

Where:

EG	-	Experimental Group (taught with scaffolding teaching strategy)
CG	-	Control Group (taught with lecture method)
X_o	-	Lecture Method
X_1	-	Scaffolding Instructional Strategy
0_1	-	Pretest
0_2	-	Posttest
0_3	-	Post-Posttest
AP	-	Academic Performance
AT	-	Attitude Questionnaire

The design has the following advantages by Gay, Mills and Arasian (2009)

i. The scores obtained from the pretest was used to statistically find out if there is any difference between the groups at the start of the study i.e to ensure similarity of the two groups academically at the start of the experiment.

ii. Individual as well as group mean pretest and post test scores can be calculated making it possible for one to determine the superiority of one teaching strategy relative to the other.

iii It may be as a result that any difference in the performance of the groups could only be attributed to the treatments given, since the treatment administered is the only difference between the two.

3.3 Population of the Study

The population of the study comprised all senior secondary two (SS2) students in Giwa and Giwa co-educational senior secondary school II owned by Kaduna State Government (Table 3.1). The schools were fifteen (15) from Giwa Education Zone, in Kaduna State. The target population consisted of senior secondary two (SS2) students offering Biology with an average age of 16 years. The total number of students in the population was 3092 comprising of 1990 boys and 1102 girls.

The choice of the senior secondary school II students for this study was based on the fact that they have earlier been taught Biology for at least one year and they are more stable in school. The detail of the population is presented in Table 3.1.

Table 3.1: Population of the Study

S/N	Name of the School	No. of Boys	No. of Girls	Total	Education Zone
1.	G.D.S.S. Kwangila	183	146	329	Giwa
2.	G.S.S. Aminu	156	92	248	Giwa
3.	G.S.S. Kaura	213	118	331	Giwa
4.	G.S.S. T/Jukun	102	161	263	Giwa
5.	G.S.S. K/Kuyanbana	266	89	355	Giwa
6.	G.S.S. Magajiya	133	30	163	Giwa
7.	G.S.S. Likoro	41	11	52	Giwa
8.	S.I.A.S.S.S. K/Karau	109	110	219	Giwa
9.	G.S.S. Jama'a	122	68	190	Giwa
10.	G.S.S. G.S.S. Fatika	25	5	30	Giwa
11.	G.S.S. Basawa	170	30	200	Giwa
12.	G.S.S. Ganganra	91	21	112	Giwa
13.	G.S.S. Giwa	146	76	222	Giwa
14.	G.S.S. Yakawada	115	25	140	Giwa
15.	Yusufu Aboki Sec. Sch. Shika	118	120	238	Giwa
	Total	**1990**	**1102**	**3092**	

Source: Kaduna State Ministry of Education: Education Inspectorate Unit, 2018, Zaria

3.4 Sample and Sampling Procedure

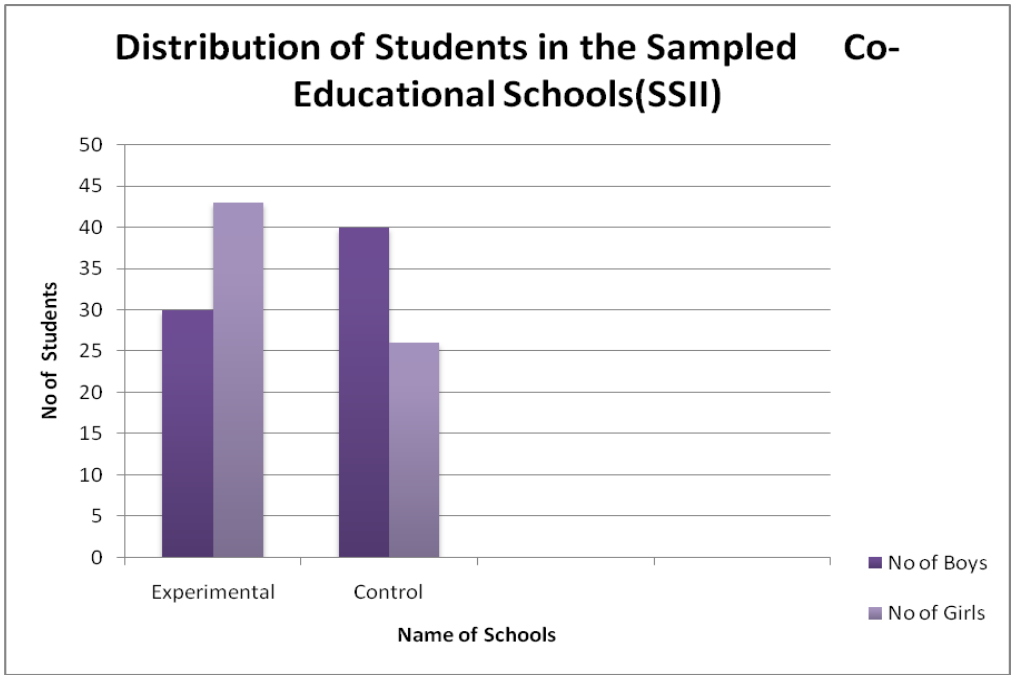
Names of all the fifteen state owned co-educational secondary schools in Giwa Education Zone were compiled (Table 3.1). The names of schools were written on pieces of paper from the zone and were put in a hat folded and shuffled. Simple random sampling technique involving the draw-from the hat method was used. The picking and shuffling was done until the five schools were obtained. The students from these five schools were given pretest to find their similarity and the result subjected to ANOVA to find if they were significantly different. The result obtained showed significant difference and was further subjected to Scheffe's test to determine the schools that had means that were not

significantly different. Two schools that were not significantly different were randomly selected and were randomly assigned to experimental and control groups. The result of ANOVA and Scheffe's test at ($P \leq 0.05$) are presented in the Appendix X. The two classes were intact with sample size of 139 SSII students. The Experimental class comprise thirty (30) female and fourty-three (43) males, given total of seventy three (73) while the Control had forty (40) males and twenty-six (26) females, given a total of sixty six (66). This sample size of 139 was in line with central limit theorem (Tuckman, 1975) and Wallen and Frankel (2000) that recommended that minimum sample size of 30 subjects is viable for experimental study of this nature and central experimental theory which recommended minimum of 30 sample size as noted by (Tuckman, 1975, Sambo, 2008). Details are shown in Table 3.2 and Figure 3.2.

Table 3.2: Sample for the Study

S/No.	Name of School	No. of Male	No. of Female	Total	LGA
1.	Experimental	43	30	73	Giwa
2.	Control	40	26	66	Giwa
	Total	**70**	**69**	**139**	

Fig. 3.2: Sample for the Study



3.5 Instrumentation

The following instruments were used.

i. Ecology Performance Test (ECPT)

ii. Attitude to Ecology Questionnaire (AEQ).

3.5.1 Description of Ecology Performance Test (ECPT)

For the purpose of data collection, Ecology Performance Test (ECPT) items was adopted from the West African School Certificate Examination (WASCE) past question papers. The test consisted of 40 multiple choice items with response of four options (one correct answer and three destractors for each item). The items were based on the following concepts: Basic Ecological Concept, the functioning Ecosystem, Ecological Management and Ecology of population. The forty (40) items were meant to assess the academic performance and

retention of the students. The items in the test were selected to cover the relevant areas of the concepts taught.

3.5.2 Description of Attitude to Ecology Questionnaire (AEQ)

The second instrument is Attitude to Ecology Questionnaire (AEQ). It was adopted from (Lawal, 2009) and comprised of 20 statements on student attitude toward Ecology concepts taught. It was administered as a pretest and posttest to the Experimental and Control groups. This is to determine if there is any significant change based on the treatment experienced. It is a 5-Likert Point Scale rating as follows: Strongly Agreed (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). The responses are assigned weights of 5, 4, 3, 2 and 1 respectively for favourable statements. Each student was required to tick appropriate option. The two validators approved the Attitude to Ecology Questionnaire as satisfactory.

3.5.3 Validation of the Instruments

The two instruments designed for the study were validated, these are;

i. Ecology Performance Test (ECPT)

ii Attitude to Ecology Questionnaire (AEQ)

3.5.4 Validation of Ecology Performance Test (ECPT)

The content of instrument (ECPT) were validated by three Professors, two from Science Education and one Professor from Life Sciences, with speciality in Ecology all of Ahmadu Bello University, Zaria and a Biology teacher from Government Girls Secondary School Samaru. The validators were requested to determine the face validity of the linguistic level of the questions, vocabulary, structure and style used, framing and suitability of the questions. Other aspects validated included appropriateness of the questions to illicit the

required information from students, the extent to which the questions covered the content of Ecology in Biology SSII curriculum, appropriateness of the instructions, mark allocation and adequacy of the model answers prepared. Comments and suggestions of the validators were used in making the final drafts of the instruments. It was suggested that questions five (5) and thirty-two (32) should be recast, the questions updated to forty (40) from thirty-five. Instructions and time to be written on the question paper and the options for the answers to be corrected to the same letters A-D.

3.5.5 Validation of Attitude to Ecology Questionnaire (AEQ)

The Attitude to Ecology Questionnaire (AEQ) was validated by two experts in the Department of Educational Psychology, Ahmadu Bello University, Zaria. The experts were an Associate Professor and Professor. They were requested to:

i. Study the instrument and certify if the statements were considered to be testing the attitude of students in Ecology concept.

ii. Certify if the items are appropriate for the level of the students under study.

iii. Check for possible errors in the instrument.

iv. Suggest appropriate corrections on the possible errors observed in the instrument.

The experts validated the instrument and added the time allowed for writing the test which was omitted.

3.6 Pilot Testing

The aim of the pilot testing includes the following:

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 instrument.

iii. to determine the reliability of the instrument

iv. to determine the difficulty and discrimination features of the items

A pilot test was conducted using the Ecology Performance Test (ECPT) on SS 2 students of Government Secondary School, Bomo, Giwa, Local Government Secondary School, Zaria. The school was not part of the sample for the study, this is to prevent the study participants from having an idea of the instrument. The instrument consisting of 40 multiple items was administered to 33 senior secondary II Biology students. The researcher with the assistance of the Biology teacher of the school administered the instrument which lasted for forty minutes. Instructions on how to answer the questions were read and explained to the students by the researcher. This was done to ensure that the students answer the instrument (i.e. test items–ECPT) carefully. After two weeks the pilot testing was repeated.

The Attitude to Ecology Questionnaire (AEQ) was also conducted on SS II students of Government Secondary Schools, Bomo, Giwa Local Government Secondary School, Zaria. The instrument consisted of twenty (20) statements was administered to thirty-three (33) senior secondary II Biology students. The researcher with the assistance of the Biology teacher of the class administered the instrument which lasted for thirty minutes. Instructions on how to answer the statements were read and explained to the students by the researcher.

Table 3.3 Table of Item Specification for Ecology Performance Test (ECPT)

S/No.	Concepts	Knowledge	Compre-hension	Applic-ation	Analysis	Evalu-ation	Total	Percentage %
1.	Basic Ecological Concept	4	4	2	-	2	12	30.0
2	The Functioning Ecosystem	3	6	2	1	1	13	32.5
3.	Ecological Management	2	2	1	1	1	7	17.5
4.	Ecology of Population	2	2	2	1	1	8	20.0
							40	**100**

Adapted from Bloom Cognitive Taxonomy

3.6.1 Reliability Coefficient of the Instruments

The data obtained from the pilot testing of test-retest of Ecology Performance Test (ECPT) were used to determine the internal consistency and reliability coefficient of the ECPT items. The study employed Pearson's Product Moment Correlation Coefficient (PPMCC) formula on the data obtained from the pilot testing. The detailed calculation is shown in Appendix IX. the reliability, r = 0.88 was obtained.

Cronbach alpha reliability coefficient was used to test the Attitude to Ecology Questionnaire (AEQ) using split half (even and odd numbers). The result of Cronbach alpha reliability coefficient of Attitude to Ecology Questionnaire (AEQ) is 0.75. This reliability coefficient was considered adequate for the internal consistencies of the instruments as suggested by Spiegel (1992). ($\alpha = 0.05$).

3.6.2 Item Analysis

Item analysis was carried out on the data generated from the pilot study in order to determine the Facility Index of the items. For the purpose of standardization of the Instrument (ECPT) facility index and discrimination index were determined as follows:

Facility Index (FI)

The facility index of an item indicates the percentage of candidates that got an item right (Furst, Grunlund, Williams and Lehman, in Mahmud (2009). The following are the rightful steps in computing the facility index for each item 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 one third of the bottom scoring group.

iv. Determine the percentage of high scores and low scores of each item.

v. 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 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 (ECPT) with facility index 0.65 (which is line with Inyang (1988), James (2000) and Usman (2008) who opined that facility index within the range of 0.30 to 0.70 can be adopted.

Discrimination Index

The discrimination index of a test is a measure of its ability to discriminate between high and low achievers as a whole (Furst, Grunlund, Williams and Leyman, in Mahmud 2009). This was 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 the formula given by Furst (2000) in Olorukooba (2001).

$$D_1 = \frac{Ru - Ri}{1/2\,N}$$

Where D = discrimination index

Ru = Number among upper 27% of respondents

Ri = 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 item should be re-worded.

Discrimination index for each item is 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 is regarded as moderately positive and is accepted for the present study. This was used in selecting the final items of the test ECPT See Appendix VII.

3.7 Administration of Treatment

The lesson activities were designed in steps based on Djwantoro's (2010) model of scaffolding instructional strategy. Thus, the instructions was administered according to stages outlined below:

Step 1: Introduction, assessing the previous knowledge or skill of the learner through discussion or questioning such as what is Ecology?

Step II: Task discussion. This step involves the introductory part to raise students' interest on the topics as well as to help them to connect with previous knowledge. It is then followed by the theoretical background of the concept such as the Basic Ecology Concept. This is done in traditional lecture format.

Step III: Students were carefully divided into groups of five (5) and were presented with a task to achieve a common goal. This was followed by distributing procedures or steps, hints, questions, cue cards which are scaffolds. The scaffolds were carefully selected and prepared to be relevant and useful to the task which were within the students' ZPD. At this stage, teacher turns role to become coach or facilitator providing additional help or clarification to those in need individually or group. Students are allowed to make mistakes and to progress in their own pace. If a common mistake is found, further clarification for the whole groups will be given.

Step IV: There is a whole class discussion of students findings on the task. Students gave their responses and solutions to the task. The scaffold is withdrawn (fading) as students gained competence.

Step V: Evaluation: Questions are asked based on the topic taught and objectives of the lesson. It is a key to evaluate students' understanding and provide positive and corrective feedback.

Here is scaffolding Lesson Model Presented in a Flow Chart

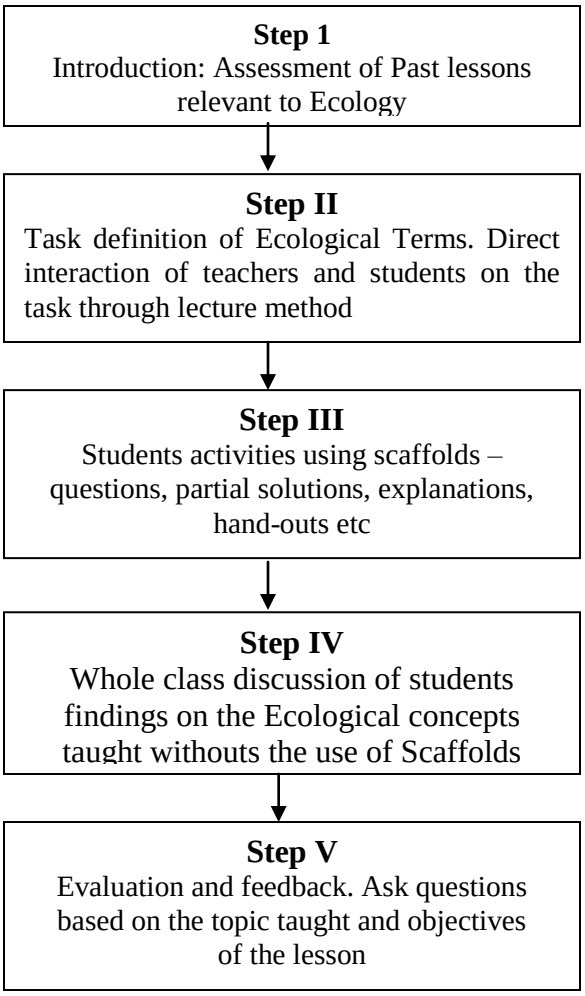


Fig. 3.3: A flowchart of Scaffolding Instructional Strategy
Source: Adapted from Djwantoro (2010).

Teaching the Control Group

The control group was taught using the conventional lecture method. The teacher taught by defining, explaining the concepts under Ecology similar to the Scaffolding Strategy.

3.8 Method of Data Collection

The data were collected through the research instruments. Three types of data were collected during the research work. These are:

i. Pretest (to ascertain their group equivalents)

ii. Posttest (to ascertain their performance level and attitude to a concept taught)

iii. Postpost test (to ascertain their retention level)

3.9 Method of Data Analysis

The data collected from this study was used in two folds.

Answering Research Questions

The data collected for the purpose of research question was analyzed in form of mean scores and standard deviation and mean difference and also mean rank, sum of mean rank and mean rank difference was used.

The Hypotheses Testing

The hypotheses were tested at $P<0.05$ level of significance.

The null hypotheses are re-stated below and the statistical analysis used as follows:

H_{01} There is no significant difference between the mean performance scores of senior secondary students II taught Ecology concepts using Scaffolding Instructional Strategy and those taught using Lecture Method.

Independent Sample t-test was used to test this hypothesis.

H_{02}: There is no significant difference between the mean performance scores of male and female students taught Ecology concepts using Scaffolding Instructional Strategy. Independent samples t-test was used to test this hypothesis.

H_{03}: There is no significant difference in the retention of Ecology concepts taught using the Scaffolding Instructional Strategy and Lecture Method.

Comparative sample t-test was used to test this hypothesis.

H_{04}: There is no significant difference in the retention of Ecology concepts of male and female subjects taught using Scaffolding Instructional Strategy.

Independent sample t-test was used to test this hypothesis.

H_{05}: There is no significant difference between the attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method.

Wilcoxon Signed Rank test was used to test the hypothesis.

H_{06}: There is no significant difference in the attitude of male and female students taught using Scaffolding Instructional Strategy.

Kruskalwallis test was used to test the hypothesis.

CHAPTER FOUR

DATA ANALYSIS, RESULT AND DISCUSSION

4.1 Introduction

This study investigated the "Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among senior secondary school II students of Giwa Education Zone". The various responses were, grouped and tabulated towards ensuring an objective analysis and interpretation of the findings. Descriptive statistics which comprised of mean and standard deviation were used to answer the research questions and independent sample t-test, Wilcoxon signed test and Kruskal-wallis test at 0.05 level of significance were used to test the hypotheses stated. The chapter is presented under the following subheadings:

4.2 Data Analysis and Results

4.2.1 Answering the Research Questions

4.2.2 Testing the Null Hypothesis

4.3 Summary of Findings

4.4 Discussion of Findings

4.2 Data Analysis and Results

This section answers the stated research questions using mean, standard deviation and mean difference.

4.2.1 Answering the Research Questions

Research Question 1: What is the difference between the mean performance of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method? To answer this research question the performance scores of the students were subjected to descriptive statistics using mean and standard deviation. The summary is presented in Table 4.01.

Table 4.1 shows mean and standard deviation computed from posttest result of Senior Secondary Students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method.

Table 4.01: Mean and Standard Deviation for Experimental and Control Groups

Group	N	Mean	SD	Mean diff.
Experimental	73	22.55	3.85	4.36
Control	66	18.19	3.19	

Results in Table 4.01 indicates that the students exposed to Scaffolding Instructional Strategy had a mean score of 22.55 while students taught using Lecture Method had a mean score of 18.19. This implies that students exposed to Scaffolding Instructional Strategy had a higher mean score and a mean gain of 4.36 over those taught using Lecture Method. To find if mean differences was significant, the mean scores were subjected to t-test statistical analysis.

Research Question 2: What is the difference between the mean performance score of male and female students taught Ecology using Scaffolding Instructional Strategy?

To answer this research question, posttest mean performance score of male and female students taught using Scaffolding Instructional Strategy were subjected to descriptive statistics. Mean and Standard Deviation were computed and summary is shown in Table 4.2.

Table 4.02: Mean and Standard Deviation of Male and Female Students in Experimental Group

Group	N	Mean	SD	Mean diff.
Male	30	17.32	3.17	0.38
Female	43	16.94	2.83	

Table 4.02 indicate that the academic performance of male and female students exposed to Scaffolding Instructional Strategy have a mean score of 17.32 and 16.94 respectively with the mean difference of 0.38. To find out how significant the mean difference was the mean scores were subjected to t-test statistical analysis.

Research Question 3: What is the difference between retention scores of students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method?

Table 4.03 shows the results of post-posttest that were subjected to descriptive statistics of mean and standard deviation and were computed as shown in Table 4.03.

Table 4.03: Mean and Standard Deviation of Retention Score Between Experimental and Control

Group	N	Mean	SD	Mean diff.
Experimental	73	22.19	3.88	5.96
Control	66	16.23	2.17	

Table 4.03 shows that the mean retention score of students exposed to Scaffolding Instructional Strategy is 22.19 while mean retention score of students taught with Lecture Method is of 16.23. To find out whether the difference was significant, the mean scores were subjected to t-test statistical analysis.

Research Question 4: What is the difference between the mean retention score of male and female students taught Ecology using scaffolding instructional strategy?

Table 4.4 shows mean and standard deviation from post posttest mean retention score of male and female students taught Ecology using scaffolding instructional strategy subjected to descriptive statistics.

Table 4.04: Mean and Standard Deviation of Retention Score of Male and Female Students of Experimental Group

Group	N	Mean	SD	Mean diff.
Male	30	21.63	3.76	0.45
Female	43	21.18	3.96	

Results in Table 4.04 indicate that the academic performance between male and female students taught Scaffolding Instructional Strategy had a mean score of 21.63 and 21.18 respectively. A mean difference of 0.45 was observed. To find out how significant the difference was the mean scores were subjected to t-test statistical analysis.

Research Question 5: What is the difference between the attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method?

To answer the research question, results of Posttest Attitude to Ecology Scale Questionnaire (AESQ) of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method were subjected to descriptive statistics of mean and standard deviation were computed and summary is shown in Table 4.05.

Table 4.05: Mean and Standard Deviation of Attitude of Students of Experimental and Control

Group	N	Mean	SD	Mean diff.
Experimental	73	13.52	1.09	3.36
Control	66	10.16	1.12	

Table 4.05 shows that the attitude of students taught Ecology with Scaffolding Instructional Strategy has a mean score of 13.52 while attitude of students taught in Lecture Method have a mean score of 10.16 with a mean difference of 3.36. To find how significant the mean difference was subjected to t-test statistical test.

Research Question 6: What is the mean difference between the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy?

Table 4.06 shows the summary of the posttest result of students taught ecology using Scaffolding Instructional Strategy subjected to descriptive statistics of Mean and Standard Deviation.

Table 4.06: Mean and Standard Deviation of Attitude of Male and Female Students in the Experimental Group

Group	N	Mean	SD	Mean diff.
Male	30	21.63	3.76	
Female	43	21.19	3.96	0.44

Table 4.06 indicates that the attitude of male and female students exposed to Ecology using Scaffolding Instructional Strategy had mean score of 21.63 and 21.19 with a mean difference of 0.44. To find out how significant the difference in mean scores was subjected to t-test statistical analysis.

4.2.2 Testing the Null Hypotheses

This section investigates the stated research hypotheses using independent sample t–test Wilcoxon signed rank test and Kruskalwallis test.

Hypothesis One: There is no significant difference between the mean performance scores of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method.

Table 4.07 shows the summary of the analysis of the posttest means performance score of senior secondary school II students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method subjected to independent t-test.

Table 4.07: Summary of Independent t-test Analysis of Experimental and Control Group

Group	N	Mean	SD	Df	t-cal	P-value	Remark
Experimental	73	22.55	3.85	137	6.43	0.001	Significant
Control	66	18.19	3.19				

p<0.05 level

The experimental group has a mean score of 22.55 and standard deviation of 3.85 while the control group has a mean score of 18.19 and standard deviation of 3.19. Table 4.07 reveals that there is a significant difference between the mean performance scores of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method. This was because the P-value is less than 0.05 level of significant at df 137. It was found that Scaffolding Instructional Strategy increased performance of students more than the Lecture Method. Therefore, the null hypothesis which state that, there is no significant difference between the mean performance scores of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method, was rejected.

Hypothesis Two: There is no significant difference between the mean performance scores of male and female senior secondary school II students taught Ecology using the Scaffolding Instructional Strategy.

Table 4.08 shows the summary of analysis of mean performance scores of male and female students taught Ecology using the Scaffolding Instructional Strategy subjected to independent t-test statistics.

Table 4.08: Summary of Independent t-test Analysis of Mean Scores of Male and Female Students in Experimental Group

Group	N	Mean	SD	df	t-cal	P-value	Remark
Male	30	17.32	3.17	71	1.25	0.80	NS
Female	43	16.94	2.83				

p≤0.05 level

The 4.08 shows mean score of male was 17.32 with standard deviation of 3.17 while the female mean score was 16.94 with standard deviation of 2.83, it further reveals that there is

no significant difference between the mean performance scores of male and female students taught Ecology using the Scaffolding Instructional Strategy. This was because the p-value of 0.80 is higher than the 0.05 level of significiant at df 71. Therefore, the null hypothesis which state that, there is no significant difference between the mean performance scores of male and female students taught Ecology using the Scaffolding Instructional Strategy was retained.

Hypothesis Three: There is no significant difference between the mean retention scores of senior secondary students taught Ecology using scaffolding instructional strategy and those taught using lecture method.

Table 4.09 shows the summary of the analysis of the mean retention scores of Senior Secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method subjected to comparative sample t-test.

Table 4.09: Summary of Independent t-test Analysis of Retention of Students of Experimental and Control Groups

Group	N	Mean	SD	df	t-cal	P-value	Remark
Experimental	73	22.19	3.88				
				137	10.397	0.00	S
Control	66	16.23	2.17				

$p \leq 0.05$ level

Table 4.09 shows the experimental group mean score of 22.19 and has a standard deviation of 3.88 while the control has 16.23 and a standard deviation of 2.17, it further reveals that there is a significant difference between the mean performance scores of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method. This was because the calculated p-value of 0.00 is less than the 0.05 level

of significance at df 137. Therefore, the null hypothesis which states that, there is no significant difference between the mean performance scores of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method was rejected.

Hypothesis Four: There is no significant difference in the mean retention scores of Ecology concept of male and female senior secondary school II students taught using the Scaffolding Instructional Strategy.

Table 4.10 shows the summary of the analysis of the mean retention scores of male and female students taught Ecology using the Scaffolding Instructional Strategy subjected to independent t-test statistical analysis.

Table 4.10: Summary of Independent t-test Analysis of Mean Retention Scores of Male and Female Students of Experimental Group

Group	N	Mean	SD	Df	t-cal	P	Remark
Male	30	21.63	3.76				
Female	43	21.18	3.96	71	1.027	0.3	NS

$p \leq 0.05$ level

Table 4.10 shows the mean score of male students was 21.63 with a standard deviation of 3.76 while that of the female students was 21.18 with a standard deviation of 3.96, it further reveals that there is no significant difference in the mean retention scores of male and female students taught Ecology using Scaffolding Instructional Strategy. This is because the p-value of 0.30 is higher than 0.05 level of signficiant at df 71. Therefore, the null hypothesis which states that, there is no significant difference between the mean retention scores of male and female students taught Ecology using the Scaffolding Instructional Strategy was retained.

Hypothesis Five: There is no significant difference between the attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method.

Table 4.11 shows the summary of the analysis results of attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method subjected to Wilcoxon signed ranks test.

Table 4.11: Summary of Wilcoxon Signed Rank Test Analysis of Attitude of Students of Experimental and Control

Group	N	Mean	SD	df	Z-cal	P-value	Remark
Experimental	73	13.56	1.09	137	2.18	0.02	S
Control	66	10.06	1.12				

$p \leq 0.05$ level

The mean score of experimental group was 13.56 and standard deviation of 1.09 while the control group had a mean score of 10.06 and a standard deviation of 1.12. It further reveals that there was a significant difference between attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method. This was because the p-value of 0.02 was less than 0.05 level of significant at df 137. Therefore, the null hypothesis which states that, there is no significant difference between attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method was rejected.

Hypothesis Six: There is no significant difference in the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy.

Table 4.12 shows the results of attitude of male and female students taught Ecology using Scaffolding Instructional Strategy subjected to Kruskalwallis test.

Table 4.12: Summary of Kruskalwallis Test Analysis of Attitude of Male and Female Students of Experimental Group

Group	N	Mean	SD	Mean rank	df	Cal. value	P-value	Remark
Male	30	21.63	3.76	29.20				
					1	7.46	0.01	S
Female	43	21.19	3.96	42.44				

$p \leq 0.05$ level

The male mean score was 21.63 with a standard deviation of 3.76 and mean rank of 29.20 while the female mean score was 21.19 and standard deviation of 3.96 and a mean rank of 42.44. This revealed that there is statistically significant difference in the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy. This was because the p-value (0.006) obtained was less than 0.05 at df 1. Therefore, the null hypothesis which state that, there is no significant difference between the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy was rejected.

4.3 Summary of Findings

The summary of findings is as follows:

i. There was significant difference between the mean performance scores of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method in favour of the experimental group.

ii. There was no significant difference between the mean performance scores of male and female students taught Ecology concepts using the Scaffolding Instructional Strategy.

iii. The study reveals a significant difference between the mean retention score of senior secondary students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method in favour of the experimental group.

iv. There was no significant difference in the mean retention score of Ecology concepts of male and female subjects taught using Scaffolding Instructional Strategy.

v. The study reveals there was significant difference between the attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method in favour of the experimental group.

vi. The study also reveals that there was significant difference in the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy.

4.4 Discussion of Findings

The result from testing hypothesis one shows that the experimental group whch was exposed to Scaffolding Instructional Strategy performed significantly better than their counterparts in the control group taught Ecology using Lecture Method. The significant difference in academic performance in favour of the experimental group suggests that the Scaffolding Instructional Strategy was more effective than the Lecture Method. This findings is in conformity with the study of Ogunseemi (2013), Chukwuagu (2016), Bansal (2017) who found that students taught using Scaffolding Instructional Strategy performed better than those taught using Lecture Method. This is because the Scaffolding Instructional Strategy is a useful strategy that makes learners to be independent and problems solvers.

The effectiveness of the Scaffolding Instructional Strategy may be attributed to the pattern of the instruction which is learner centred and provided a variety of activities for the students to interact with better understanding and learning. The relatively low performance of students in the control group (Lecture Method) in the ECPT is an indication that the Lecture Method used in teaching Ecology in the study is not quite effective in promoting meaningful learning of Ecology. The ineffectiveness of Lecture Method to promote interaction in the class was also supported by the observation of Lakpini (2010) who reported that it discourages interaction among students and incapable of imparting scientific skills.

The finding of this study which shows that the experimental group taught using Scaffolding Instructional Strategy performed better than the control group taught using Lecture Method is supported by the observation of Owolabi (2006) that meaningful learning takes place when teaching instruction is used alongside instructional strategies that promote active participation of students in the learning process. Danmole and Adeoye (2004) believed that methods that would involve active students participation such as Cooperative Learning, Guided discovery, Scaffolding, use of analogy and problem-solving can go a long way to improve learning. The findings from the study shows that Scaffolding Instructional Strategy can enhance academic performance.

The analysis of hypothesis two reveals that there is no significant difference between the mean performance scores of male and female students taught Ecology concepts using the Scaffolding Instructional Strategy. This is in line with the finding of (Chianson, Kurumeh and Obida, 2011) and Nejem and Muhanna, (2014) which shows that when participants

become both visually and physically engaged in a collaborative learning environment, both male and female retained learnt concept equally. The reason for the equal academic performance of male and female students is the metacognitive teaching strategy which may not be unconnected with the fact that both see themselves as equals and capable of actively collaborating in classroom activities. Ogunboyede (2003) in a study of sex difference and students performance found that boys are not better than girls, in terms of educational performance. Lawal (2009) found no significant difference in academic performance by gender when taught using conceptual change instructional strategy.

The finding of Tekerek, Yeniterzi, Ercan (2011) show that there was difference between the performance scores of male and female SS II students' taught algebraic processes using social constructivism instructional strategy. From the results obtained, male student performed better than female students taught using the constructivists' strategy that the difference was not significant. The finding confirms with Ezirim (2006); Dhimar and Patel (2013); Duyilemi and Bolajoko (2014) who observe that male students had high achievement score than their female counterparts in the experimental group. Tekerek *et al*. (2011) found that there was a significant difference between the gender and the total Mathematics attitude score.

Pandian (2004) investigation on male and female students' performance in Biology, found that gender had no significant influence in the subject. Olagunju (2001), investigated sex, age and performance in Mathematics. The result shows that there is no significant difference in the performance of male and female counterparts. Azih and Nwosu (2011), who investigated the effects of instructional scaffolding on the performance of male and

female students in financial accounting in Abakaliki Urban of Ebonyi State reveals that Scaffolding Instructional Strategy was superior to the conventional method in improving the performance of male and female students in financial accounting. The test of interaction show that gender has no signficiant interaction with teaching approach on students' mean performance. Summary of the result reveals that Scaffolding Instructional Strategy was superior to the conventional method in improving the performance of male and female students in financial accounting. The test of interaction shows that gender had no significant interaction with teaching approach on students mean performance.

The result of null Hypothesis three reveals that there is significant difference between the mean retention score of senior secondary students taught Ecology using Scaffolding Instructional Strategy (SIS) and those taught using Lecture Method (LM) with the Scaffolding Instructional Strategy group having a higher retention of the concept taught than the control (Lecture Method). This shows that teaching with Scaffolding Instructional Strategy enabled the students in the experimental group to retain more knowledge of the Ecology concept.

This finding is in agreement with the study of Lawal (2009) whose result shows that there is a significant difference in the post-post test, mean score of the Experimental Group and that of the Control Group. This shows that the conceptual change instructional strategy used enabled subjects in the experimental group to retain more knowledge of the concept taught than the subjects taught using Lecture Method. The higher performance score of subjects in the experimental group in the postpost-test can be attributed to the instructional strategy use. This is in collaboration with the result obtained with the Scaffolding

Instructional Strategy (SIS) over that of the Lecture Method. This finding tends to imply that the Scaffolding Instructional Strategy (SIS) led to more effective learning and higher retention ability than the Lecture Method (LM). Bunkure (2012), reports that meaningful learning improves retention while confusion or interference decreases the speed and efficiency of learning and accelerates forgetting. Therefore, the findings of the study reveal that when a good instructional strategy is used, it will improve academic performance and retention of the students.

In line with the finding is the study of Narli (2011); Chianson, Kurumeh, and Obida (2011). Narli (2011) findings reveal that the students in the constructivist learning show higher retention of almost all the concepts related to cantor set theory than the students in the traditional class. In their study, Chianson, Kurumeh and Obida (2011) findings show that students who were subjected to the cooperative learning strategy were able to retain the concepts of circle geometry more than those students who were taught using the conventional learning approach.

Akinbobola and Folashade (2009), compared the effectiveness of constructivist teaching methods and the conventional method with reference to academic performance, retention and attitude. They found that students exposed to constructivist teaching method had higher cognitive performance, more positive attitude and higher retention level than those taught using Lecture Method. The findings are in agreement with the findings of this study that there is significant difference between the mean performance scores of students taught Ecology using Scaffolding Instructional Strategy and those taught using Lecture Method. The significant difference in the retention of Ecology concepts in this study could be linked to the Scaffolding Instructional Strategy which provide active participation and interaction

among students and teacher. Bunkure (2012), reports that meaningful learning improves retention while confusion or interference decreases the speed and efficiency of learning and accelerates forgetting. Therefore, the findings of this study reveals that scaffolding Instructional Strategy improved the students' academic performance, and retention in Ecology.

The finding of Ahmad (2016), reveals that, there was no significance in the retention ability of students in geometry taught using Scaffolding–enriched collaborative strategy and those taught using collaborative learning strategies. This proved that the scaffolding enriched collaborative strategy did favour neither the experimental group one nor experiment group two, the issue of teacher students' interactions which are vital variable for promoting learning and retention also did not play any significant role. This diagrees with finding of Abraao (2006) and Mariam (2011) that social learning made students to attain higher level thinking and preserve information for longer times than students working individually. Mamman and Isah, 2014) report that information discussed and clarified in the classroom are retained. So lack of significant difference could not be by chance, because the collaborative and scaffolding strategies allows students active participation but it may be due to students poor rehearsal or previous unpleasant experience.

The result from testing hypothesis four reveals that there is no significant difference in the mean retention score in Ecology concepts of the male and female subjects taught using Scaffolding Instructional Strategy. This is supported by the findings of Lawal (2009), who found no significant difference when male and female students were taught using conceptual change Instructional strategy but found significant gender difference when

exposed to traditional Instructional Strategy. ViAnn (2004) investigation results reveal no significant gender-related differences but female achieved slightly higher grades than male. This finding is supported by the reports of Bichi (2008) that shows no significant difference between male and female performance in science.

The Scaffolding Instructional Strategy favours both male and female subjects equally in the learning of the Ecology concepts. They both benefited equally. The fact that neither, the male nor female performed significantly better than the other seem to make Scaffolding Instructional Strategy gender friendly. The finding however, conflicts with those of some other researcher. Ogunleye (2006), reports that males perform better than their female counterparts in Physics subject. Okeke (2009), Solomon (2009) and Duyilemi (2010) all reports significant difference in performance in favour of males in their researches. Aguele and Uhumniah (2007) in their studies of integrated science found that the male students performed better than female students in their cognitive, affective and psychomotor skill. Oluwatoyin (2010), in contrary observed that women perform better when they are exposed to science. Bilesanmi-Awoderu (2006) have provided reports that there are no longer distinguishing differences in the cognitive, affective and psychomotive skill performance of students in respect of gender.

The analysis of hypothesis five reveals that there is significant difference between the attitude of students taught Ecology with Scaffolding Instructional Strategy and those taught using Lecture Method. Nachi (2002), states that attitude seems to account for some significant percentage of the differences in academic performance in science. Okebukola (2006) also stressed that students' attitudes to science have significant effect on academic performance in science. Therefore, higher academic performance in science is linked to

positive attitudes towards science learning. Kacha (2005), found that students taught Biology concept using Vee-diagram instructional strategy performed better in Niger State than students taught using Lecture Method and they also show a positive attitude towards Biology.

The finding of this study is also in line with the study carried out by Lakpini (2006), on the effect of a conceptual change instructional strategy on academic performance, retention and attitudes of Biology students with varied ability levels in Zaria. It was revealed that high and average ability students had positive attitudes to conceptual change instructional strategy than their counterparts in the control group. Bunkure (2012) also in his study on effects of constructivist teaching strategy on academic performance, retention and attitude of senior secondary school Physics students of Kano State found that students in the experimental group show more positive attitudes than the control group taught with Lecture Method. These findings can be concluded that the instructional methods used which are learner-centred must have brought the significant difference positive attitude to that of the teacher-centred Lecture Method.

Bitrus (2012) in a research on effects of science process skills, approach on academic performance and attitude of integrated science (basic science) students with varied abilities in Potiskum found no significant change among students in both the experimental and control group which was in contrary to the finding of the researcher's investigation. Bay (2001) recorded that students achieve a positive attitude and good retention ability for Mathematics when they are instructed using constructivist method of teaching. Douglas and Olsen (2008) analyzed the assessment of students in relation to constructivist teaching and achieved good performances, a positive attitude and good retention ability in

Mathematics. This suggested that the constructivist teaching strategy has favoured the experimental group.

This is in line with the finding of the researcher's study which reveals that the Scaffolding Instructional Strategy favoured the experimental group in their retention and positive attitude to the Ecology concepts taught. Thus showing the effectiveness of Scaffolding Instructional Strategy. The strategy used in Scaffolding which involves interaction of students and teachers must have brought about the significant difference which favoured the experimental group in retaining the concept taught better than the control group.

The result of hypothesis six reveals that there is significant difference in the attitude of male and female students taught Ecology using Scaffolding Instructional Strategy.

The finding of this study is in line with the study of Nwosu (2003) who found that the experimental group taught using the constructivist method had a significantly more positive attitude to Physics than the control group taught using traditional method. Also, Olorukooba (2001) found that using cooperative instructional strategy to teach secondary school students chemistry, helped to develop positive attitude of students towards the subject. The attitudinal change to the Ecology concepts taught with Scaffolding Instructional Strategy can be attributed to the scaffolds used for the teaching. The attitude expressed by the experimental group can also be described as being a positive one and can be attributed to the scaffolding Instructional Strategy used in teaching the Ecology concepts. The positive attitude could be attributed to the educational benefits the subjects derived from the use of the strategy.

These benefits include the improvement the methods have on the performance of the students in the Ecology concepts taught, exposure of students to varied activities as well as the interpersonal relation among the students. Also, the free atmosphere and relaxed relationship between learner and the teacher who acted only as a coach or facilitator in the teaching process. This finding is in line with Lawal (2008) who reported that positive attitude of learners towards a subject enhances meaningful learning and better concepts formation. His findings reveal that male and female students had no significant difference in respect of their scientific attitude. Government and private school students show significant difference in respect of their scientific attitudes. John and Ademola (2014) who investigated the relationship between scientific attitude, attitude towards science and academic performance of secondary school students and found that scientific attitude, attitude towards science do not significantly predict academic performance. Attitude and attitude towards science has better but no significant relationship with science performance mean score by gender. The result of this study which shows significant difference in the attitude of male and female student caught using Scaffolding Instructional Strategy and those taught using lecture method disagreed with the findings by Akinbobola (2008), Afolabi and Akinbobola (2009) who investigated the effect of Cooperative Learning Strategies compared with the traditional method in order to find attitude of students in circle geometry between male and female senior secondary students. Their fidning revealed that no significant effects existed between male and female attitude towards geometry.

The study of Tekerek, Yeniterzi, and Ercan (2011) was in disagreement with the result that there was significant difference between the attitude of male and female students taught

Ecology using Scaffolding Instructional Strategy. Tekerek *et al* (2011) found no significant difference existing between the attitude of SS II students taught algebraic processes using social constructivism instructional strategy and those taught using conventional method of teaching. The finding of Bishi (2002) showed no significant difference also between male and female performances in science.

The study of Ayub, Lian and Mukti, (2005) that assessed attitudes toward calculus of 62 diploma students of University Putra Malaysia shows that female participants had more positive perceptions with more favourable reactions toward calculus when compared with the males. Specifically, females perceive calculus as more important in their everyday, lives compared to males. Female students, also put forth more effort, such as working more calculus exercises than those given by lectures throughout the calculus course. Adamu (2014) reports on significant gender difference in calculus achievement of engineering students. Similarly, the studies of Etukudo and Utin (2006); Farayola (2011); Onyishi and Agwagah (2011) laid support to this finding. Their studies show that there was no significant gender difference in Mathematics achievement. However, the finding is in disagreement with the findings of Arslan, Carl and Sabo (2012) which show that female students have more positive attitude than male students towards Mathematics and had higher Mathematics grades. It also disagree with the findings of Mendick (2005); McGraw, Lubienski and Strutchens (2006) that show that males tend to perform better than females in Mathematics.

Ogunkola and Bilesanmi-Awoderu (2000) opine that the issue of gender is an important one in science education especially with increasing emphasis on ways of boosting

manpower for technological development as well as increasing the population of females in science and technology fields. There is a strong association between gender and response to science education. The likely influence of gender factors on students academic performance in Ecology when they are taught using Scaffolding Instructional Strategy and Lecture Methods investigated favoured male and female students equally in the learning of Ecology concepts. They all have good interaction in the learning of the concept whereby the MKO explained to others and they all gained competence.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study determine the Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among senior secondary school II students in Giwa Education Zone of Kaduna State, Nigeria. This chapter is discussed under the following sub-headings:

5.2 Summary

5.2.1 Major Findings

5.3 Conclusions

5.4 Contribution to Knowledge

5.5 Recommendations

5.6 Limitation of the Study

5.7 Suggestions for Further Study

5.2 Summary

The purpose of this study is the determination of the Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among senior secondary school II students in Giwa Education Zone of Kaduna State, Nigeria. Six research objectives, research questions and six hypotheses were formulated for this study. A quasi-experimental design was adopted for the study involving pre-test, post-test and post-post test as described by Sambo (2008). He recommended 30 subjects as viable for central experimental study of this nature and central limit theory recommended minimum of 30 sample size.

The sample comprised of a total of 139 senior secondary II Biology students drawn from two randomly selected Government Secondary schools in Zaria, Kaduna State. Two instruments were developed and pilot tested to ascertain their reliabilities. The study employed Pearson's Product Moment Correlation Coefficient (PPMCC) formula on the data obtained from Ecology Performance Test (ECPT) of the pilot study (Olayiwola, 2007). The reliability, r 0.88 was obtained. Cronbach alpha reliability coefficient was used to test the Attitude to Ecology Scale Questionnaire (AEQ) using split half. The result of Cronbach alpha reliability coefficient of AEQ is 0.75. The validity of each instrument was checked by experts in Faculty of Education and Department of Life Sciences A.B.U. Zaria. The data collected for the study was classified into three

(a) Pretest Ecology Performance Test data

(b) Post-test Ecology Performance Test data

(c) Post-post test Ecology Performance Test data

Descriptive Statistical Mean and standard deviation were used to answer research questions and statistical t-test, Wilcoxon signed rank test and Kruskalwallis were used to test the null hypotheses at 0.05 level of significance for retaining or rejecting the hypotheses. The results summaries are provided in Tables 4.4 – 4.12 and the research findings are indicated as follows:

5.2.1 Major Findings

The following are some of the major findings of the study:

i. Students taught Ecology using Scaffolding Instructional Strategy performed significantly better than those taught using Lecture Method.

ii. The male and female students taught Ecology using Scaffolding Instructional Strategy have no significant difference between them.

iii. Student taught Ecology using Scaffolding Instructional Strategy performed significantly better in their retention of the concepts than those taught using Lecture Method.

iv. The male and female students taught Ecology using Scaffolding Instructional Strategy showed no significant difference between them in their retention of the concepts.

v. Students taught Ecology using Scaffolding Instructional Strategy showed a better positive attitude than those taught using Lecture Method

vi. The male and female students taught Ecology using Scaffolding Instructional Strategy showed significant difference in their attitude.

5.3 Conclusions

From the results and the findings, it could be concluded that:

i. The use of Scaffolding was found to enhance performance of secondary school students in Ecology.

ii. It was also concluded that the retentive ability of students taught with Scaffolding Instructional Strategy was better than that of Lecture Method.

iii. The students taught with Scaffolding Instructional Strategy have better attitude to the Ecology concepts taught than the students taught with Lecture Method.

iv. Both male and female students taught Ecology using Scaffolding Instructional Strategy benefited equally.

v. The students taught using Scaffolding Instructional Strategy have better performance in the Ecology concept taught than the students taught using Lecture Method.

5.4 Contributions to Knowledge

The study investigated the Effects of Scaffolding Instructional Strategy on attitude, retention and performance in Ecology among senior secondary school students in Giwa, Kaduna State. Based on the findings of this research work, the study has established the following contributions to knowledge.

i. Scaffolding enhanced conceptual understanding of Ecology concepts which had a positive impact on their performance.

ii. The Scaffolding Instructional Strategy has produced and facilitated improved retention ability among male and female students in public school in Giwa.

iii. The social interactions that students and teachers have in Scaffolding Instructional Strategy increase their pedagogical capacity to work together and enhance their academic performance.

iv. Both gender (male and female) benefited equally well when taught Ecology concepts using Scaffolding Instructional Strategy making Scaffolding Instructional Strategy gender friendly.

5.5 Recommendations

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

i. The teaching of Ecology should be carried out with tasks that involve using Scaffolds that promotes interaction among students and teachers.

ii. Science teachers should be encouraged to attend seminars, workshop, conference and in-service training programme specifically on Ecology teaching using Scaffolding Instructional Strategy model of Djwantoro (2010).

iii. The teaching of Ecology in secondary schools should be conducted in relaxed atmosphere as in Djwantoro's (2010) model of Scaffolding Instructional Strategy.

iv. The educational materials needed to be used for teaching and such should be funded by the Parents Teachers Association (PTA) or non-governmental organization (NGO)

5.6 Limitation of the Study

The following limitations were observed regarding this study:

i. The scope of this study was restricted to public secondary school in Zaria. Therefore, the finding might not cover private schools.

ii. The curriculum content was limited to only SS II Ecology and not the entire Senior Secondary School Biology curriculum.

iii. The experimental group had more than the number of recommended number of students in a class.

5.7 Suggestions for Further Studies

From the literature reviewed, it is obvious that Scaffolding Instructional Strategy is not yet popular in our schools in teaching various subjects. Therefore, the researcher is suggesting that further studies be conducted in the following areas.

i. This research work can be replicated in Junior Secondary school level.

ii. Scaffolding instructional strategy can be experimented in other units of Biology since the present study is restricted to Ecology.

iii. This study can also be carried out in other states in Nigeria.

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APPENDIX I

ECOLOGY PERFORMANCE TEST
ECOLOGY PERFORMANCE TEST (ECPT)

Instruction: Answer all the questions **Time: 40 minutes**

Each question is followed by four options lettered A – D. find out the correct option for each question and write on your answer sheet. Give only one answer to each question.

1. The complex relationship between the members of a community and between the community as a whole and its physical environment is
   A. Ecosystem
   B. Habitat
   C. Environment
   D. Niche

2. A secchi disc is used in the determination of
   A. Rainfall
   B. Tides
   C. Waves
   D. Turbidity

3. In which of these associations is much harm done to one of the partners?
   A. Symbiosis
   B. Epiphytism
   C. Commensalism
   D. Parasitism

4. Grasses → Grasshopper → Lizard → Snake → Hawk
   In this food chain, the group with few members is
   A. Grasses
   B. Grasshopper
   C. Lizards
   D. Hawks

5. A process which involved the stages of occurrence of organism on a cleared plot of land is called?
   A. Ecosystem
   B. Food chain
   C. Food web
   D. Succession

6. Nitrification is…….
   A. Conversion of nitrates to nitrogen
   B. Fixing nitrogen into plants
   C. Conversion of nitrates to nitrites
   D. Changing of ammonia to nitrite, then nitrates

7. A population is defined as the collection of:
    A. Similar organism that are found in the same habitat
    B. Similar organisms that breed in-the same habitat
    C. Similar organisms that interbreed freely in the same habitat
    D. Similar organism eating the same food

8. As a head of a group, your teacher asked your group to find the population of dragon flies in the school compound. Which of following methods will you use?
    A. Quadrat method
    B. Transect method
    C. Capture – recapture method
    D. Census method

9. Which of the following practices should be stopped in order to avoid global warming?
    A. Afforestation
    B. Combustion of natural gas
    C. Using nuclear energy to power car
    D. Encouraging people to recycle their rubbish

10. Plants which can survive in places where water supply is limited are called
    A. Bryophytes
    B. Mesophytes
    C. Xerophytes
    D. Hydrophytes

11. Transect method can be used in Ecology to show the……..
    A. Number of plants and animals in a habitat
    B. Population of a particular plant species
    C. Distribution of organisms along a line
    D. Heights of trees in section of a forest

12. Green plants are important in the ecosystem because they are the…….
    A. Primary consumers
    B. Producers
    C. Decomposers
    D. Secondary consumers

13. Anemometer is an instrument for measuring
    A. Relative humidity
    B. Altitude
    C. Wind speed
    D. Turbidity

14. Which of the following group of factors is completely abiotic?
    A. Salinity, tide, plankton, turbidity
    B. Temperature, pH, soil, insect
    C. Wind, altitude, humidity, light
    D. Conifers, wind, pH, rainfall+

15. A relationship between two living organisms with mutual benefit is called……
    A. Parasitism
    B. Saprophtism
    C. Ecosystem
    D. Symbiosis

16. In an ecosystem, animals which feed directly on plants are called
    A. secondary consumers
    B. primary consumers
    C. producers
    D. predators

17. Which of the following ecological factors are common to both terrestrial and aquatic habitats?
    A. Rainfall, temperature and light
    B. Salinity, rainfall and altitude
    C. Tides, wind, rainfall and altitude
    D. pH, salinity, rainfall and humidity.

18. In a community, bacteria and fungi are referred to as
    A. Producers
    B. Decomposers
    C. Scavengers
    D. Consumers

19. Which of the following relates to edaphic factors?
    A. Structure of the earth's surface
    B. Influence of living organisms on each other
    C. Temperature, rainfall and humidity
    D. Influence of soils on plant and animals

20. Nitrifying bacteria are important because they
    A. Release nitrogen to the atmosphere
    B. Convert atmospheric nitrogen to ammonia
    C. Combine ammonia with nitrogen
    D. Oxidize ammmonium salt to nitrates

21. In a savanna ecosystem the abiotic factors include
    A. Legumes, temperature and sandy soil
    B. Water, temperature and soil
    C. Minerals, oxygen and reptiles
    D. Water, soil and grasses

22. Physiological adaptation to very dry condition in animals is called:
    A. Hibernation
    B. Aestivation
    C. Rejuvenation
    D. Xeromorphism

23. Organisms in an ecosystem are usually grouped according to their trophic level as
    A. Carnivores and epiphytes
    B. Consumers and parasites
    C. Producers and consumers
    D. Producers and saprophytes

24. A food web is more stable than a food chain because
    A. It contains more organisms
    B. It has greater energy source
    C. It is not easy to destroy
    D. Every organism has an alternative source

25. Which of these is NOT an adaptive feature for arboreal life?
    A. Possession of long tail
    B. Possession of claws
    C. Possession of teeth
    D. counter shading in coat colour

26. Which of the following is true of climax community?
    A. It persists until the environment or climate changes
    B. It changes drastically from one year to the next
    C. It is first stage in succession
    D. It is made up of the tallest trees and the smallest

27. In a typical predator food chain involving secondary and tertiary consumers, the organisms become progressively
    A. Smaller and more numerous along the food chain
    B. Equal in number and size along the food chain
    C. Larger and fewer along the food chain
    D. Parasitized along the food chain as consumers get bigger

28. Mangrove swamp can be found
    A. On a seashore with flat terrains
    B. Where a river meets the sea .
    C. On a mud flat near the sea
    D. Where two rivers meet

29. An example of plant adaptation to a xerophytic environment is represented by the development of……
    A. Fleshy tissue and reduced leaves
    B. Broad canopy and extensive surface root system
    C. Thick barks and broad leaves
    D. Rough leaves and shallow root system

30. Which of the following factors is LEAST likely to affect animals living in a fresh water habitat?
    A. Turbidity
    B. Temperature
    C. pH
    D. Salinity

31. Which of these materials is not required for insect collection in an ecological field-trip?
    A. Pooter
    B. Secchi disc
    C. Spreading brand
    D. Jar containing alcohol

32. The type of vegetation that can be found in a habitat can be affected by the following except……..
    A. Nature of the soil particles
    B. Amount of rainfall
    C. Mineral content of the soil
    D. Farming activities

33. Which of the following statements is not true of population?
    A. Members of a population may be of the same specie
    B. Members of a population may be of the same specie but do not interbreed
    C. Size of a population may be limited by space
    D. Some species can form another population elsewhere.

34. Which of the following abiotic factor that affects a population?
    A. Predator
    B. Parasite
    C. Consumer
    D. Temperature

35. The distribution of organisms in a fresh water habitat like stream or pond is determined by the following factors except?
    A. Light penetration
    B. pH of the soil
    C. Rainfall
    D. Temperature

36. Which of the following is a biotic component of an ecosystem?
    A. Soil
    B. Rainfall
    C. Light
    D. Fungi

37. The maximum size of a population that a given area can support is known as……..
    A. Population density
    B. Carrying capacity

    C. Population growth
    D. Maximum population

38. The producers in a food chain in an aquatic environment are…….
    A. Birds
    B. Phytoplankton
    C. Zooplankton
    D. Fishes
    E.

39. A community reaches a climax when?
    A. Only pioneer organisms are present
    B. New habitant are constantly being formed
    C. There is an introduction of new plants and animal species within the community
    D. The composition and size of a community remains constant over a long period

40. Which of the following components make up an ecosystem?
    A. Decomposers, animals and anon-living factors
    B. Living and non-living factors
    C. Plants and non-living factors
    D. Plants, decomposers and non-living factors

APPENDIX II

MARKING SCHEME

ANSWERS TO ECPT

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

APPENDIX III

LESSON PLAN FOR EXPERIMENTAL GROUP

Lesson Plan I

Class: SSII

Subject: Biology

Topic: Basic Ecological Concepts

Duration: 1 Hr 20 mins

Instructional Materials: Pictorial Representations, Cue Cards,

Previous Knowledge: Students have been taught the meaning of ecology

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

(i) define ecology

(ii) explain the term habitat, population, biotic community, hydrosphere, ecological niche, atmosphere, environment

(iii) name the different types of habitat

(iv) list instruments for measurement of ecological factors.

(v) state the uses or functions of the instruments.

(vi) describe two of the instruments and how they are used.

Teacher's Ac\ivity	Students' Activity	Strategy
Step 1 Teacher asked questions on the past lesson relevant to the topic such as; what is ecology?	Students respond to the question	Question and answer
Step 2: Teacher introduced the lesson through lecture method students were connected to previous knowledge through questions such as: Explaining the meaning of the various concepts listed with examples	Students listen to the explanation	Explanation presentation guided practice
Step 3: Students sit according to groups of 5 and work on the study material and the activity work. The students are given the ecological concepts with the activity 1a to work on: Including the scaffold given.	Students are in groups of 5. They interacted with one another to get the table completed. The teacher goes round (soft scaffold) to help any group that have difficulty by given hint and prompts.	Guided practice Hard and soft scaffolds.

The students are to complete the table of organism with their habitats. The teacher goes round to see their work and assist students with difficulty with hints and prompts (soft scaffold) **Activity 1b:** Division of habitats with examples student fill in the aquatic habitats with examples from the scaffolds provided. **Activity 1c:** Students to state the factor for which the instruments are used and how to use them using the scaffolds given.		
Step 4: Scaffolds are withdrawn (fading). Students return to their seats. There is class discussion of students answers to the task on activity 1a, 1b and 1c.	Students respond by answering the questions to the activity	Guided practice Independence practice
Step 5: The teacher asks questions to test the understanding of the students on the topic where there are incorrect or inappropriate answers, the teacher corrects (Evaluation)	Students get feedback from the teacher to affirm the correct answers and correct the wrong ones.	Independent practice Re-teaching and lesson closing..

Activity 1a: Naming habitats complete the following table by filling in as precisely as possible the habitat of each of the organism from the scaffolds provided

I. Complete the following table by filling in precisely as possible the habitat of each of the organisms from the scaffolds provided.

Organism	**Precise Habitat**
Fish	
Lizard	
Spirogyra	
Tadpole	
Rhizopus	
Flowering plant	

Activity 1b: Division of Habitats with Examples

II. Add one organism each to fill the habitat.

	Aquatic	**Examples**
(I)	Fresh water	?
(II)	Salt (marine)	?
(III)	Brackish water ((Mixture of salt water and fresh water)	Estuaries, lagoon

Activity 1c: Students to State the Factor for which the instruments are Used and how to use them using the scaffolds given

III. Instrument for Measurement of Ecological Factors

Instrument	**Factor Used for**
Raingauge	
Wind vane	
Sweep net	
Barometer	
Quadrat	
Hydrometer	

Instrument	**How it is Used**
Thermometer	
White/secchi disc	
Anemometer	
Pooter	

usually lives in specific habitat that suit its way of life and promote its survival. Two main habitats exist: The **Aquatic** and the **Terrestrial** habitat.

Aquatic habitats are divided into three main types:

1. The **marine** habitat: These are the open sea, the seashore and the salt lakes. They are salt water with low dissolved nutrients.
2. The **fresh water** habitat: This can be standing/ stagnant water bodies **(lentic type)** such as the ponds, lakes, rice field flooded by freshwater or the free running water bodies **(lotic types)** such as the rivers, springs and streams. The water is salt-free.
3. The **estuarine/brackish** water habitat: This contains a mixture of salt water and fresh water due to its connection to the open sea and the influence of tidal waves that mixes fresh water from the rivers and salt water from the sea. Examples are estuaries and lagoons.

Terrestrial habitats are divided into three types:

1. Arboreal habitat
2. Ground habitat
3. Underground habitat

While different living organisms lived in different habitats. It is observed that where an organism lived is mostly determined by its structure, its behaviour and its response to other organisms in that habitat. This takes us to another ecological concept, the **niche**. While habitat is about the 'residence' of the organism, the niche is about the role the organism plays in that habitat. Thus, a **niche** is the functional status of an organism within an ecosystem.

Population is defined as a group of living organisms of the same species living in the same place at the same time. In other words, a population is a group of similar organisms in a community. Examples are bacterial population, fungal population etc. A population usually grows and maintain itself like the individual organisms that make it up.

A biotic community is defined as a group/population of different kinds of organisms living together and interacting with one another in an area or habitat. The community is a loosely organised unit comprising different types of organisms living together and enjoying some form of benefit from their interactions. Communities vary in size. A fish pond containing tadpole, algae, bacteria, small floating plants, protozoa and fish is a community. Biogeographical zones, each of which contains characteristic plant and animal life are called **biomes**.

Ecosystem is defined as the interactions that exist among the living organisms themselves and with their non-living components to produce a stable system that produce continuous maintenance of life on earth. An ecosystem may be terrestrial or aquatic. Examples of terrestrial ecosystem include grass lawn and decaying wood in the soil. Examples of aquatic ecosystem are the pond, oceans, estuaries and seashores.

Components of an Ecosystem

Biotic Components

The biotic components of an ecosystem encompass the producers, the consumers and the decomposers.

Producers are the green plants. Green plants are the lifeblood of every ecosystem. They use their light absorbing pigment called chlorophyll to trap light energy from sunlight. The energy generated is used during the process of photosynthesis to make organic molecules from simple inorganic molecules (CO_2). These plants are autotrophs i.e. self-feeders.

Consumers are animals that feed on organic substances. They feed on plants or other animals and are referred to as heterotrophs (use organic substances as source of energy).

Decomposers: They are unicellular and multicellular organisms like bacteria and fungi that feed on the dead bodies of the producers and the consumers and in the process bring about the decay of such dead bodies. They break down these dead bodies into simple chemical compounds, which can be assimilated by plants and use again.

Abiotic Components of the Ecosystem

In the preceding section, we have mentioned the biotic components of the ecosystem. However, living organisms also interact with their physical environment and these interactions influence and

Source: Biology for Senior Secondary Schools I.O.S. Obayori, P.O. Bolatiri, L.B. Salam MELROSE Books And Publishing Limited.

SUMMARY OF BASIC ECOLOGICAL CONCEPTS

Terrestrial habitat

Instrument	Factor for which it is used
Thermometer	Measurement of temperature
Rain gauge	Determining quantities of rainfall
Anemometer	Measuring wind speed
Wind vane	Determining wind direction
Quadrat	Determining population of plants/animals
Sweep net	Collecting flying insect
Pooter	Collecting small insects from leaf litter/rocks/walls
Light meter	Determining light intensity
Hygrometer	Determining relative humidity
Barometer	Determining atmospheric pressure
pH indicator	Determining level of alkalinity or acidity of a soil sample.

Aquatic habitat

Instrument	Factor for which it is used
Thermometer	Measuring temperature
pH indicator	Determining acidity/alkalinity of water or soil
Plankton net	Collecting micro-organisms
Hydrometer	Determining water density
White disc/secchi disc	Determining turbidity
Meter rule/height metre	Measuring depth of water
Float/specimen tube containing pebbles/sand	Determining speed of flow of water

Arboreal Habitat

Instrument	Factor for which it is used
Pooter	Collecting small insects on tree trunk/bark
Height meter/metre rule	Measuring height/distance
Thermometer	Measuring temperature
pH indicator	Measuring acidity/alkalinity
Mist net	Catching birds
Sweep net	Collecting insect
Hygrometer	Humidity measurement

Source: Narrative Ecology, Evolution and Genetics M.M. Babatunde Softwords Nig. Ltd.

Instrument	How it is used
Thermometer	• Hanging it up in atmosphere/dipping it in water/soil for some times and take readings. • Leaving it for some time interval/allowing the movement of mercury to be steady. • Reading off the temperature.
Rain gauge	• Leave in a suitable place on the ground. • After rainfall read off the level of water in the cylinder.
Anemometer	• Set up in convenient place. • Observe the speed/rate of rotation.
Quadrat	• Throw randomly in the chosen habitat. • Identify and count organisms within the quadrat. • Several throws and obtain average, or • Identify and count organisms within quadrat. • Several placement and take average.
Pooter	• Point collecting tube towards tree/wall/rock • Suck through the mouthpiece.
Float/specimen tube containing pebbles/ sand	• Timing the passage of the float/tube • Over a measured distance
White disc/secchi disc	• Sink a weighted white disc. • And noting the depth at which it just cannot be seen.
pH indicator	• Place some soil/water in a clean crucible lid/water glass and add pH indicator for 1 to 2 minutes. • Tilt the container so that the indicator drains out. • Compare its colour with the chart supplied with the indicator

Various Instruments for Ecological Field Work

Experimental Group – Lesson Plan II

Class: SSII

Subject: Biology

Topic: Classification of Ecological Factors

Duration: 1 Hr 20 mins

Instructional Materials: Study Material/Cue Cards, Charts of Different Biomes

Previous Knowledge: The students have been taught ecological concepts.

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

(i) state the interrelationships between living things and their environment.

(ii) state that habitat is defined by ecological factors which are present there.

(iii) list the aquatic habitats – marine, brackish, fresh water.

(iv) list the terrestrial habitats – arboreal, ground and underground

(v) state ecological factors in terrestrial habitats – climatic (e.g. rainfall, light, wind), topographic and edaphic factors.

(vi) state ecological factors in aquatic habitats – rainfall, speed of flow, salinity, turbidity and pH.

(vii) state features of organisms which fit them for life in particular habitats.

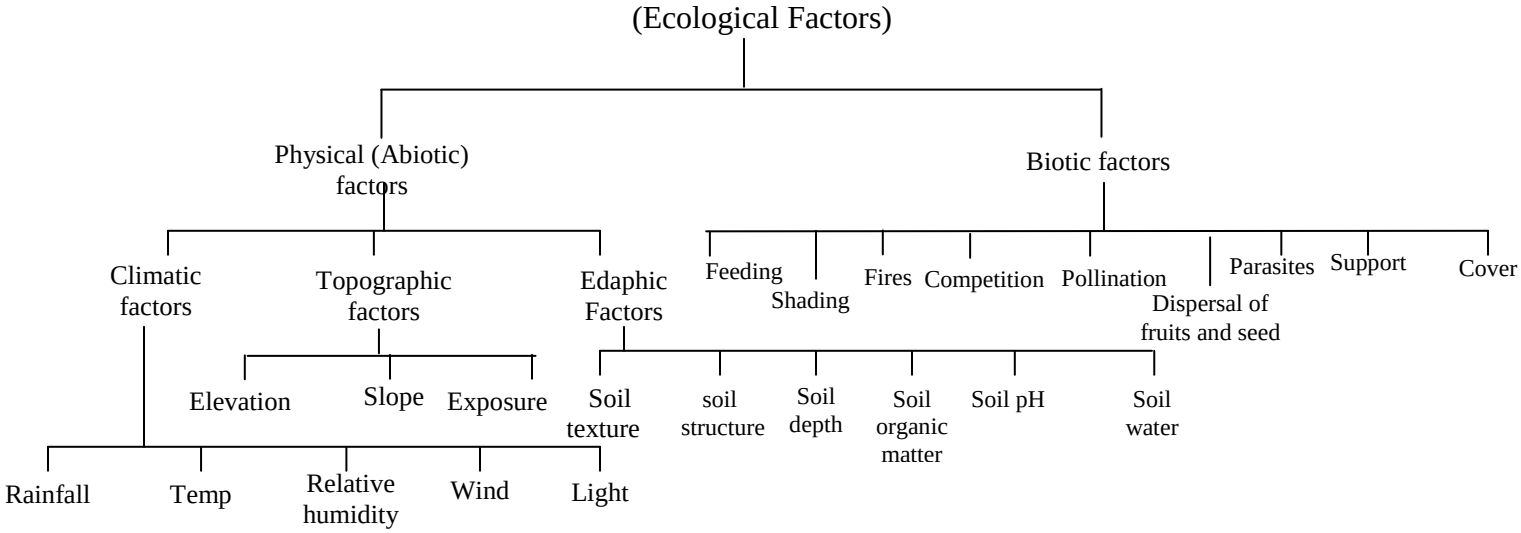
(viii) list types of biomes, local biomes in Nigeria or West Africa.

Teacher's Activity	Students' Activity	Strategy
Step I Teacher asked questions based on the previous lesson such as: What is a habitat? Give examples.	Student respond with answers	Question and answer
Step 2: Teacher introduced the lesson through lecture method. Explaining what ecological factors are and how they affect each habitat	Students listen to the explanation and illustrations	Explanation presentation

Step 3: The students are put into their groups, they are given study material and the activity work.	Student sit according to their groups and work on the activities given. Students are given in tabular form the ecological factors as study material (scaffolds) in a tabular form **Activity 2a:** Classification of ecological factors. Students to fill in the missing factors on the table from the scaffolds provided **Activity 2b:** Students to study the material and answer the following questions in their worksheet: (i) List ecological factor common to terrestrial habitats. (ii) List different types of habitat (iii) List organisms that can be found in the habitat name above. (iv) List five (5) abiotic factors.	Guided practice Hard and soft scaffolds.
Step 4: Scaffolds are withdrawn (fading) students return to their seats. There is class discussion of students activity work.	Students respond by answering the questions to the activity	Guided practice Independence practice
Step 5: The teacher asks questions to test the understanding of the students on the topic. Where there are inappropriate or incorrect answers the teacher corrects (Evaluation)	Students get feedback from the teacher to affirm the correct answers and correct the wrong ones.	Independent practice Re-teaching and lesson closely.

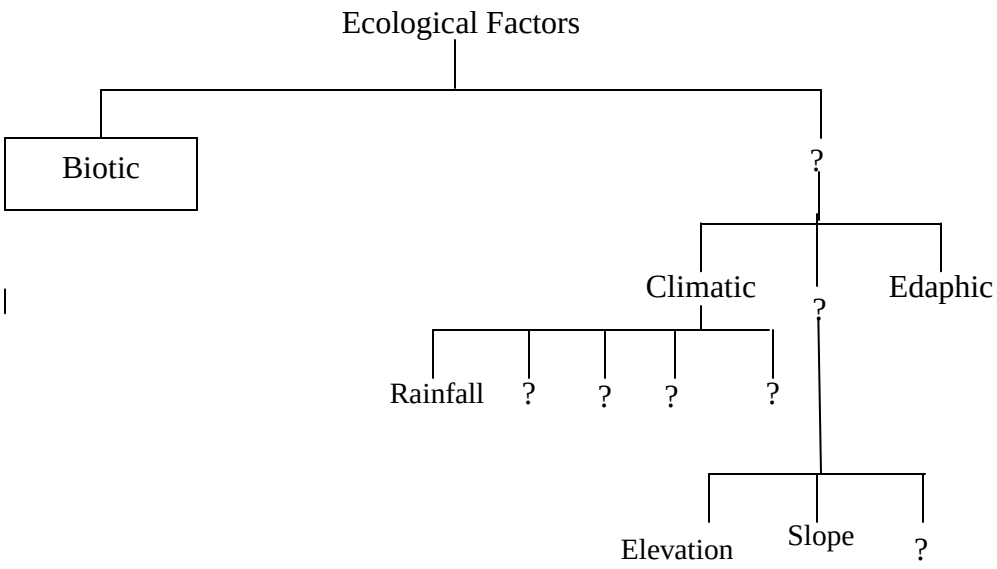
SCAFFOLD

Classification of Ecological Factors Habitat



New Practical Biology for Senior Secondary Schools D.A. Maxwell. Onibonoje Press & Book Industries (Nig.) Ltd

Activity 2a: Students to fill in the missing factors on the table



Activity 2b

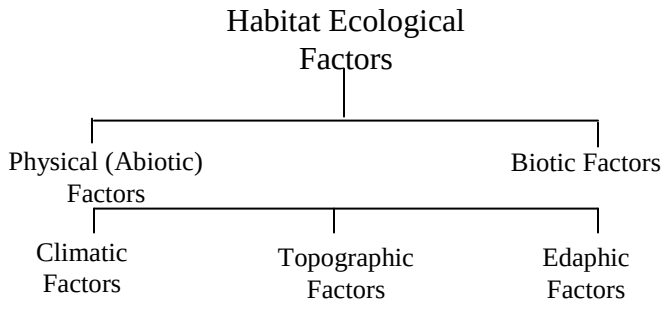
(i) List ecological factor common to terrestrial habitats.

(ii) List different types of habitat.

(iii) List organisms that can be found in the habitat named above.

(iv) Name 5 biotic factors

SCAFFOLD



Biotic Factors are those factors which relate to living things.

Living things influence other living things:

a. Feeding

b. Shading from light

c. Fires

d. Competition

e. Pollination

f. Dispersal of fruit and seeds

g. Parasites

h. Support

i. Cover

Activity 2b: Study the material before you and answer the following questions in your worksheet.

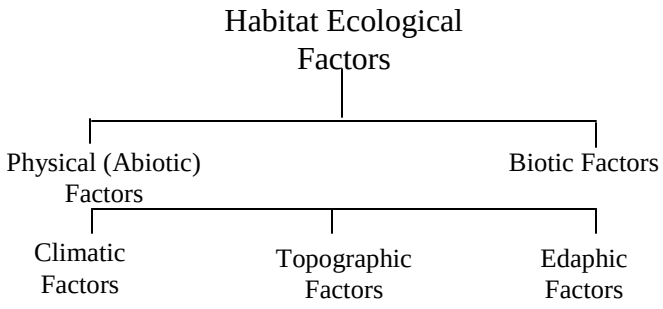
Ecological factors are those factors in the environment which can influence living or cause changes in any habitat be it aquatic or terrestrial:

i. List the ecological factors common to terrestrial habitats

iii. List the different types of terrestrial habitats?

iv. What organisms can you find in the named habitat above?

iv. Name 5 biotic factors



Biotic Factors are those factors which relate to living things.

Living things influence other living things:

a. Feeding

b. Shading from light

c. Fires

d. Competition

e. Pollination

f. Dispersal of fruit and seeds

g. Parasites

h. Support

i. Cover

Activity 2b: Study the material before you and answer the following questions in yhour worhsheet.

Ecological factors are those factors in the environment which can influence living or cause changes in any habitat be it aquatic or terrestrial:

i. List the ecological factors common to terrestrial habitats

ii. List the different types of terrestrial habitats?

iii. What organisms can you find in the named habitat above?

iv. Name 5 biotic factors

Experimental Group – Lesson Plan III

Class: SSII

Subject: Biology

Topic: The Functioning Ecosystem

Duration: 1 Hr 20 mins

Instructional Materials: Study Material Pictures of Organisms (scaffolds)

Previous Knowledge: The students have been taught about ecological factors that affect different habitats

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

(i) state the component of an ecosystem;

(ii) state that an ecosystem is a community made up of producers, consumers and decomposers;

(iii) define a food chain and web;

(iv) explain that the number of individuals in a food chain decreases from one trophic level to another, which gives rise to a pyramid of numbers;

(v) state that organisms derive energy from the food they eat; and

(vi) state that populations of different organisms are found together in ecosystems.

Teacher's Activity	Students' Activity	Strategy
Step I Teacher asked questions based on the previous lesson such as; What are ecological factors that are common to all habitats?	Students respond with answer and where the responses are not correct, the teacher gives some hints and prompts to lead them in given correct answers	Question and answer
Step 2 Teacher introduced the lesson through lecture method. The teacher explains the components of an ecosystem with a schematic representation. He went on to link food chain and web to trophic level and pyramid of numbers and energy flow in an ecosystem. Students are given examples of food chain and food web as scaffolds	Students listen to the explanation and illustrations	Explanation presentation
Step 3: Students are put into their groups. They are given scaffold (study material) and	Students sit according to their groups and work on the activities given. Activity 3ai Classify	Guided practice Hard and soft scaffolds.

the activity work.	ecosystem into 2 components. (Biotic & Abotic) (ii) Classify the living things in an ecosystem into three kinds (producer, consumer and decomposer) (iii) Give examples of the above mentioned three (producers, consumers and decomposers) (bi) Complete the chains below: Guinea grass →? → toad →? → hawk. (ii) diatoms →? → water flea →? → big fish. (iii) Humus →? → domestic fowl →?	
Step 4: Scaffolds are withdrawn (fading). Students return to their seats. There is class discussion of the activity work.	Students respond by answering the questions to the activity	Guided practice independence practice
Step 5: The teacher asks questions to test the understanding of the students on the lesson. Where there are inappropriate or incorrect answers the teacher corrects. (Evaluation).	Students get feedback from the teacher to affirm the correct answers and correct the wrong ones.	Independent practice Re-teaching and lesson closing.

Activity 3ai: Classify ecosystem into 2 components

ii. Classify the living things in an ecosystem into three kinds/group.

iii. Give examples of the above mentioned three groups.

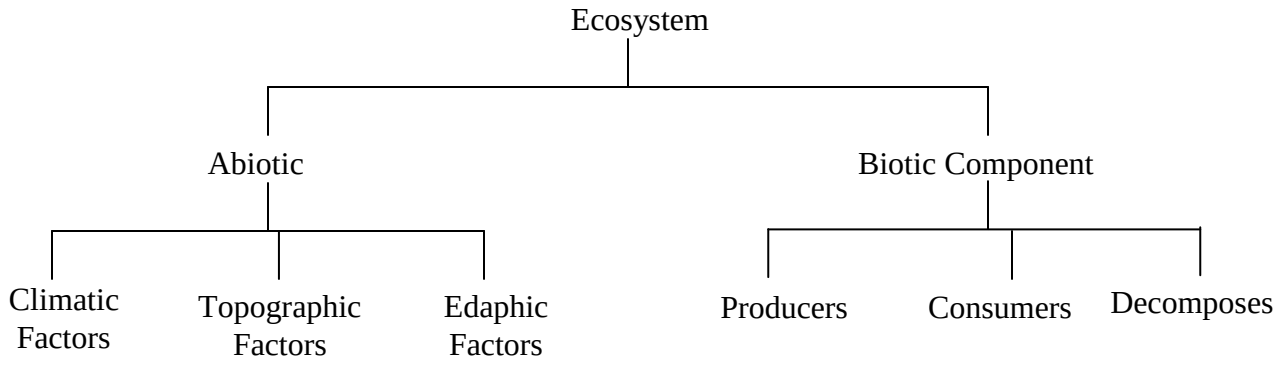
bi) Complete the chains below:

Guinea grass ⟶ ? ⟶ toad ⟶ ? ⟶ hawk

ii. Diatoms ⟶ ? ⟶ water flea ? ⟶ big fish

iii. Humus ⟶ ? ⟶ domestic fowl ⟶ ?

SCAFFOLD



Schematic Classification of Ecological Factors

New Edition, Senior Secondary Biology I, .O.C., Asun, J.O. Aina, Learn Africa Plc

Experimental Group – Lesson Plan IV

Class: SSII

Subject: Biology

Topic: Population Studies

Duration: 1 Hr 20 mins

Instructional Materials: Study material (scaffold) Pictorial materials for collecting living organisms for study, poster, sweep net, plankton net, Tullgren funnel

Previous Knowledge: The students have been taught about habitat and ecosystem and factors affecting habitats.

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

(i) define population;

(ii) state the different techniques of determining the population size of species; and

(iii) determine the population size of maize.

Teacher's Activity	Students' Activity	Strategy
Step I Teacher asked questions based on the previous lesson. (i) What are the two divisions of habitat as ecological factors? (ii) What are abiotic factors? (iii) Mention the community of ecosystem	Students respond with answer	Question and answer
Step 2 Teacher introduced the lesson through lecture method explaining the procedure of determination of population size. He explained complete total (count), transect method, sampling, capture, marked, release and recapture. The teacher explained the quadrat, volume sample, transect method and capture, marked, release and recapture method.	Students' listen to the explanation and illustration	Explanation presentation
Step 3: The students are put into their groups. They are given study material and the activity work. The teacher goes round to see what the students are doing, where there is incorrect step taken the teacher guides the group to the right path.	Students sit according to their groups and discuss the study material and do the activity given. The activity is to determine the population size of maize grains, using the capture marked, release and recapture method. Maize grains	Guided practice Hard and soft scaffolds.

	are provided in a container. (ii) Handful of maize grains are removed from the container (iii) they are marked with markers and counted and recorded (iv) The answer is recorded as A (v) Pour them back to the main population of maize grains. (vi) Mix thoroughly. (vii) Bring out another handful of maize which will include marked and unmarked. (viii) Count and record as B (ix) Select the ones market as B and count, then record them as C. (x) Then using the formula: $\frac{\text{Pop. Size A x B}}{\text{C}}$ (xi) Calculate/estimate the population size of the maize grains. (xii) Each student is actively involved in the process of calculating the population size.	
Step 4: Scaffolds are withdrawn (fading) Students return to their seats. There is class discussion of students activity work. **Step 5:** The teacher asks questions to test the understanding of the students on the topic. Where there are inappropriate or incorrect answers the teacher corrects (Evaluation)	Students respond by answering the questions to the activity. Where there is need for correction, the teacher carried out. Students get feedback from the teacher to affirm the correct answers and correct the wrong ones.	Guided practice independence practice Independent practice Re-teaching and lesson closely.

Activity 4a: List three methods of population studies.

4b: Determine the population size of maize grains using the capture and recapture method using the scaffold provided.

FUNCTIONING ECOSYSTEM

An ecosystem is a basic functioning unit in nature. It is made up of living organisms (plants and animals) and their non-living environment. The biotic or living components such as the producers and consumers interact in their environment resulting in the ecosystem being a functional unit.

AUTOTROPHS, HETEROTROPHS AND DECOMPOSERS

Autotrophs

Definition: Autotrophs are organisms (green plants and some bacteria) which can use sunlight or chemicals to manufacture their food from inorganic susbtances during the process of photosynthesis. In other words, autotrophs are organisms capable of synthesizing their own food, hence they are called **producers.** Autotrophs provide food for the other organisms in the habitat. Terrestrial examples of autotrophs are grasses, trees and shrubs while aquatic autotrophs are phytoplanktons, water hyacinths, sea weeds etc.

Heterotrophs

Definition: Heterotrophs are organisms, mainly animals, which cannot manufacture their own food but depend directly or indirectly on plants for their food, hence they are called **consumers.** Animals that feed directly on green plants (producers) are called **herbivores** or **primary consumers** while animals or organisms that feed on the primary consumers are called **carnivores** or **secondary consumers.** Animals that feed on the secondary consumers are called **tertiary consumers.** Heterotrophs include all animals, carnivorous plants, fungi, most protists and some bacteria.

Consumers are heterotrophs that feed on other organisms. They include all holozoic organisms such as herbivores, carnivores, omnivores, decomposers and parasites. Some examples of consumers or heterotrophs in a terrestrial ecosystem are caterpillar, cow, dog, lion, toad, hawk, lizard, man etc while aquatic heterotrophs include water fleas, tadpoles, larvae of insects and fishes.

Decomposers

Definition: Decomposers are organisms that feed on dead organisms and other decaying organic materials. Decomposers help to break down dead organic matter and release simple chemical compounds which plants can absorb and use again. Examples of decomposers are insects such as termite, larvae of housefly, bacteria and fungi.

6.2 FOOD CHAIN, FOOD WEB AND TROPHIC LEVEL

Food Chain

Definition: Food chain is defined as a feeding relationship involving the transfer of energy through food from producers to consumers.

Examples of food chain in terrestrial habitat are:

(i) Guinea grass (producer) → grasshopper (primary consumer) → toad (secondary consumer) → snake → hawk (tertiary consumer)

(ii) Grass (producer) → Antelope (primary consumer) → Lion (secondary consumer)

Essential Biology for S.S. Schools M.C. Michael

Every food chain usually begins with a producer (green plant) that is fed on by a herbivore (primary consumer) which is in turn fed on by a carnivore, e.g. toad and the carnivore is again fed on by snake and the snake is fed on by a bigger carnivore such as the hawk. Example of a food chain in aquatic habitat:

diatoms (producers) → mosquito larvae (primary consumers) → Tilapia fish (secondary consumers) → whales (tertiary consumers)

During the process which occurs in food chain, food energy is transferred from one organism to another in a linear form. The arrow shows the direction in which the food is being transferred, even though most food chains begin with producers, there are few exemptions that start with dead plants or animals. e.g.

humus → earthworm → domestic fowl → man.

Foodweb

Definition: Food web is defined as a complex feeding relationship among organisms in the same environment with two or more inter-related food chains.

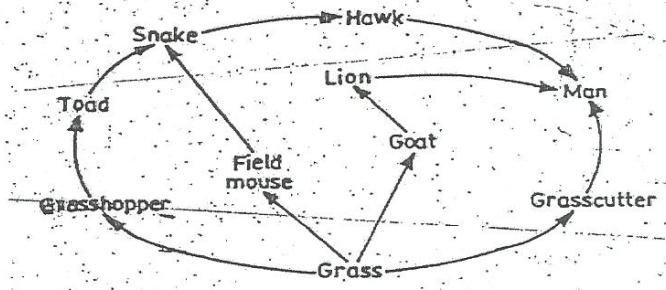


Fig. 6.1 Food web (in a terrestrial habitat)

Food web contains two or more food chains and therefore more organisms than food chain. In nature, the interaction in feeding are more complicated because a single plant could be fed upon by more than one or two organisms. When a consumer feeds on different types of plants or animals in a food web, it has a better chance of survival in its ecosystem. Figure 6.1 is an example of a food web in a terrestrial habitat

In the food web in figure 6.1, there are four food chains in the terrestrial habitat. Example of a food web in an aquatic habitat is illustrated in figure 6.2.

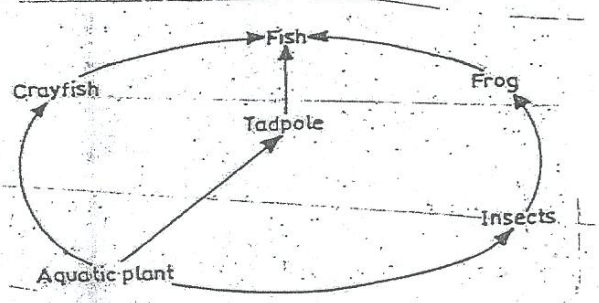


Fig. 6.2 Food web (in an aquatic habitat)

In the above food web, there are three food chains in the aquatic habitat.

Differences Between Food Chain and Food Web

Food Chain	Food Web
(i) It is a linear feeding relationship.	It is a complex feeding relationship.
(ii) It involves one food chain.	It involves two or more food chains.
(iii)It involves fewer organisms.	It involves many organisms.
(iv)Organisms have lesser chance of survival.	Organisms have greater chance of survival.

Source: Essential Biology for S.S. Schools M.C. Michael

The activity is to determine the population size of maize grains, using the capture marked, release and recapture method. Maize grains are provided in a container.

(ii) Handful of maize grains are removed from the container

(iii) They are marked with markers and counted and recorded

(iv) The answer is recorded as A

(v) Pour them back to the main population of maize grains.

(vi) Mix thoroughly.

(vii) Bring out another handful of maize which will include marked and unmarked.

(viii) Count and record as B

(ix) Select the ones marked as B and count, then record them as C.

(x) Then using the formula:

$$\text{Pop. Size } \frac{A \times B}{C}$$

(xi) Calculate/estimate the population size of the maize grains.

(xii) Each student is actively involved in the process of calculating the population size.

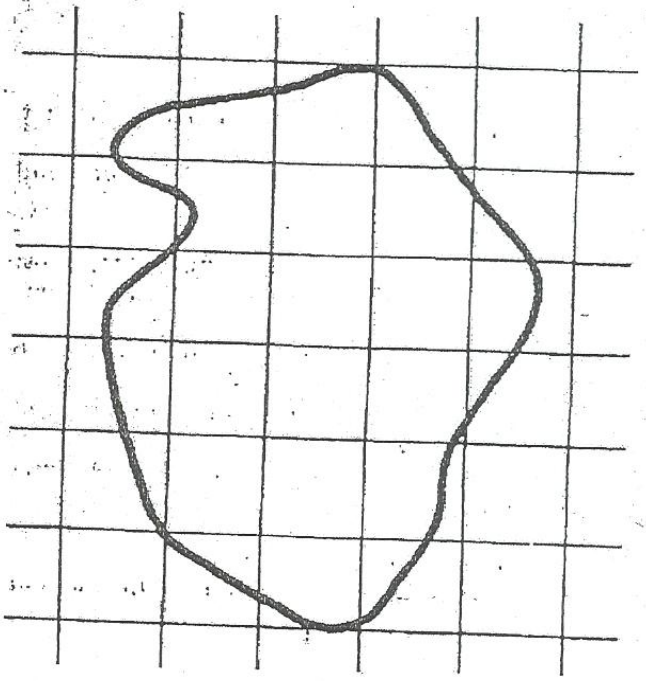
Density and distribution

If a habitat is small enough, it may be possible to determine the density or distribution of a population by counting and recording the position of every member (see grid method below). However, in most habitats it will be necessary to use sampling techniques such as quadrats or transects.

Grid method

In this method, we note where every member of the population being studied occurs, and record this on a map. Once the map is complete, we can work out the average density per unit area for the species and make conclusions about its distribution throughout the habitat. Proceed as follows:

1 Divide the area into conveniently-sized squares - say 1 m^2 - using twine and sticks, as in Fig. 4.17 (and see Fig. 4.34).
2 Mark out a corresponding grid on a previously prepared map of the area.
3 Examine each square of the study area in turn.
4 Record the position of every specimen of each species being studied on the map.



Quadrat method

Quadrats can be used to determine the density and distribution of plant species in a habitat. Proceed as follows:

1 Throw the quadrat at random as shown in Fig. 4.16B and inspect the area on which it falls.
2 Record, on a map, whether the species is present or absent within the quadrat (Fig. 4.18). This

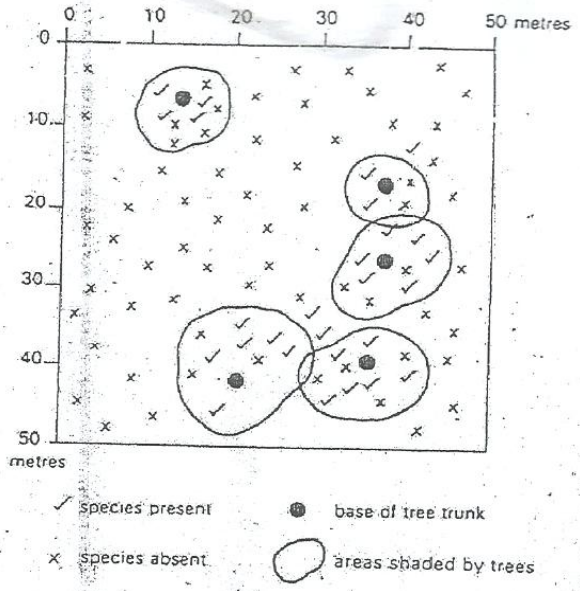
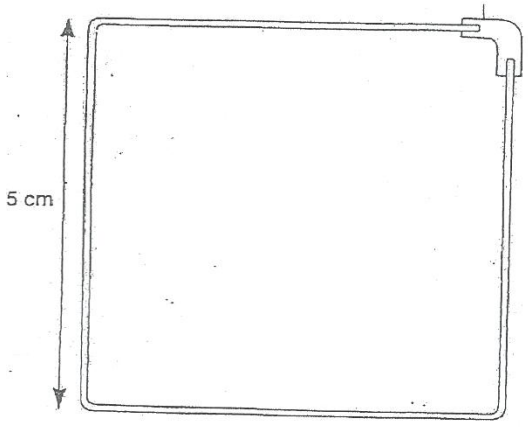


Fig 4.18

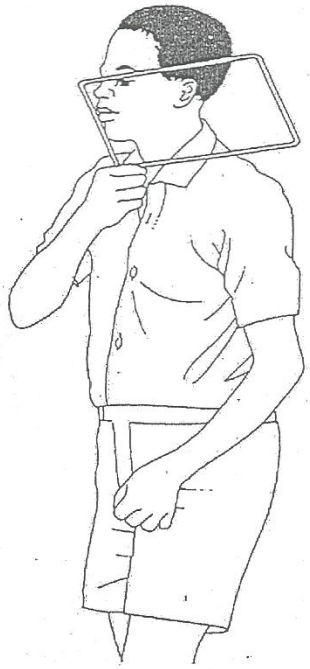
time, there is no need to count the number of specimens enclosed.
3 Repeat the process until sufficient throws have been made to sample the habitat thoroughly.
4 Examine the map and draw conclusions about the way the species is distributed through the habitat.

Transect method

A transect records the distribution of plants along a line and is useful for showing up changes in vegetation in places like a hillside, a pond or a seashore (Fig. 4.19). A long measuring tape or a length of rope marked at convenient intervals using a felt-tipped pen is used. This is laid along the selected line and every plant which touches it is recorded. Plants which do not actually touch are ignored. It is best to work with a partner when preparing a transect. Then one of you can name and note the position of the plants touching the rope, while the other records the facts in a previously prepared table.



A quadrat. It is made from a length of strong, firm wire. To make each right-angle bend put the wire round the corner of a wooden box and hammer it gently into shape.
A quadrat may be of any size, depending on the habitat and size of plants to be studied. One with sides of 25 cm is suitable for many investigations. For studies on larger plants a quadrate up to 1 m^2 would be better, or a 2 cm^3 quadrate may be preferred if tiny moss plants are to be investigated.



fixed number of throws - say 50 - and from the results, the average number of plants per m^2 is calculated. If we know the area of the habitat, we can estimate the total number of the plants it contains. (We assume that the plants are distributed uniformly through the habitat. This may not be the case, and is a possible source of error.) Two or more species may be sampled at the same time using this method.

Note that to be reliable, quadrat sampling must be random. This means we must not decide beforehand where the quadrat is to land, but let it fall by chance. It is best to look ahead while throwing the quadrat behind you as in Fig. 4.16B so that you cannot see where it will land.

Capture/recapture

This method is used to estimate animal populations; for example, the number of cockroaches in a dirty kitchen. It involves catching a certain number of the animals; placing a suitable mark on them so they can be recognised later, and releasing them. (In the case of cockroaches for example, a dot of waterproof paint might be placed on the dorsal surface of the thorax with a small brush.) After a time - say one week - a second catch is made, and the number of marked and unmarked animals is counted. We then estimate the size of the population by using the following formula

$$\frac{n \times M}{m} = N; \quad \text{where}$$

n = total number of animals (both marked and unmarked) in the second sample;
M = total number of marked animals in the first sample;
m = total number of marked animals in the second sample;
N = total size of population.

The method is based on the following assumptions:

1 that individuals do not move out of or into the ecosystem.
2 that the marked individuals are randomly distrib uted in the population.
3 that the marked individuals are a random sam- ple.
4 that initial capture and marking does not influ ence recapture.
5 that none of the marks have worn off during the interval between the two catches.

Do you agree that results obtained by this method should be treated as approximations and not as exact values?

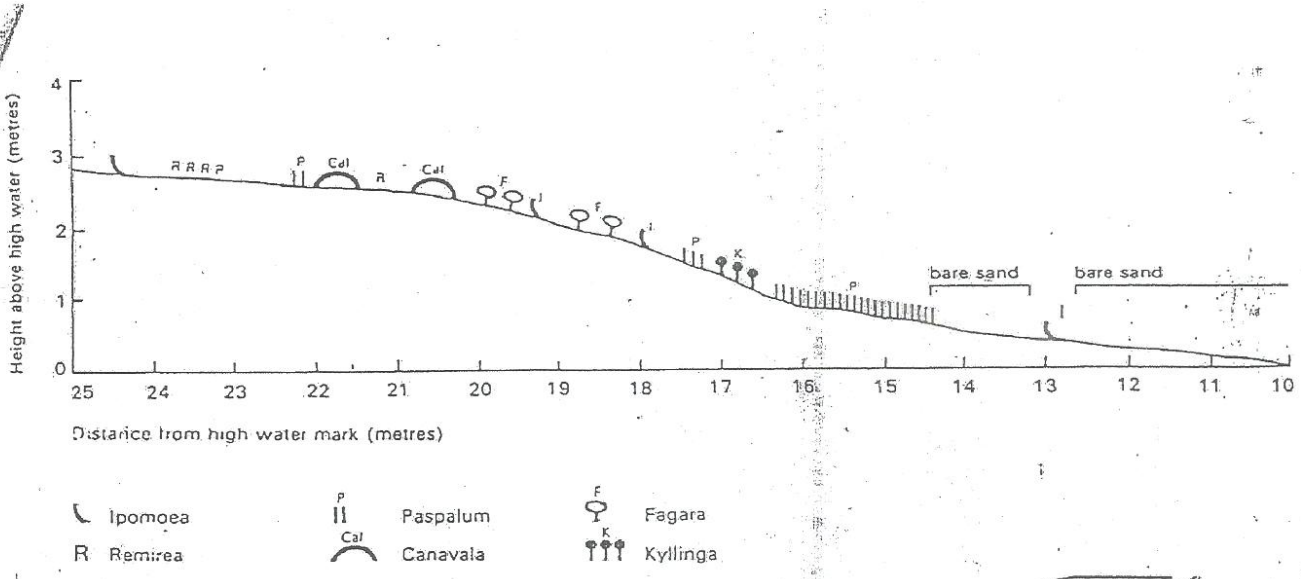


Fig 4.19 Transect across part of a sandy beach

Often, it is not necessary to record every plant which touches the rope. If records are made at regular intervals, this may be sufficient to show how the vegetation is changing. The most useful interval to choose will depend on the site. For a long hillside it might be every metre and for a pond bank every 15 – 25 cm.

Collecting and identifying

At times, in your ecological investigations, you will need to collect specimens of the plants and animals you are studying. Collecting plants is usually easy. Bring back samples of any plant you want to identify in a plastic bag. Before picking a plant, make brief notes on where it was found, and its habit of growth. Make sketches or write descriptions of any part of the plant you cannot remove, or any part you suspect may fade or fall off.

Animals are more difficult to collect because they are able to escape or go into hiding. Several visits are usually necessary and a variety of techniques needs to be used. Some apparatus and techniques for collecting insects and small aquatic invertebrates are illustrated in Figs. 4.20 to 4.22.

Useful collecting, measuring and recording materials to take with you when you visit the habitat are listed in Table 4.1. Label each specimen or its container with a number or other distinguishing mark as you collect it, and make a note in your field notebook or clipboard *at the time.*

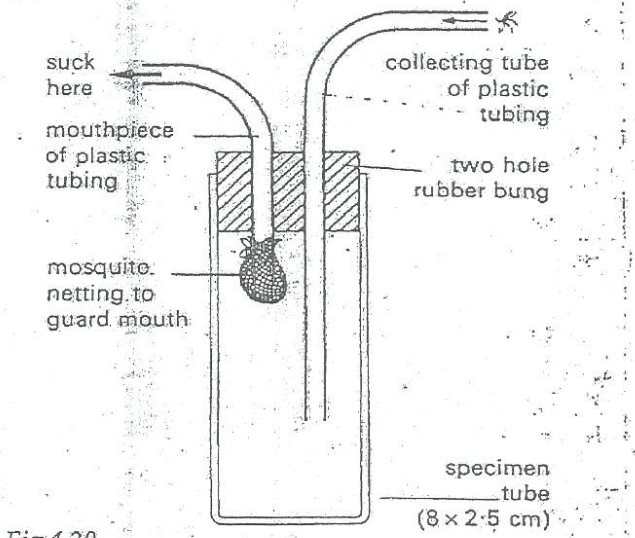


Fig 4.20

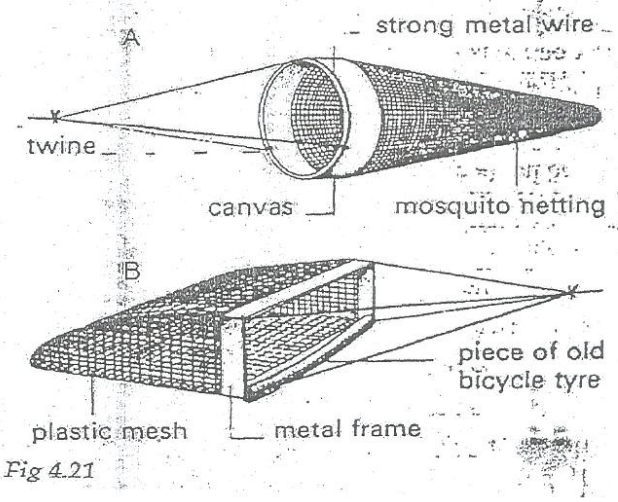


Fig 4.21

Experimental Group – Lesson Plan V

Class: SSII

Subject: Biology

Topic: Ecology Association

Duration: 1 Hr 20 mins.

Instructional Materials: Pictorial materials organisms in a habitat

Previous Knowledge: The students have been taught – habitat, population and ecological factors.

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

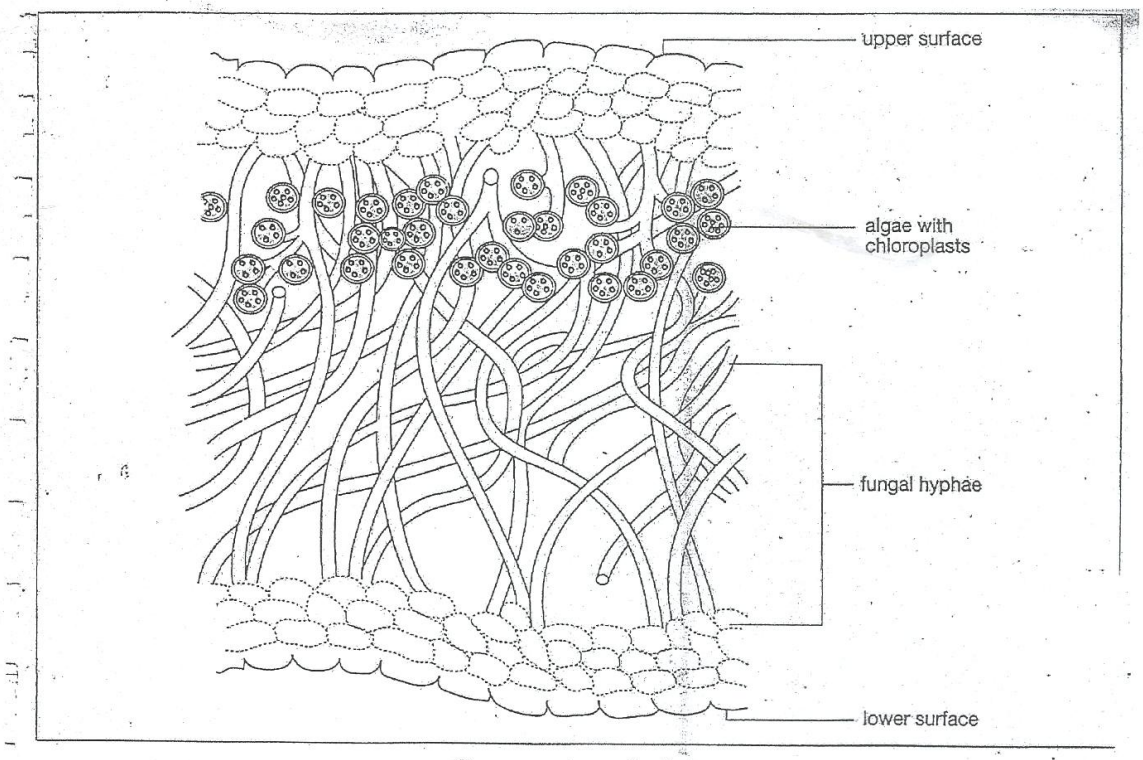
(i) explain the term associations;

(ii) state the three groups of the association – beneficial, harmful and neutral; and

(iii) list the various forms – symbiosis, parasitism and commensalisms

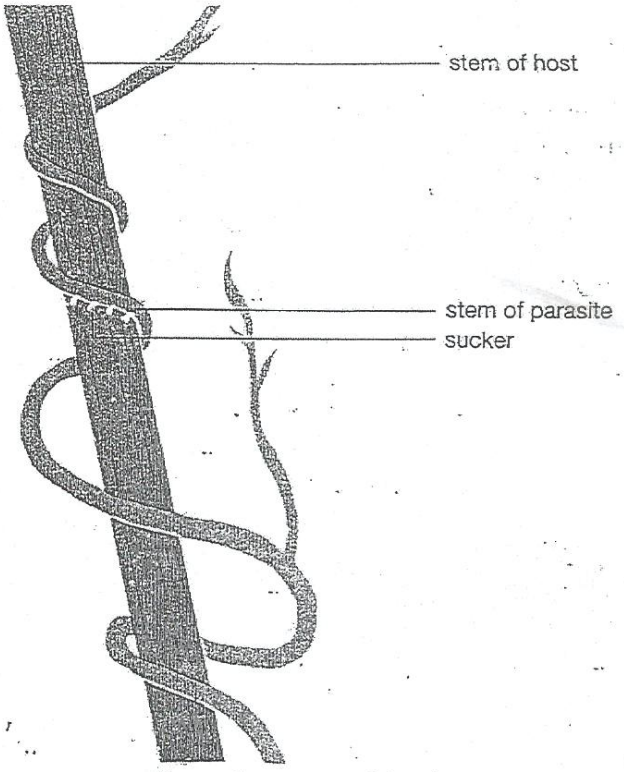
Teacher's Activity	**Students' Activity**	**Strategy**
Step I : Teacher asked questions based on the previous lesson (i) What is a food chain/web? (ii) What is an ecosystem? (iii) What are aquatic factors that affect organism in their habitat?	Students respond with answers and where they are incorrect, the teacher lead them with hints and prompts to the answer	Question and answer
Step 2: Teacher introduced the lesson through lecture method. The teacher explains the term associations and the types and list the various types under study.	Students listen to the explanation and illustrations	Explanation presentation
Step 3: Students are put into their groups. They are given study material and the activity work. Teacher goes round to see whether they are doing the right thing and guide them where they are not.	Students sit according to their groups and discuss the study material and work on the Activity 5. from the picture A (cross-section of a lichen). (i) Identify the two different species in the association What type of association? Picture B (Cassytha (a parasitic plant) on a host plant (ii) Identify the two organisms (iii)What type of association?	Guided practice Hard and soft scaffold.

	Picture C (Remora fish and Shark) (i) What type of association? (ii) Which organisms benefit? (iii) What happens to the other organism (host)? (iv) Name the two organisms. **Picture D:** (Hermit Crab and sea Anemone) (i) What type of association? (ii) Identify and name the two organisms. **E.** Give 2 examples of the association in which one known as the parasite lives in or on and feeds at the expense of the other organism known as the host	
Step 4: Scaffolds are withdrawn (fading). Students return to their seats. There is class discussion of students' activity work.	Students respond by answering the questions to the activity.	Guided practice Independence practice
Step 5: The teacher asks questions to test the understanding of the students on the lesson. Where there are inappropriate or incorrect answers the teacher corrects (Evaluation).	Students get feedback from the teacher to affirm the correct answers and correct the wrong ones	Independent practice Re-teaching and lesson closely.

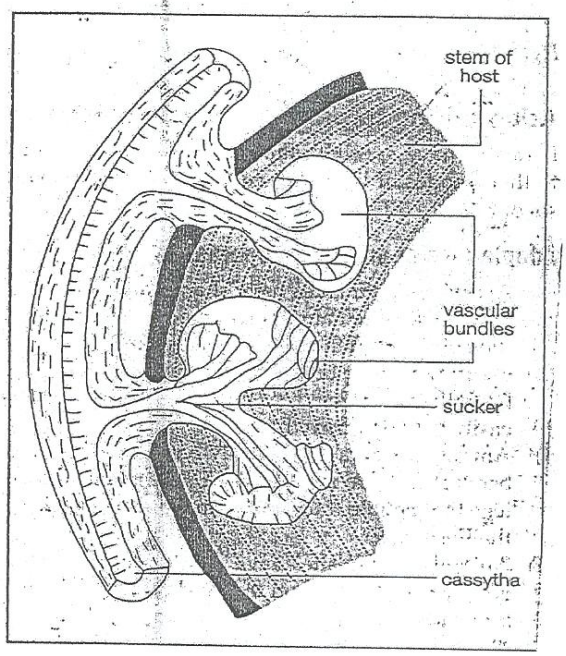


Cross-section of a lichen

New Edition Senior Secondary I.F.O.C. Ndu; P. Asun; J.O. Aina



Cassytha, a parasitic plant

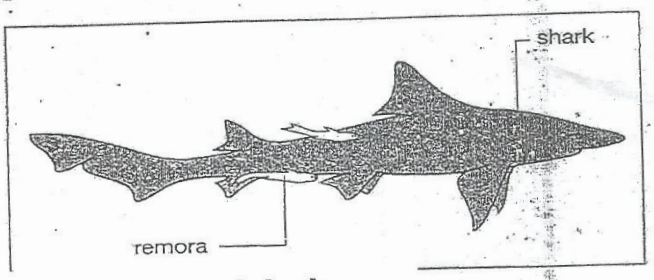


Cassytha, haustoria in host

Source: New Edition Senior Second I, F.O.C. Ndu; P. Asun; J.O. Aina

(a) Remora and shark

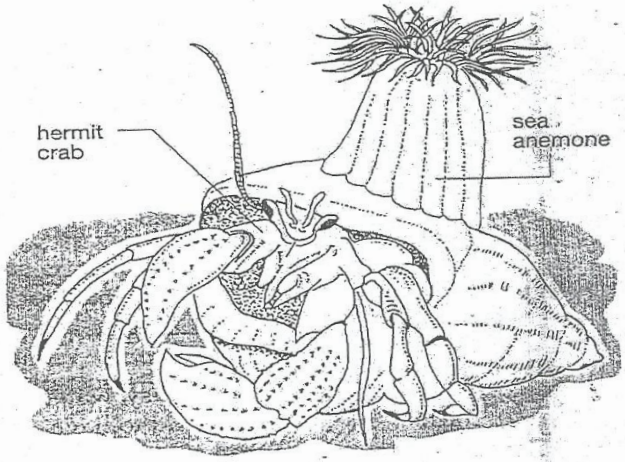
Remora is a small fish that attaches itself to the body of the carnivorous sea fish known as shark. Remora feeds on small pieces of food left over after the shark has eaten its prey. So far as can be seen, the shark does not suffer a disadvantage by the presence of the remora.



Remora and shark

(b) Man and intestinal bacteria

Some bacteria in the large intestine of man feed on undigested food there. The bacteria receive food and protection from the man. So far as can be seen, man neither gains nor suffers any disadvantage from the presence of the bacteria.



Hermit crab and sea anemone

Specimens of hermit crab (live or preserved).

Procedure

1 Observe a hermit crab.
2 Draw a hermit crab in your practical notebook.

New Edition Senior Secondary 1. F.O.C. Ndu; P. Asun; J.O. Aina

Experimental Group – Lesson Plan VI

Class: SSII

Subject: Biology

Topic: Ecological Succession

Duration: 1 Hr 20 mins.

Instructional Materials: Pictorial Materials Organisms in a Habitat

Previous Knowledge: The students have been taught – habitat, population and ecological factors.

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

(i) explain the term associations;

(ii) state the three groups of the association – beneficial, harmful and neutral; and

(iii) list the various forms – symbiosis, parasitism and commensalisms.

Teacher's Activity	Students' Activity	Strategy
Step I : Teacher asked questions based on the previous lesson (i) What is a food chain/web? (ii) What is an ecosystem? (iii) What are aquatic factors that affect organism in their habitat?	Students respond with answers and where they are incorrect, the teacher lead them with hints and prompts to the answer	Question and answer
Step 2: Teacher introduced the lesson through lecture method. The teacher explains the term associations and the types and list the various types under study.	Students listen to the explanation and illustrations	Explanation presentation
Step 3: Students are put into their groups. They are given study material and the activity work. Teacher goes round to see whether they are doing the right thing and guide them where they are not.	Students sit according to their groups and discuss the study material and work on the Activity 5. from the picture A (cross-section of a lichen). (i) Identify the two different species in the association What type of association? Picture B (Cassytha (a parasitic plant) on a host plant (ii) Identify the two organisms (iii)What type of association? Picture C (Remora fish and Shark) (i) What type of association?	Guided practice Hard and soft scaffold.

	(ii) Which organisms benefit? (iii) What happens to the other organism (host)? (iv) Name the two organisms. **Picture D:** (Hermit Crab and sea Anemone) (i) What type of association? (ii) Identify and name the two organisms. **E.** Give 2 examples of the association in which one known as the parasite lives in or on and feeds at the expense of the other organism known as the host	
Step 4: Scaffolds are withdrawn (fading). Students return to their seats. There is class discussion of students' activity work.	Students respond by answering the questions to the activity.	Guided practice Independence practice
Step 5: The teacher asks questions to test the understanding of the students on the lesson. Where there are inappropriate or incorrect answers the teacher corrects (Evaluation).	Students get feedback from the teacher to affirm the correct answers and correct the wrong ones	Independent practice Re-teaching and lesson closely.

5. **Seral communities** are large in number depending on minor differences in edaphic, topographic and other local conditions. Seral communities are therefore short lived and quick in development. The Sere is the entire sequence of temporary communities from the pioneers stage to the final stage or climax community.
6. **Climax communities** are formed after a long period of time and once formed they maintain their structure and composition.

Primary succession

The occupation by plants of an area not previously covered by vegetation is known as primary succession. Bare rocks and cliffs are common sites of primary succession. The first stage in such area is the formation of soil. The solid rocks are broken down by weathering processes such as freezing and thawing or heating and cooling, which cause substance in the rocks to expand and contract, thus splitting the rock apart. Water and wind help in breaking the fragmented rocks into smaller particles. Water enters between the particles and soluble materials such as rock salts dissolve in water. Water in combination with carbon (IV) oxide from the air forms a mild acid which dissolves substances by chemical reactions. Ultimately rocks disintegrate and soil is formed. Bacteria, fungi, algae and lichen inhabit the soil. These organisms are called **pioneers**. The death of the pioneers adds some organic matter to the soil. Algae and mosses now inhabit the land. Mosses and algae die adding more humus to the soil. Ferns and grasses now inhabit the soil. These ferns and grasses further breakdown the rock and more humus added. Shrubs move in and eventually trees. At this stage a dominant species of tree takes over the population making the environment for itself and unsuitable for other species. Tall trees for example cast shade for smaller plants. Those plants which are shade loving thrive well while those that do not like shade die off. The stage of tall and shady trees is regarded as **climax community**.

Another example of primary succession is an estuary with a high salt content and is flood twice daily. The pioneer colonizers of an estua are the red mangrove (*Rhizophora spp*). They c tolerate high salinity level, have seeds which gerr inate on the parent plants before landing on tl mud and continue to grow there. They fix ther selves in the mud and grow to tall trees with st roots. The roots form a raft which accumulat soil particles from the water and thus raise th banks. This red mangrove is followed towarc land side by white mangrove, (*Aviccenia spp* which grow on more stable and high land. Alon with these are some herbaceous plants such a *Drepanocarpus punatus*, *Hibiscus* species an *Acrsticum aureus*. With the death and decay c these plants, and accumulation of organic matter more stable soil is formed on which a normal for est flora will soon develop and thus giving climax community. The first set of animals whicl will colonize the mangrove swamps are species o insects, mud skippers, *Pila leopoldvillensis*, *Pila glauca*, *Lymnaea peregra* and crabs. In the regior of white mangroves, animals such as squirrels, rats, snakes and their predators are commonly found.

Primary succession in aquatic habitat (e.g pond)

Pond succession

At first, the pond is only a basin of water. Micro-scopic plants and animals such as bacteria, algae and protozoa soon inhabit the water. These are the pioneers. Seeds of plants and eggs of aquatic animals are brought to the pond by the feet of visiting birds. Some insects fly to the pond and some animals travel to the water. The pond starts supporting hydroids, molluscs, fish, amphibians and aquatic reptiles.

Submerged plants and floating plants begin to grow in the pond. The edge of the pond is inhabited by plants. This is submerged and floating vegetation stage.

The death of some plants and animals starts building up organic matter in the bottom of the pond and around the edges of the pond. The pond

now gets smaller and shallower. Terrestrial plants begin to grow towards the centre of the pond as organic matter builds up. Various mammals and birds visit the edges of the pond. This is the **temporary pond stage.**

Finally the whole pond is filled with organic matter. **Shrubs** and trees appear and eventually, a **forest stage (climax stage)** is reached.

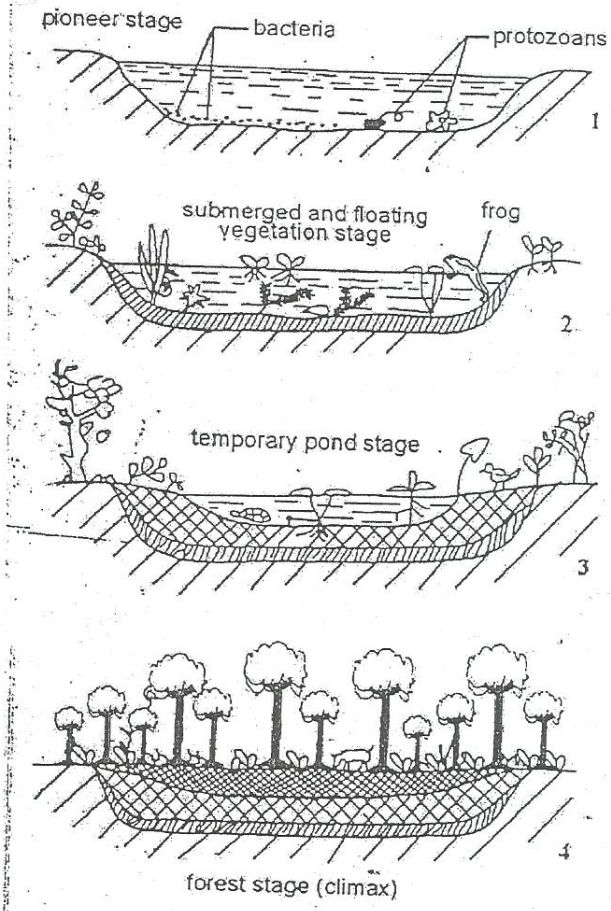


Figure 23.51. Different stages in pond succession.

Primary succession in terrestrial habitat (e.g. abandoned farmland)

First stage

In an abandoned farmland, the pioneers (first colonizers) are weeds, underground stems, seeds of plants, eggs and larvae of insects and worms. These pioneers derive their food from the left over nutrients of the old farm. Animals such as mice, rats and cane rats can now visit this vegetation to feed on grasses. Snakes and lizards are also found.

Second stage

In the second stage, seeds start to germinate, underground stems such as cocoyams grow up, grasses and weeds (shrubs) increase in population. Eggs and larvae of insects hatch and grow into adult insects. Worms increase in population. The vegetation can now provide a suitable habitat for rodents (mice, rabbits, cane rats).

Third Stage

In the third stage, weeds and grasses (herbs) are gradually being replaced by shrubs. More animals visit the habitat.

Fourth Stage

Trees now grow to replace the shrubs. Creeping plants increase. Birds, reptiles (such as snakes and lizards) and various mammals inhabit the various strata of the habitat. Species diversity is thus increased.

Climax stage (stable community)

Trees grow to very tall heights in an attempt to get light forming a forest canopy. Small trees die off due to lack of light resulting from the canopy. Plant climbers increase. A lot of leaves fall to the ground which decay and form food for detritus feeders such as snails and millipedes. Therefore, the activities of detritus feeders increase. The animal community now includes herbivorous, carnivorous, omnivorous and detritus feeders. A complex food web is now established.

Secondary succession

When succession occurs on a site previously occupied by a vegetation, it is called a secondary succession. Secondary succession occurs on areas laid bare by man such as abandoned farmland, and strip mines and road sides. Such an open area is bombarded by the seeds of numerous plants and is captured by those that can germinate most rapidly. The example of this type of succession has been discussed under terrestrial succession which is that of an abandoned farmland.

Climax of succession: A **climax community** is the end product of the succession of several seral communities over a long period at one place. Once the climax community is established it may remain indefinitely. The climax community is regarded as **steady state** which has restored the community structure towards steady state.

Types of climax communities

1. The **edaphic climax** results from soil characteristics, as in salt marshes, hill tops, ridge summits, sea coast and sand dunes.
2. The **fire climax** as a consequence of periodic burning, for example savanna in Africa.
3. The **biotic climax** is due to the activities of living things. It is infact an example of retrogressive succession . For example grasslands which are frequently grazed by animals are likely to remain grassland climax unless grazing is prevented and grassland allowed to mature to a climax community.
4. **Topographic climax** is due to local topography like slope, exposure to dry winds etc.

Characteristics of a stable ecosystem

1. It is generally believed that once the climax is attained, the community does not change at all, but this is not exactly so. Climax community changes due to aging. The climax community is heterogeneous.
2. The climax community depends on the broad climate of the region and thus in a state of **dynamic equilibrium** with the climate and is self sustaining. Example of climaxes are the tropical rain forest, the woodland, savannas and deserts.
3. Climax ecosystem has numerous microhabitats which are inhabited by different types of organisms.
4. Climax community does contain many sub-communities. For example, in a low land rain forest, the typical mature forest shows 4-5 layered or stratification of trees each layer supporting different types of epiphytes and animals.

Differences between competition and succession

Competition	Succession
1. Starts when resources are in short supply in a habitat.	Usually starts with new habitats.
2. Occures in all places inhabited by organisms.	Occurs only in a particular area.
3. The replacement of an old population by a new population is due to interspecific competition	Old polpulation is gradually being replaced with new dorminant polpulation.
4. Competition has no end, it continues in a stable or climax community.	Succession ends when a stable or climax community has been attained.
5. Competition speeds up succession. No competition, no succession.	Succession provides basis for competition.
6. The replacement of one population by another in a given environment in competition is due to survival of the fittest.	In succession, the replacement of one population by another in a particular area is transitory and it leads to climax or stable community.

APPENDIX IV

LESSON PLAN FOR CONTROL GROUP
Lesson Plan 1

Class: SSII

Duration: 1 Hr 20 Mins

Subject: Ecology

Instructional Materials: Charts Showing Different Habitats

Previous Knowledge: Students have been taught the meaning of ecology

Topic: Basic Ecological Concepts

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

(i) define ecology;

(ii) explain the term habitat, population, biotic community, hydrosphere, ecological niche, atmosphere, environment with examples; and

(iii) state the different types of habitat.

Introduction

Teacher asked questions on the past lesson such as:

What is ecology?

What is the importance of ecology?

Presentation

Step 1: The teacher explains the meaning of the concepts listed above with examples

II. Teacher shows the diagrams of some of the concepts

Evaluation

The teacher asks the students some questions on the topic:

(i) Define the term habitat

(ii) List the types of habitats with examples

(iii) Explain the following terms biosphere, environment, population, atmosphere, hydrosphere.

Summary

The teacher recapitulates the lesson and states the examples.

Assignment

Students to list the types of habitat with examples.

Lesson Plan II: Control Group

Class: SSII

Duration: 1 Hr 20 Mins

Subject: Biology

Instructional Materials: Charts showing different biomes

Topic: Classification of Ecological Factors

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

(i) state the interrelationships between living things and their environment;

(ii) state that habitat is defined by ecological factors which are present there;

(iii) list the aquatic habitats – marine, brackish, fresh water;

(iv) list the terrestrial habitats arboreal, ground and underground;

(v) state ecological factors terrestrial habitats – climatic (e.g. rainfall, light, wind), topography and edaphic factors;

(vi) state ecological factors in aquatic habitats – rainfall, speed of flow, salinity, turbidity and pH;

(vii) state features of organisms which fit them for life in particular habitats; and

(viii) list types of biomes, local biomes in Nigeria or West Africa.

Previous Knowledge

The students have been taught some basic ecological terms.

Introduction

The teacher asked questions on the past lesson such as:

Explain he term habitat

Mention the three types of habitat with examples

Presentation

Step 1

The teacher explains the term ecological factors.

Step II:

The teacher explains the ecological factors common to all habitats.

Step III

State the ecological factors in aquatic habitat.

Step IV:

Explain the term adaptation.

Evaluation

The teacher asks question on the topic:

What are the factors that defined the habitat called?

List the types of aquatic and terrestrial habitat.

What are the ecological factors that affect the habitats named above?

Assignment

Draw the following instruments. – Wind vane, anemometer, raingauge, section disc, photometer and label them.

Lesson Plan III: Control Group

Class: SSII

Duration: 1 Hr 20 Mins

Subject: Biology

Instructional Materials: Pictorial Charts of Organisms in an Ecosystem

Topic: The Functioning Ecosystem

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

(i) state the component of an ecosystem;

(ii) state that an ecosystem is a community made up of producers, consumers and decomposers;

(iii) define a food chain and web;

(iv) explain that the number of individuals in a food chain decreases from the trophic level to another which gives rise to a pyramid of numbers;

(v) state that organisms derive energy from the food they eat; and

(vi) state that populations of different organisms are found together in ecosystems.

Previous Knowledge

The students have been taught about ecological factors that affect different habitats.

Introduction

The teacher asked questions on the past lesson such as:

(i) Name the three types of habitat.

(ii) List the types of terrestrial habitat

(iii) What are the ecological factors that affect the aquatic habitats?

Presentation

Step 1

The teacher explains the component of the ecosystem.

II. The teacher added that an ecosystem is a community of producers, consumers and decomposers

III. Define a food chain and food web with examples

IV. He explains the trophic level that gives rise to a pyramid of number

V. The teacher explains that organisms derive energy from the food they eat.

VI. The teacher also explains that populations of different organisms are found together in ecosystems

Evaluation

The teacher asks questions on the lesson to assess the understanding of the students such as:

i. What are the components of the ecosystem?

ii. Explain found chain with example

iii. What is the difference between food chain and food web?

iv. How did the organism get their energy?

Assignment

1. Students to draw a pyramid of number based on the following organisms: Green plants, grasshopper lizards, snakes and hawks.
2. Write an example of food chain in aquatic habitat.

Lesson Plan IV: Control Group

Class: SSII

Duration: 1 Hr 20 Mins

Subject: Biology

Topic: Population Studies

Instructional Materials: Pictorial Mateirals for Collecting Living Organisms for study – Pooter, sweep net, plankton net, Tullgren, funnel, maize, marker, milk tins

Previous Knowledge: The students have been taught habitat, ecosystem and ecological factors affecting the habitats

Topic: Population studies

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

(i) define population;

(ii) state the different techniques of determining the population size of species; and

(iii) determine the population size of maize

Introduction

The teacher asked questions based on the previous lesson as:

(i) What is an ecosystem?

(ii) Mention the community of ecosystem.

(iii) How did organisms derive their energy.

Presentation

i. Teacher explained the term population and the different methods of determining the population size – complete total count, sampling, capture, marked, release. – recapture method, transect method.

ii. Teacher explains the procedure to determine the population size of maize grain by demonstration.

iii. The teacher also enumerates the factors that affect populations – predation, availability of food and density.

iv. The teacher will also mention the parameters of a population – size, dominance, distribution and density.

Evaluation

The teacher will assess the understanding of the lesson by asking some of the following questions:

i. What are the different methods of determining the population size?

ii. List the factors that affect population

iii. What are the parameters of a population?

Assignment

Write the procedure of determining the population of maize by capture, marked, release and recapture method.

Lesson Plan V: Control Group

Class: SSII

Topic: Ecology Associations

Duration: 1 Hr 20 Mins

Subject: Biology

Instructional Materials: Pictorial Materials of Organism in a Habitat

Topic: Associations

Previous Knowledge: The students have been taught about environment, habitat, population and ecological factors.

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

(i) recognize the different type of association that exist between different species of organisms;

(ii) recognize that living things have adaptations in response to environmental factors; and

(iii) recognize that the availability of water is the principal factor for the distribution of plants and animals.

Introduction

The teacher asked questions based on the last topic such as:

i. Mention the different methods of determining the population size.

ii. What are the factors that affect population?

Presentation

The teacher explains the term association that exist between different species of organisms

II. The teacher went on to stress further that in a community there are different kinds of close relationships between organisms of different species.

III. The teacher adds that some of these associations are beneficial, some are harmful and some are neutral.

IV. These associations include symbiosis, parasitism and commensalisms.

Evaluation

The teacher will assess the understanding of the lesson by asking some of the following questions:

i. What is the term association mean in relation to existence of different species of organisms?

ii. Mention the association that are beneficial, harmful and neutral.

Assignment

Draw the diagram representing the association of alga and fungus.

Lesson Plan VI: Control Group

Class: SSII

Subject: Biology

Topic: Ecological Succession

Duration: 1 Hr 20 Mins

Instructional Materials: Pictorial Materials of Succession in a Pond

Topic: Ecological Succession

Previous Knowledge:

The students have been taught about organisms in the habitat and their interactions.

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

(i) define the term succession;

(ii) mention types of succession;

(iii) state major characteristics of succession;

(iv) explain stages of succession in a pond and an abandoned farmland;

(v) state features of a climax stage or stable community;

(vi) describe the process of succession in a pond; and

(vii) state the differences between primary and secondary succession.

Introduction

The teacher asked questions on the last lesson such as:

(i) Mention the different methods of determining the population size.

(ii) What are the factors that affect population size?

Presentation

The teacher explains the term succession

II. The teacher added further by mentioning the types of succession

III. The teacher listed the characteristics of succession

IV. The teacher explains the process of succession in a pond.

V. The teacher states the differences between primary and secondary succession.

Evaluation

The teacher asks the following questions to assess the understanding of the lesson.

i. Explain the term succession

ii. State the characteristics of succession.

iii. Describe the process of succession in a pond.

iv. State the differences between primary and secondary succession.

Summary

The teacher recapitulates the lesson and states the differences between primary and secondary succession.

Assignment

Students to describe the stages of succession with label diagrams.

APPENDIX V

ATTITUDE TO ECOLOGY QUESTIONNAIRE (AEQ)

Dear Respondent,

Below is a list of item designated by PhD student to examine the degree of students' attitude in Ecology concepts of SS II students. You are requested to freely rate yourself to indicate the extent to which the questionnaire items are interesting to you or not.

Be informed that information provided will be used strictly for this research only and will be treated with outmost confidence.

SECTION A: BIO DATA

Name of Institution

Gender: Male [ ] Female [ ]

Age

SECTION B: ATTITUDE TO ECOLOGY QUESTIONNAIRE

Please take note of the following keys to guide your response

SA Strongly Agree

A Agree

U Undecided

D Disagree

SD Strongly Disagree

	Items	**SA**	**A**	**U**	**D**	**SD**
1.	I do not like Biology teaching involving Ecology.					
2.	I like listening to my teaching on the concept of ecology.					
3.	I find Ecology concept of Biology very significant always.					
4.	I do not like Biology teaching lectures or any concept of it.					
5.	I always like to call my teacher whenever it is Ecology lesson.					
6.	I do not like to be present in class whenever it is Ecology.					
7.	The study of Ecology and its concept is useful in one's career.					

8.	I will like to pursue Biology related course in my higher degree.					
9.	My parent force me to study Ecology but I did not like it.					
10.	I like telling my friends and parents the relevance of Ecology concepts to mankind.					
11.	Studying Ecology concepts is difficult.					
12.	I always volunteer to tell my friends in school the relationship of plants and animals with their non-living environments.					
13.	I approach Ecology with a feeling of hesitation.					
14.	Ecology makes me feel uncomfortable, restless, irritable and impatient.					
15.	Ecologists have discovered that many plants and animals produce chemicals that protect them from predators and diseases.					
16.	Ecology gives an opportunity to meet some of the most important ecological issues affecting the environment.					
17.	Ecology is fascinating and fun.					
18.	Ecology is a centre of unifying principle of Biology.					
19.	Ecology concepts have important applications to other areas of Biology.					
20.	Teaching and learning about Ecological concepts have immense practice value to mankind.					

APPENDIX VI

RELIABILITY COEFFICIENT OF THE INSTRUMENT (ECPT)

Pearson Product Moment Correlation Computed for the Reliability index for the Instrument used in the Pilot Study of the research.

The formula for Pearson Moment Correlation is given below:

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

N - Number of respondents

X is test scores at first administration

Y is test scores at second administration

ΣX is scores at first administration is summed

ΣY is scores at second administration is summed

Σx^2 is scores at first administration is squared and summed

ΣY^2 is scores at second administration is squared and summed

$(\Sigma x)^2$ is scores at first administration is summed and squared

$(\Sigma y)^2$ is scores at second administration is summed and squared

Where:

N=30	ΣX = 264	ΣY=279	ΣX2-2470	ΣY2=2789	ΣXY=2517

Pearson Product Moment Correlation Formula is:

$$r = \frac{N\left(\sum XY\right) - \sum X \sum Y}{\sqrt{\left[N\sum X^2 - \left(\sum X\right)^2\right]\left[N\sum Y^2 - \left(\sum Y\right)^2\right]}} = \frac{30 \times 2517 - 264 \times 279}{\sqrt{\left[30 \times 2470 - 264^2\right]\left[30 \times 2789 - 279^2\right]}}$$

r = 0.884

APPENDIX VII

ITEM ANALYSIS OF ECPT TEST ITEMS

S/NO	A.F.I = $\frac{U + L}{N}$	$D_1 = \frac{Ru - Ri}{\frac{1}{2}N}$
1	0.60	0.54
2.	0.68	0.57
3.	0.70	0.67
4.	0.58	0.54
5.	0.45	0.51
6.	0.67	0.54
7.	0.68	0.64
8.	0.71	0.66
9.	0.65	0.58
10	0.81*	0.70
11.	0.65	0.83
12.	0.70	0.56
13.	0.58	0.65
14.	0.59	0.70
15	0.59	0.45
16.	0.69	0.70
17.	0.65	0.56
18.	0.67	0.67
19	0.43	0.70
20	0.17*	0.69
21	0.66	0.64
22.	0.58	0.65
23.	0.70	0.62
24.	0.77*	0.61
25.	0.52	0.42
26.	0.54	0.54
27.	0.67	0.65
28.	0.58	0.66
29.	0.65	0.55
30.	0.62	0.54
31.	0.65	0.56
32.	0.70	0.68
33.	0.65	0.67
34.	0.82*	0.45
35.	0.55	0.63
36.	0.64	0.65
37.	0.70	0.59
38.	0.58	0.51
39	0.67	0.61
40	0.67	0.62

APPENDIX VIII

RAW SCORES OF THE TWO SETS OF TESTS FOR DETERMINING THE COEFFICIENT OF RELIABILITY OF THE TEST INSTRUMENT

S/NO.	X	Y	X^2	Y^2	XY
1.	8	7	64	49	56
2.	7	10	49	100	70
3.	13	11	169	121	143
4.	7	9	49	81	63
5.	7	8	49	64	56
6.	8	13	64	169	104
7.	10	7	100	49	70
8.	8	7	64	49	56
9.	5	8	25	64	40
11.	10	12	100	144	120
12.	8	10	64	100	80
13.	9	9	81	81	81
14.	8	10	64	100	80
15.	9	9	81	81	81
16.	8	9	64	81	72
17.	9	8	81	64	72
18.	12	12	144	144	144
19.	8	15	64	225	120
20.	7	5	49	25	35
21.	6	6	36	36	36
22.	8	7	64	49	56
23.	11	13	121	169	143
24.	7	6	49	36	42
25.	16	13	256	169	208
26.	8	8	64	64	64
27.	8	8	64	64	64
28.	11	9	121	81	99
29.	7	13	49	169	91
30.	11	5	121	25	55
31.	8	10	64	100	80
32.	10	10	100	100	100
N=30	$\Sigma X=264$	$\Sigma X=279$	$\Sigma X^2=2470$	$\Sigma X^2=2789$	$\Sigma XY=2517$

Note: x and y are first and second tests scores for early childhood education pupils

APPENDIX IX

RELIABILITY RESULT OF AEQ

Case Processing Summary

		N	%
Cases	Valid	40	100.0
	Excluded[a]	0	.0
	Total	40	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.752	.706	14

Item Statistics

	Mean	Std. Deviation	N
Question 1	4.4750	.55412	40
Question 2	1.6000	.74421	40
Question 3	1.7000	.85335	40
Question 4	4.4000	.59052	40
Question 5	3.0750	.97106	40
Question 6	1.8750	1.13652	40
Question 7	4.0500	1.08486	40
Question 8	1.6500	.73554	40
Question 9	2.6000	1.19400	40
Question 10	4.5000	.55470	40
Question 11	4.2500	.70711	40
Question 12	2.3750	1.12518	40
Question 13	4.2500	.77625	40
Question 14	4.2750	.84694	40

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Covariances	.003	-.353	.365	.718	-1.036	.024	14
Inter-Item Correlations	.018	-.468	.556	1.024	-1.187	.059	14

APPENDIX VIII

RELIABILITY RESULT OF AEQ

Case Processing Summary

		N	%
Cases	Valid	40	100.0
	Excluded[a]	0	.0
	Total	40	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.752	.706	14

Item Statistics

	Mean	Std. Deviation	N
Question 1	4.4750	.55412	40
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Question 6	1.8750	1.13652	40
Question 7	4.0500	1.08486	40
Question 8	1.6500	.73554	40
Question 9	2.6000	1.19400	40
Question 10	4.5000	.55470	40
Question 11	4.2500	.70711	40
Question 12	2.3750	1.12518	40
Question 13	4.2500	.77625	40
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Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
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Inter-Item Correlations	.018	-.468	.556	1.024	-1.187	.059	14

APPENDIX X

STATISTICAL ANALYSIS OF THE DATA

Oneway

Descriptives

All school score

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
School A - GSS Basawa	37	11.3514	3.27631	.53862	10.2590	12.4437	6.00	18.00
School B - GSS Giwa	39	18.9231	4.03527	.64616	17.6150	20.2312	13.00	26.00
School C - GSS Jama'a	32	22.7500	4.07985	.72122	21.2791	24.2209	15.00	32.00
School D - GDSS Kwangila	36	22.9167	4.50000	.75000	21.3941	24.4392	16.00	34.00
School E - GSS Muchia	37	21.6757	4.27560	.70290	20.2501	23.1012	16.00	34.00
Total	181	19.4088	5.91126	.43938	18.5418	20.2758	6.00	34.00

ANOVA

All school score

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3401.686	4	850.422	51.825	.000
Within Groups	2888.060	176	16.409		
Total	6289.746	180			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: All school score

Scheffe

(I) SCHOOL GROUP	(J) SCHOOL GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
School A - GSS Basawa	School B - GSS Giwa	-7.57173*	.92965	.000	-10.4659	-4.6775
	School C - GSS Jama'a	-11.39865*	.97790	.000	-14.4430	-8.3543
	School D - GSS Aminu	-11.56532*	.94832	.100	-14.5176	-8.6130
	School E - GSS Muchia	-10.32432*	.94180	.090	-13.2563	-7.3923
School B - GSS Giwa	School A - GSS Basawa	7.57173*	.92965	.000	4.6775	10.4659
	School C - GSS Jama'a	-3.82692*	.96620	.004	-6.8349	-.8189
	School D - GSS Aminu	-3.99359*	.93625	.210	-6.9083	-1.0789
	School E - GSS Muchia	-2.75260	.92965	.072	-5.6468	.1416
School C - GSS Jama'a	School A - GSS Basawa	11.39865*	.97790	.000	8.3543	14.4430
	School B - GSS Giwa	3.82692*	.96620	.330	.8189	6.8349
	School D - GSS Aminu	-.16667	.98418	.400	-3.2306	2.8973
	School E - GSS Muchia	1.07432	.97790	.877	-1.9701	4.1187
School D - GSS Aminu	School A - GSS Basawa	11.56532*	.94832	.000	8.6130	14.5176
	School B - GSS Giwa	3.99359*	.93625	.002	1.0789	6.9083
	School C - GSS Jama'a	.16667	.98418	.210	-2.8973	3.2306
	School E - GSS Muchia	1.24099	.94832	.788	-1.7113	4.1933
School E - GDSS Kwangila	School A - GSS Basawa	10.32432*	.94180	.000	7.3923	13.2563
	School B - GSS Giwa	2.75260	.92965	.002	-.1416	5.6468
	School C - GSS Jama'a	-1.07432	.97790	.007	-4.1187	1.9701
	School D - GSS Aminu	-1.24099	.94832	.788	-4.1933	1.7113

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

Homogeneous Subsets

All school score

Scheffe

SCHOOL GROUP	N	Subset for alpha = 0.05		
		1	2	3
School A - GSS Basawa	37	11.3514		
School B - GSS Giwa	39		18.9231	
School E - GSS Muchia	37		21.6757	21.6757
School C - GSS Jama'a	32			22.7500
School D - GSS Aminu	36			22.9167
Sig.		1.000	.085	.792

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 36.043.

b. The group sizes are unequal. The harmonic mean of the group sizes is used.

Type I error levels are not guaranteed.

Hypothesis One

Group Statistics

	Group ret	N	Mean	Std. Deviation	Std. Error Mean
Post test Mean performance	Scaf	73	22.55	3.85815	.41611
	Lecture	66	18.19	3.10901	.30414

Independent Samples Test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Post test Mean performance	Equal variances assumed	6.437	137	.0001	6.36101	.57369	4.31158	7.55715

Hypothesis Two

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Scaffolding Instructional Strategy	Male	30	17.3233	3.1764	.77003
	Female	43	16.9416	2.8318	.51808

Independent Samples Test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Scaffolding Instructional Strategy	Equal variances assumed	1.248	71	.805	.22171	.89304	-1.55896	2.00237

Hypothesis Three

Group Statistics

	Group ret	N	Mean	Std. Deviation	Std. Error Mean
Retn	Scaf	73	22.1918	3.88250	.45441
	Lecture	66	16.2273	2.71064	.33366

Independent Samples Test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Retn	Equal variances assumed	10.397	137	.000	5.96451	.57369	4.83007	7.09895

Hypothesis four

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Scaffolding Instructional Strategy	Male	30	21.6333	3.76447	.68730
	Female	43	21.1814	3.95951	.60382

Independent Samples Test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Scaffolding Instructional Strategy	Equal variances assumed	1.027	71	.308	-.94806	.92324	-2.78895	.89282

Hypothesis Five

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Scaffolding Instructional Strategy	73	3.5616	1.09273	1.00	5.00
Lecture method	66	4.0606	1.12152	1.00	5.00

Ranks

		N	Mean Rank	Sum of Ranks
Lecture method - Scaffolding Instructional Strategy	Negative Ranks	17[a]	23.44	398.50
	Positive Ranks	32[b]	25.83	826.50
	Ties	17[c]		
	Total	66		

Test Statistics[a]

	Lecture method - Scaffolding Instructional Strategy
Z	2.183[b]
Asymp. Sig. (2-tailed)	.02

Hypothesis Six

Ranks

	Group	N	Mean Rank
KRU	Male	30	29.20
	Female	43	42.44
	Total	73	

Test Statistics[a,b]

	KRU
Chi-Square	7.46
df	1
Asymp. Sig.	0.01

Department of Science Education

FACULTY OF EDUCATION

AHMADU BELLO UNIVERSITY, ZARIA

Vice Chancellor: ***Professor Ibrahim Garba*** *B.Sc, M.Sc(ABU) Ph.D DIC (London), FNMGS*

Head of Department: ***Professor S.S. Bichi*** *NCE, B.Ed, M.Ed, PhD(ABU) AKC. Lond.*

Your Ref:
Our Ref: DSE/VRI/Vol.1

Date 16TH May, 2017

Dear sir/Madam,

VALIDATING RESEARCH INSTRUMENT

This is to introduce the bearer Janet Adesola Sangowawa with the registration number Ph.D/EDU/4017/2011-2012 as one of our Ph.D. Science Education students.

The above postgraduate student is about to go for pilot testing and pre-data seminar. She has an instrument for validation on a study topic: **Impact of Scaffolding Strategy on Attitude, Retention and Performance in Ecology among Senior Secondary School of Zaria, Kaduna, Nigeria.**

The instrument is for you to study and validate accordingly

The objective of the study, the research questions and hypotheses are attached herewith for your reference.

Thank you.

Yours Faithfully

Prof. M.A Lakpini

Student's Supersvisor