IMPACT OF SCIENC-TECHNOLOGY-SOCIETY (STS) INSTRUCTION ON PERFORMANCE AND RETENTION OF ECOLOGY CONCEPTS AMONG SLOW LEARNERS IN SECONDARY SCHOOLS, KADUNA, STATENIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN SCIENCE EDUCATION

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AUGUST, 2016

DECLARATION

I Maryam Garba Abdullahi (M.ED/EDUC/47383/12-13) declare that the work in this dissertationentitled "**Impact of Science-Technology-Society (STS) Instruction on Performance and Retention of Ecology Concepts among Slow Learners in Secondary Schools, Kaduna State,Nigeria"** has been carried out by me in the Department of Science Education. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was presented previously for another degree or diploma at this or any other institution.

Maryam GarbaABDULLAHI	**Signature**	**Date**

CERTIFICATION

This dissertation entitled **"Impact of Science-Technology-Society (STS) Instruction on Performance and Retention of Ecology Concepts among Slow Learners in Secondary Schools, Kaduna State, Nigeria"** by Maryam Garba ABDULLAHI, meet the regulations governing the award of the degree of Masters in 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 father Engr. Garba Abdullahi for his deeming efforts in seeing that I accomplished this milestone. May Allah grant you His Mercy and His Jannah.

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ABBREVIATIONS USED

SSS: Senior Secondary School

MLT: Mastery Learning Theory

WAEC: West African Examination Council

FME: Federal ministry of education

EE: Environmental Education

EG: Experimental Group

CG: Control Group

BPT: Biology Performance Test

OPERATIONAL DEFINITION OF TERMS

Slow Learners:in this study refers to those who achieved below 50% in successive tests or examinations, but do not have any learning disability.

Active Learning:thisrefersto learners actively involved in the lesson being taught to them.

STS Instructional Strategy: this is a method of instruction that is basically student centred and activity oriented. It encourages students to interact with each other and with the teacher, and explore scientific concepts in the context of human experiences, with direct social relevance to the society.

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ABSTRACT

This study investigated the Impact of Science-Technology-Society (STS) Instruction on Performance and Retention of EcologyConcepts among Slow Learners in Secondary Schools inKaduna. The study employed apre-test, posttest, post posttest quasi experimental design. The population consisted of 190 SS2 science students consisting of 105 males and 85 females. Two schools were purposively selected and were randomly assigned control and experimental groups using a toss of a coin. The slow learners were selected using three years consecutive exam results of students who obtained below a score of 50 marks in biology (Ofonime, 2007). The subjects were taught for six weeks using STS Instruction and Lecture Method for the experimental and control groups respectively. The instrument used for thepre-test, posttest, and post posttest was the Biology Performance Test (BPT). The objectives of this study were to: (i) determine the effect of STS Instructional Strategy on students' academic performance in S.S.S biology; (ii) investigate if the use of STS Instructional Strategy enhanced retention of learned ecological concepts among senior secondary students (iii) assess if gender differences existed between performance scores of slow learners taught using STS Instructional Strategy.Three research questions were raised with corresponding hypotheses stated. The null hypotheses were tested using t-test statistics with level of significance at $P \leq 0.05$.The major findings from the study indicated that slow learners exposed to STS Instructional Strategy in learning ecology concepts performed significantly betterthan those exposed to lecture method. Slow learners taught ecological concepts using STS Instruction retainedmore ecological concepts than those taught using lecture method. Lastly, there was no significant difference in the mean academic scores of male and female slow learners taught ecological concepts using STS Instruction. Based on the findings of the research it was recommended that STS Instruction is an alternative teaching strategy to attain the goal of learning and teaching of slow learners. It can therefore be used in teaching to help slow learners retain knowledge better. In conclusion this study yielded positive results using STS Instructional Strategy on the performance and retention of ecological concepts taught to slow learners in selected public Senior Secondary Schools in Kaduna, Nigeria.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Education in science is a crucial factor in all round development of a nation. Science remains one of the most important subjects in the school curriculum. Science Education has been defined by many scholars, educators, educationists and philosophers in several ways; Atadoga (2008), defined science education as the field of study which emphasises the impart of science principles, ideas, laws and theories on individuals and communities that are taught through scientific approaches based on educational principles, sociology, psychology and evaluation viewing science as a human enterprise. Millar, (2004) defined science as referring to a product (a body of knowledge), a process (a way of conducting enquiry) and an enterprise (the institutionalized pursuit of knowledge of the material world.). Science remains one of the most important subjects in the school curriculum, but it has failedto excite students. Onwu (2009) gave two reasons why science does not appeal to many students.

i. Firstly he reported that science isfrequently taught poorly, often as rote memorization of complex facts and abstract data,
ii. Secondly, science educators have failed in their social responsibility to provide students and the general public with an understanding of science as it is today.

Science is not about the things that humans construct, rather material explanations used for natural phenomena which ideally, must be objectively and empirically testable with universal outcomes.

Biology, a branch of science, is the study of living things and their vital processes. It seeks to explain their nature, functions and place of living organisms including man in their environment. Biology is essential to human society because it gives an understanding of how life is formed and how it works, changes and responds to environmental influences. It influences human health, reproduction, quality of life, nutrition and almost every aspect of human's everyday life.An extremely broad subject, biology is divided into branches including ecology.

The persistent poor performance of students in biology, specifically in ecological concepts at Senior School Certificate Examination (WAEC, Chief Examiner report, 2007 - 2012) leaves one in doubt about the effectiveness of the teaching methods popularly used by the biology teachers for teaching the subject. The poor performance in ecology was traced to past ecology WAEC questions according to the Chief Examiner's reports of 2007 - 2012; although educators have advocated the use of some of the innovative strategies which include cooperative learning, problem solving and constructivism (Nwosu and Nzewi 1998). Okeke (1995) and Oyegebu (1999) found out that teachers use the lecture method in teaching ecology which is found to be ineffective in teaching of science instruction.The most commonly used method in schools for teaching is the lecture method. This method involves the teacher telling the students information. The teaching is centered on the teacher and there is usually no opportunity for the students to interact, which is one of its many disadvantages.Severalresearches on the use of Lecture Method such as James (2000), Usman (2000) and Bichi (2002) pointed out that it only encourages rote learning and as such does not enhance academic performance and positive attitude towards science among both male and female students. It is not an interactive teaching method as it does not provide for feedback to students. For effective teaching and learning of science in general, and biology in

particular, the use of a method which will enhance students understanding of taught concepts which will bring about meaningful learning is required.

One of the objectives of teaching and learning is to make the learners become more cognitively active in their own learning. (Atadoga & Onaolapo, 2008.) They further stated that it implies that learning activities are well selected, prepared, organised and presented in a way that the learners are afforded opportunities for cognitive engagement. This can be achieved when learners are engaged in learning activities that emphasise observation, thinking, discussion reading, writing and drawing (Atadoga & Onaolapo, 2008).

One of the goals of secondary education in Nigeria by the Federal Ministry of Education in its National Policy on Education (FME, 2004) is "inculcating in the child the spirit of enquiry and creativity through exploration of nature and the local environment". Also stated in the National Policy on Education is that "education should aim at helping the child acquire appropriate skills, abilities and competencies both mental and physical as equipment for the individual to live in and contribute to the development of his society". Biology is a compulsory subject for all students in the sciences and some art students excluding technical students at the senior secondary school level; however numerous problems are associated with the teaching of the subject such as lack of material resources or improvised materials. Beli, (2008) in his paper on Developing mastery for effective instructional delivery in primary science pointed out that over population, lack of teachers knowledge on improvisation and inadequate use of teaching materials in schools are factors that affect proper teaching and learning of science in schools.

The last twenty years has seen a number of changes in science teaching, of which one of the most significant has been the development of a wide range of materials which use contexts and applications as a starting point for developing an understanding of scientific ideas. Such approaches are variously described as 'context-based', 'applications-led' or using 'STS' (Science-Technology-Society) links.

Science-Technology-Society (STS) Instructional Strategy has been found to enhance learning and understanding of science concepts. This method involves students first hand experiences which provide real-world situations or contexts which in turn provide relevancy and a concrete point of reference (Yager, 1993).The method intended for this research involves student participation, active engagement in seeking out facts and finding solutions in relation to societal problems. Students find out things as they are in contact with what they are being taught which will make learning interesting and remembering easier for the student. Lack of student activities and participation in the learning process is assumed to be linked to the teaching method used by the teacher, which may be a factor contributing to the poor performance of students in the sciences. This makes for the need to change the teaching strategy that is capable of enhancing academic performance and retention of concepts learned.STS Instructional Strategy is activity oriented and student-centred teaching method capable of enhancing academic performance in science students.In respect to the mentioned reasons above, STS strategy will be used in this study using biology as the subject in teaching ecological concepts in these topics;

i. organisms and their habitats
ii. decomposition in nature
iii. ecological management
iv. tolerance and adaptation

v. pollution

The distinctive characteristic of scientific knowledge is that it provides material explanations for the behaviour of the material world, that is, explanations in terms of the entities that make up the world and their properties. It seems natural, and rather obvious that learning science will involve acts of 'showing' as well as of 'telling' (Millar, 2004). Nworgu, (1999) noted that contrary to the spirit of science, science teachers still teach without the necessary activities needed for proper understanding of the concept. Sharma and Hyland, (1991) found out that students exposed to direct experience on concrete objects performed better than those exposed to verbal instruction. Gbamanja, (1991) stated that biology teaching involves exposing students to several opportunities to understand different types of concepts, principles and expose students to direct physical materials that will make some meaning to the cognitive framework. Practical work according to Woolnough, (1994) provides students with valuable insights into scientific practice and can increase interest in science and motivation for its continued study. Practical work is necessary for developing students understanding of scientific concepts and explanations. Biology as a subject to be taught to students requires materials for cognitive development and meaningful learning.This is why the teaching of biology should be done using live objects which encourages deductive and inductive reasoning obtainable from the environment.

Slow learners are children who are doing poorly in school, yet are not eligible for special education; their intelligence test scores are too high for consideration as a child with mental retardation" (Mercer, 1996) (MacMillan, Gresham, Bocian, &Lambros, 1998). Although slow learners may have special educational needs, they do not fit

neatly into the special education system (MacMillan, Gresham, Bocian, &Lambros, 1998).

According to Verma, (2013),a slow learner can be described as a student who has the ability to learn necessary academic skills, but at a rate and depth below average when compared to their peers. In order to grasp new concepts, a slow learner needs more time, a number of repetitions, patience and often more resources from teachers to be successful. In children with this condition, reasoning skills are typically delayed, which makes new concepts difficult to learn and grasp. This study intended to seek the impact made on slow learners using STS Instruction on Performance and Retention among such students.

Retention according to Learning Theories Knowledgebase, (2010)is remembering what you paid attention to. It includes symbolic coding, mental images, cognitive organisation, symbolic rehearsal, motor rehearsal. Bichi, (2002) defined retention as the ability to retain and consequently remember things experienced or learned by an individual at a later time. When teaching is characterised by rote learning, and the facts thus learned are not long retained, nor do they seem to have much effect in changing behaviour (Akinbobalola and Folashade, 2009). However when it is organised and meaningful, in which students apply principles, solve problems and interpret experimental data, learning becomes effective and the facts thus learned are retained with the passage of time. In essence anything that affects 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. When a material is forgotten, it means it has not been retained and hence cannot be remembered at a later period. Using STS strategyto teach biology to students may increase the

retention of concepts taught to students.STS instructional strategy has been found to enhance students understanding of science concepts and brings about meaningful learning.

Specific results of student accomplishments in science experienced through the STS approach have been extensively documented (Banerjee & Yager, 1992, 1995; Blunck, Giles, & McArthur, 1993;Kellerman & Liu, 1996; Liu & Yager, 1996; Liu, Yager, Blunck, & Seo, 1995; McComas,1996; McShane & Yager, 1996; Myers,1996; Varrella, 1996; Yager, 1998). Collectively, these published reports of the use of STS indicate measurable improvements in student achievement with respect to mastery of science concepts and processes; the ability to apply science concepts and processes in new situations, particularly those in real-life settings; and understanding and use of the basic features of science (i.e., the nature of science). The reports also indicate significant increases in student curiosity about the natural and human-made world, significant improvement in student attitudes toward science and science related careers, and significant growth in students' creative abilities relevant to science (such as the quality and quantity of student generated questions, proposed explanations, and methods of testing the validity of those explanations).Hence, this study intends to find out what impact (whether positive or negative) that STS may have on the academic performance and retention of slow learners of senior secondary students in ecology.

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 technological fields (Ogunkola & Bilesanmi-Awoderu,2000). In Nigeria, and perhaps the whole of Africa,gender bias is still very prevalent (Arigbabu & Mji, 2004). This is a view to which Onyeizugbo (2003)

has also alluded in pointing out that “sex roles are somewhat rigid in Africa particularly in Nigeria…gender differences are emphasised”. It is common place to see gender stereotypes manifested in the day-to-day life of an average Nigerian.

In conclusion, this study is also aimed at finding if the impact of STS instruction on slow learners performance and retention of concepts taught in ecology is gender related or not.

1.1.1 Theoretical framework

The theoretical framework of this study is based on Blooms Mastery Learning Theory (MLT).Mastery learning is an instructional method that presumes all learners can learn if they are provided with the appropriate learning conditions. Specifically, mastery learning is a method whereby students are not advanced to a subsequent learning objective until they demonstrate proficiency with the current one (Mastery learning, 2009). Benjamin Bloom’s Mastery learning was derived from John B. Carrols model of school learning in 1963. Bloom transformed this model into an effective working model for mastery learning. According to Bloom (1968) mastery learning is an instructional methodthat presumes that all individuals can learn if they are provided with appropriate learning conditions. To Bloom, given a supportive instructional system, 95 percentof all learners can learn and achieve lesson objectives at near the same mastery level, the responsibility of the educator is to plan remedial instruction and include their use in classroom situation before proceeding to the next unit. According to Bloom (1971), mastery learning suggests procedure whereby a learner’s instruction can be so managed in a group based classroom instruction so as to enhance his fullest development. This as a result generates positive interest and attitude towards the subject learned than usual classroom methods. Learning is an active process. Facets of the process include selection and transformation of information, decis

ion making, generating hypotheses, and making meaning from information and experience.It takes individual learners different time to learn a task. Bloom (1968) pointed out that centrality of group instruction is effective for some learners but ineffective for others. For example, instruction provided to a group of twenty to seventy learners is likely to be very effective for some learners and relatively ineffective for other learners. Bloom condemns a situation where it is expected by teachers that some students will be successful and some will not. Mastery learning proposes that all or almost all students can master what they are taught. It suggests procedures whereby a learner's instruction can be managed so as to promote its fullest development.

According to Bloom (1971) this aspect of teaching and learning is likely to be replete with errors which are compounded overtime and unless there are ways of identifying and correcting the flaws in both the teaching and learning, the education system is likely to produce individual differences in learning which continue and are exaggerated over time. Bloom further emphasized that much individual differences in learning may be regarded as man -made and accidental rather than as fixed in the individual at the time of conception.Bloom (1976) argued that many individual differences in school learning are man-made and accidental rather than fixed in the individual at the time of conception. To him, individual differences in learning can be overcome by allowing each learner adequate time and using good quality instruction. His major argument is that what any person in the world can learn, almost all persons can learn, if provided with appropriate conditions of learning.To Bloom, the basic task in education is to find strategies which will take individual differences into consideration but which will do so in such a way as to promote the fullest development of an individual learner.

When the learner prepares visuals such as text, graphics, web sites, or activitiesin which another can participate, or endeavours to explain material to other students, or works in a group context, learning is especially powerful.(Sunny,2009) This is also seen in STS being an activity based instructional strategy where learners are engaged in the applications of science through the use of their critical thinking skills and content knowledge. This study therefore intends to find out how much impact has STS on the academic performance and retention of slow learners of senior secondary school in ecology.

A comment from Bobbi DePorter's 'Quantum Learning' (1999, 2004) is that we learn:

i. 10% of what we read
ii. 20% of what we hear
iii. 30% of what we see
iv. 50% of what we see and hear
v. 70% of what we say
vi. 90% of what we say and do

Blooms mastery learning theory is a group based method. It differs from conventional classroom instruction in that:

I. It emphasizes mastery of all objectives in each learning unit.
II. It uses diagnostic progress test (formative test) to identify each learner's errors
III. It uses systematic feedback i.e. correctives for helping learners overcome learning difficulties and finally,
IV. It provides additional time for those learners who need it, allows variation in learning-time and emphasizes high level of achievement for all learners.

Traditional instruction holds time constant and allows mastery to vary while mastery learning holds mastery constant and allows time to vary (Robinson, 1992).

From this, it can be seen that full engagement of seeing and doing collectively have the highest percentage involving active participation of the individual which is relative of STS strategies. Active learning engages the whole person, not just the intellectual mind.According to Erinosho, (2008) learning is an active process. When people try to do things and fail or succeed, emotions are triggered, and these have a significant effect on how we remember. The advantage of active learning over passive learning is based on constructivist theory as well as outcomes of studies conducted in this domain.

Philosophy and rationale of mastery learning

One component of mastery learning is its educational philosophy -- its set of beliefsabout learning and teaching. These beliefs are what shape the methods of mastery learning and the attitudes of the teachers who use the mastery approach. This section is devoted to explaining these beliefs. The other component of mastery learning is its method of instruction. Mastery learning involves a set of clear steps for selecting content, teaching, and determining students' progress. None of these steps is new in itself, but as a package they are extremely effective in enabling most students to learn well. These various steps will be enumerated later in the manual.

The belief system of mastery learning starts from two basic assumptions:

1) Virtually all students can learn all important academic content to a level of excellence.
2) The primary function of schools is to define learning objectives, and to help all students to achieve them.

According to Bloom, what looks like a difference among students in rate of learning is usually really a difference in proportion of time spent on task. In a typical 45 minute period,"good" students might spend 90% of the time really learning, while "slow" students might be spending only 33%. Again, then, these differences can be made to

vanish if educators can find teaching approaches which increase the "slow" learners' time on task.

This study on the impactof using STS Instructionon the performance and retention of ecological concepts learnt among slow learners is therefore hinged on this theory.

1.2 Statement of the Problem

Biology is one of the core subjects in Nigerian secondary school curriculum, as a result of its importance, more students enrolled for biology in the Senior Secondary Certificate Examination (SSCE) than for physics and chemistry (West African Examination Council, 2011).Examination results released in 2011 by WAEC revealed that only 31% of the 1,540,250 candidates that sat for the WASSCE May/June passed the examinations.West African Examination Council (WAEC) Chief Examiners Report of (2005),(2006), (2007), and (2008) stressed candidate's poor performance in Biology, and it was reported to be largely due to lack or shortage of resource materials.

Table 1.1: Statistics of Biology results in May/June SSCE (2007-2012)

Year	Total no. of candidates that sat for the exam %	Number & percentage of different grades		
		Credit (1-6) %	Pass (7-8) %	Fail (9) %
2007	609,026(92.7)	96,202(15.79)	142,044(23.32)	370,800(34.62)
2008	841,868(95.46)	36,348(31.29)	286,909(34.08)	291,475(34.62)
2009	1036,520(97.17)	322,310(31.39)	365,140(35.57)	339,070(33.03)
2010	1203,028(99.41)	466,155(38.75)	354,108(29.43)	319,060(26.52)
2011	1347,050(96.34)	492,422(36.52)	409,584(30.41)	362,238(26.89)
2012	5135,283(97.63)	488,302(31.81)	478,840(31.19)	509,849(33.21)

Source: WAEC Annual Report 2007-2012

Table 1 shows the percentage of students that passed biology at Senior School Certificate Examination (SSCE) conducted by the West African Examination Council (WAEC). As the table shows, the number of students that passed biology at credit level

(A1-C6) was consistently less than 50% for the period of six years (2007-2012) in Nigeria(West African Examination Council, 2012).

McPherson, (2001) and Isah, (2011) observed that many science students experience difficulty in science courses due to lack of understanding of the methods and processes of science.Other reasons were attributed to teachers' persistence in adhering to traditional method of teaching (Yager, 1993). Traditional method of teaching results in poor mastery and retention of concepts(Muhammad, 2009). Okebukola (2009) and Gyuse (2009) revealed that teachers' use of lecture method in teaching ecology has contributed to poor performance in biology.

Ecology as a concept in biology has to do with the environment around us. Therefore there is the need for active participation of learners in the study of ecology using activity based teaching strategy. A slow learner can be described as a student who has the ability to learn necessary academic skills, but at a rate and depth below average when compared to their peers. In order to grasp new concepts, a slow learner needs more time, a number of repetitions, patience and often more resources from teachers to be successful. Another reason why traditional mode of teaching cannot suffice slow learners is that it is not activity based; slow learners need hands–on minds-on methods to learn well. Furthermore, studies conducted on academic performance have shown that poor performance by students are based on the fact that teaching methodologies employed by teachers are mostly not learner friendly which according to Lakpini, (2006), is most often inadequate.

The use of STS has been found to enhance students understanding of subject matter learnt as reported by (Yager, 2000).Dambana, 2011 also found that STS instructional strategy enhanced meaningful learning of genetics concepts amongst students in

colleges of education. STS is student- centred, encourages critical thinking and also a multi-sensory stimulation strategy in enhancing the academic performance of students. This studytherefore sought to find outthe impact of Science-Technology-Society (STS) Instruction on the performance and retention of ecology among slow learners. Also the study sought to find out whether STS is gender friendly or otherwise.

1.3 Objectives of the Study

The objectives of this study are to:

i. determine the effect of STS Instructional Strategy on students' academic performance in S.S.S. biology;
ii. investigate if the use of STS Instructional Strategy enhances retention of learned ecological concepts among senior secondary students.
iii. assess if gender differences exist betweenperformance scores of slow learners taught using STSInstructional Strategy.

1.4 Research Questions

From the problem stated in the study, the following questions were formulated for answering.

i. What is the difference between the academic performance mean scores of slow learners taught ecological concepts using STS Instructional Strategyand those taught with lecture method?
ii. What is the difference between the mean scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using lecture method on theretention ability of ecological concepts taught?
iii. What is the difference between the academic performance mean scores of male and female slow learnerstaught ecological concepts using STS Instructional Strategy?

1.5 Null Hypotheses

The following null hypotheses were formulated for testing at P≤ 0.05 level of significance;

HO_1 There is no significant difference between the mean academic scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture method.

HO_2 There is no significant difference between the retention ability of slow learners taught ecologicalconcepts usingSTS Instructional Strategy and those taught using Lecture Method.

HO_3 There is no significant difference between the mean academic scores of male and female slow learners taughtecologicalconcepts usingSTS Instructional Strategy.

1.6 Significance of the Study

The findings of this study would hopefully be of benefit to science educators in the following ways;

i. Encourage teachers to use the environment in teaching as a first hand resource in lesson activities,
ii. Give students a better opportunity for understanding of the subject as they interact with their environment, and enhance the ability to retain concepts learnt in their natural state,
iii. If this strategy is found to be successful, curriculum planners would be able to incorporate the use of STS instructional strategy as part of the curriculum in the syllabus of the natural sciences for teaching purposes,

iv. Text book publishers would draw attention to the use of the STS instructional strategyalong with other practical activities that relate to its use in certain areas/ topics in the biology text books that are published,

v. Sensitize the ministry of education to see to the establishment of STS instructional strategy in academic planning in educationfor all schools,

vi. Stimulate further researches in this subject area for better science education teachers in the field of STS instructional strategy in biology.

vii. Professional bodies such as STAN and NERDC would benefit from this study in the improvement of science instruction in Senior Secondary Schools in Nigeria.

1.7 Scope of the Study

This study is delimited to senior secondary school II students (SS2) of selected public schools in Kaduna Education Zone of Kaduna State. The reason for selecting SS2 students is that they have more time andhave acquired some basic knowledge in biology more than the new intakes in SS1, and their counter parts in SS3 are too busy preparing for their final examination in WAEC, NECO and UTME.

Ecologyconcepts were taught to students under the topics; the organism and its habitat, decomposition in nature, ecological management, tolerance, adaptation and pollution using STS Instructional Strategyand Lecture Method. The reason for choosing Ecological concepts is due to its use of natural resources within the environment; also it covers a large part in the syllabus of biology from SSI-III and poor performance by students in this area.

1.8 Basic Assumptions

The basic assumptions for this study are:

i. All the SSII students in the study sample have adequate introduction to ecology.

ii. The teachers teaching biology are qualified to teach the subject s recommended by the National Policy on Education (FME, 2013).

iii. The schools under study run the same academic calendar and use the same syllabus.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This study investigated the Impact of STS Instruction on Performance and Retention of ecology concepts among slow learners in Kaduna.

In this chapter, related literature was reviewed and discussed under the following sub-headings;

- Nature and Teaching of Ecology at Senior Secondary School
- Ecological Concepts and Academic Performance
- Science Teaching Methods
- Science Technology and Society (STS)
- STS Instructional Strategy
- STS Instructional Strategy on Academic Performance
- Use of Environment-Based Education in Teaching
- Slow Learners
- Effects of Teaching Method on Academic Performance in Science
- Teaching Method in Relation to Retention of Learned Materials
- Gender and Academic Performance in Science Education
- Overview of Similar Studies
- Implications of Literature Reviewed on the Present Study

2.2 Nature and Teaching of Ecology at Senior Secondary School

Current studies on how students learn science have started revealing new ideas and innovative instructional approaches that have proved effective. Examples include: the use of analog, inquiry, cooperative learning, problem solving and constructivism

(Agbenyeku, 2012). Constructivism is a kind of learning strategy that lays emphasis on active role of learners in the process of constructing their own knowledge. Thus, a constructivist based method in a science instruction is the method which accepts the child's ownership of idea (Nworgu, 1997 in Agbenyeku, 2012). Central to the constructivist perspectives is that a learner constructs meaning from new information and event as a result of an interaction between that individual's alternative concepts and his or her current observation.

Okebukola (2009) and Gyuse (2009) found out that teachers use the lecture method in teaching Ecology which is found to be ineffective in teaching of science instruction. The teaching of Ecology is found to be neglected by teachers during the teaching and learning activities. Eguabor, (1997) in Ribah, (2011) found that only a chapter, page, or paragraph is normally given prominence in pages of textbooks, newspaper, Education news Bulletins of the study of Ecology etc. This could be the reason(s) behind students' poor performance, as well as shunning and fearing the learning of Ecology by students. This study is intended toconnect students with their learning environment as they interact actively with the use of their senses, in order to learn about ecology.

2.2.1 Ecological concepts and academic performance

Biology is an experimental subject and any activity that lends credence to ecological and interactive studies provides an opportunity to investigate and collect data which can be subjected to statistical analysis and provide empirical evidence for scientific research. Students have still some problems in science concepts and specifically the concept of ecology. Student's misconceptions cannot be eliminated easily by traditional methods. Traditional instruction does not help to encourage students to work together, to share ideas and information freely with each other. Traditional methods mainly use lecture strategy rather than several instruments to extend students intellectual

capabilities and have not brought more successful results for expected aims of science education. One possible solution for this problem is to make students more active learners in science classrooms.

Students should be able to apply what they learn in school to their daily life situations. Weaver (1998) pointed out that students found topics more interesting when they have some relevance to their daily lives or experience. One alternative way is to change the instruction from teacher-centred to student-centred using a constructivist approach. Constructivism is mainly linked to student's alternative conceptions and their own experience.

The persistent poor performance of students in biology, specifically in ecological concepts at Senior School Certificate Examination (WAEC Chief Examiner report, 2003-2012) leaves one in doubt about the effectiveness of the teaching methods popularly used by the biology teachers for teaching the subject. The poor performance in ecology was traced to past ecology WAEC questions according to the Chief Examiner's reports of 2003- 2012. Although educators have advocated the use of some of the innovative strategies which include cooperative learning, problem solving and constructivism (Nwosu and Nzewi 1998). Okeke (1995) and Oyegebu (1999) found out that teachers use the lecture method in teaching Ecology which is found to be ineffective in teaching of science instruction. The teaching of Ecology is found to be neglected by teachers during the teaching and learning activities. Eguabor, (1997) found that only a chapter, page, or paragraph is normally given prominence in pages of textbooks, newspaper, Education news Bulletins of the study of Ecology etc. This could be the reason(s) behind students' poor performance, as well as shunning and fearing the learning of Ecology by students.

In another study, Hamilton-Ekeke (2007) compared three groups of Nigerian school students. Students who were taught ecology by taking them to the school farm, pond, and nearby stream performed better than a matched group who were taught only in the classroom.

Azoro et al., (2011), asserted that taking students out of the classroom to learn is an essential strategy for learning biology. Learning outside the classroom is a tour undertaken by both students and teachers into the natural environment of the organism in order to study its characteristic. Organisms are observed in their natural environment in order to expose the details of its general characteristics. Students are expected to carry along their writing materials to jot down important events or observation made in the course of the study. Since ecology as a concept is activity based it is hoped that when taught using activity-based instructional strategy such as STS,slow learners academic achievement and retention may be enhanced. This study therefore sought to determine the impact STS has on the academic performance and retention of slow learners in ecological concepts at senior secondary school level.

2.3 Science Teaching Methods

Methods are the tools of the teacher for reaching the set goals and objectives. The effective teacher has multiplicity of methods at his disposal and must be prepared to select the ones, which will be most effective for leading the learner to desired behaviour. Educational methods sometimes called techniques are ways and means adopted by teacher to direct the learners' activities toward an objective. It is therefore a process of cognitive, affective and psycho motor development whose aim is to mould the learner towards a total contribution to the development of the learner and the community (Durosaro, 2002). In achieving this by the teacher, there is the need to

improve on the instructional methods in the teaching and learning process especially in teaching science subjects. Omoifo, (1999) stated that methods of teaching adopted by teachers are strong determinants of achievements in learning. For effective learning, teaching can be realised by the teacher who is to facilitate the process of learning. The purpose of using teaching aids is to confer more permanently information on the learner. Carefully selected and skilful use of aids makes understanding easier and therefore making learning more meaningful. There are several methods of teaching Biology which include lecture, demonstration, discussion, inquiry, laboratory methods to mention a few, the new trend being that all pure sciences should be taught practically. The methods selected would depend on a number of variables such as the number of instructional materials, funds, complexity of the topic, age of the students and their mental ability. STS instruction has been chosen because of its all-round active approach in providing for the learners.

2.3.1 Lecture method

Expository approach otherwise known as lecture method is the oldest approach employed in our schools for teaching both Science and Arts subjects (Agbulu, 2002). It involves verbal presentation of ideas, concepts, principles, generalization and facts. The objective is to impart or inculcate information to the students. The teacher does much of the activity in form of talking while; the pupils are either passive or slightly involved. Expository approach harbors two basic skills which every teacher must endeavor to explore for effective dissemination of information to the students. These skills include: clear and good command of language and ability to write clearly and boldly on the chalk-board. In expository approach, the teacher knows everything and that the learner is almost blank. It is the teacher's role to impart his knowledge merely by telling his students. The expository approach derives from the commonly held notion that in the

teacher –student relationships, the teacher, as an embodiment of knowledge, gives out what he knows to his students. Teachers make practically all the decisions; the mode of instruction; organization of learning experiences and materials; sequence; pacing and style of information dissemination. Teacher is therefore, the expositor and actor, while students are listeners, speaking only when called upon to answer questions, ask questions or demonstrate a procedure.

This method is favoured by many school teachers since large amount of materials can be covered to a large class size in a single period. The advantagesof this method are; It saves time and energy, It uses cheap and limited apparatus, It encourages the art of note taking among students, It encourages wide reading and research as students would not get everything the teacher said in the class. Disadvantages of this method are; It does not cater for individual differences as it is usually teacher centred, It lacks student participation, It makes the lesson boring as students listen passively while the teacher lectures, Teaching aids in teaching concepts are always neglected in the lecture method of teaching.

From the above observations, Mang and Mankilik, (2001) suggested the following guidelines for using lecture method;Lecture method should not be used alone in one lesson. It could be used to develop or build the lesson. This method was used to teach the control group, as it is the most widely used method of teaching by most teachers of secondary schools.

Discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships and new truths to be learned.

Among the advantages of discovery learning are; it encourages active engagement, promotes motivation,and promotes autonomy, responsibility, independence, the development of creativity and problem solving skills, a tailored learning experience. The disadvantagesinclude: creation of cognitive overload, potential misconceptions, and teachers may fail to detect problems and misconceptions.

In its essence, inquiry-oriented teaching engages students in investigations to satisfy curiosities, with curiosities being satisfied when individuals have constructed mental frameworks that adequately explain their experiences. One implication is that inquiry-oriented teaching begins or at least involves stimulating curiosity or provoking wonder. There is no authentic investigation or meaningful learning if there is no inquiring mind seeking an answer, solution, explanation, or decision.

According to Wilke and Straits, (2005) the advantages of inquiry learning include active, meaningful, and higher-level learning. Specific benefits (adapted from Svinicki, 1998 in the American Biology Teacher, (2005) are listed for each.

a) Inquiry Learning Involves Active Learning that: increases attention to task(s), focuses attention on critical variables, is more motivating than passivity, forces construction of a response as opposed to simple recognition, produces early and frequent feedback, creates an episodic memory from which to reconstruct knowledge.

b) Inquiry Learning Results in More Meaningful Learning That: makes use of personal associations, involves deeper processing of ideas, involves confronting misconceptions, is often more concrete initially, occurs in an authentic context.

c) Inquiry Learning Encourages Higher Level Learning Such As: viewing the discipline as a dynamic process, not simply a static set of facts to memorize, developing

a set of problem-solving strategies for tackling the unfamiliar, encouraging a belief in one's ability to learn about the subject, accepting responsibility for one's own learning (self-regulated learners),(The American Biology Teacher, 2005).

Demonstration method involves activities which are defined and often include laboratory experiments; however there is a difference between the procedures. According to Abdullahi, (1982), it however has advantages such as; it could be used to introduce a lesson or to bring it to a climax, it saves time, and economizes the use of materials, the correct use of apparatus, prevention of accidents and breakages as well as how to secure reliable measurements and results can be achieved, it can be an excellent review of experiments performed by students, it allows the teacher to use activities that ordinarily would be too dangerous for students to carry out. Some of the disadvantages of this method include; it does not allow pupils to develop manipulative skills, and the pupils do not satisfy their psychological demand for carrying out activities on their own, visibility is usually poor, as pupils may have difficulty in seeing details of the object being demonstrated or apparatus being used, it provides less scope for pupils to become familiar with equipment and material and also for observing and recording events, sight alone cannot provide most of the scientific information that the pupil needs

Discussion method is a student-centered method based on the philosophy that "knowledge arises within the person and not from any external source" (Abdullahi, 1982).Discussion simply implies talking over subjects from various points of views and the teacher's role is not to dispense or communicate knowledge but to act as a moderator. Advantages of Discussion Method; it could be used in introducing a lesson, thus motivating students activities, it develops positive interpersonal relationship, as students interact with their teacher and their colleagues to gain knowledge from one

another, it provides pupils with a sense of confidence through frequent exchange of ideas between the pupils and the teacher, it promotes active participation and involvement of students in the lesson. Disadvantages of Discussion Method; it takes up a lot of time, it does not allow for easy coverage of syllabus, not all topics lend themselves to discussion, students who lack knowledge or background on the topic being discussed become bored and not interested in the lesson because they are not involved, topic under discussion must be unusually stimulating to capture student's attention during the lesson/discussion sessions.

Of all these methods of teaching that have been discussed, the researcher intends to use STS approach for this study, as the exact experiences of hands-on, minds-on activities which encourages higher level learning in problem solving situations will be in ecology lessons. This is in relation to STS Instructional Strategy in that there is the active involvement of students in seeking information that can be used. Also, students produce solutions to problems which they can share with the society to bring about scientific enlightenment in the society where the school is situated. From other findings generalisations could be made towards solving the problem at stake (Yager, 1993).

2.4 Science Technology and Society Teaching Strategy

"Science-Technology-Society" (STS) came from John Ziman's (1980) seminar work, Teaching and Learning about Science andSociety. In spite of its title, the book consistently referred to "STS" in its articulation of the rationale, directions, and challenges for STS in school science. The book quickly became required reading for STS science educators everywhere. Although Bob Yager (1996), claimed that Ziman coined the term STS, the term was recognized in the UK by the STSA (Science

Technology and Society Association) which existed under the auspices of the Council for Science and Society, of which Ziman was chairman.

Science and technology are flip sides of the same coin; each supports the other. Exploring the relationship between science and technology, one will discover that both affect our society as a whole. Even people who never again set foot in a laboratory after leaving school can benefit from an understanding of science and technology and how both relate to each other and to society at large. In our society, complex as it is, this fact is now truer than ever before. Science and technology will play roles in every aspect of life. In the future, "high-tech" will be more than a catch phrase—it will permeate every aspect of life. To prepare students for the challenges of the future, they must become science literate. They must be given the tools that will enable them to become responsible and productive individuals in a highly technological world. STS is an approach to teaching science in which the impacts of scientific, technological, and social matters are explored. STS teaches science from the context of the human experience and in so doing leads students to think of science as a social endeavour. STS emphasizes personal involvement in science. Students become active participants in the scientific experience.

Around the world the term STS has its own definition and use according to the time and place of usage. Some examples of these different definitions of STS in science-related curricula which are known globally as stated by Aikenhead (2005) in Abualrob (2012) are: "science-technology citizenship; nature-technology-society; science for public understanding; citizen science; functional scientific literacy; public awareness of science; variations on science-technology-society environment; and cross-cultural school science". These examples of STS categories in science are generally considered

as tools for assisting people to achieve the goals of “science for all” and “scientific literacy” besides increasing the level of interest among disinterested students to take part in school science.There Are Three Parts to STS:

i. Science concept and skill development and knowledge of the nature of science

This component of STS introduces science as a system for learning about the natural world and gives students the foundation they need to actually practice science in and out of the classroom. The ultimate goal of STS is to turn students into scientists, at least for the duration of their science education. To accomplish this, students first learn the methods of science and the skills that scientists draw on. Whenever possible, the major ideas of science are introduced from the standpoint of those who developed them. In this way, students come to see the reasoning that went into the development of these ideas.

ii. Knowledge of the relationship of science and technology, and engagement in science based problem solving

Students who understand the real-world applications of science are better able to appreciate and enjoy it. This component of STS reinforces the practical value of science. Students see that science is a system for solving practical problems. Students themselves become practical scientists—first identifying problems and then developing solutions to them. Students learn to analyze, to plan, to organize, to design, and to refine models and designs.

iii. Engagement in science-related social issues and attention to science as a social institution

This component of STS deals with the ways in which science serves human needs. The benefits may be tangible or intangible, but either way they are real. To emphasize the

social responsibility of science, scientists are shown to be concerned about the impact of their work on society as a whole. Advances in science and technology sometimes lead to thorny ethical issues. Such issues are often used as a focus for discussion and investigation. From these investigations, students draw conclusions and form reasoned opinions. By strengthening students' understanding of the connections between science, technology, and society, the teacher will enhance their appreciation and understanding of science and their ability to deal sensibly with the complex issues that will become commonplace in the decades ahead.

STS involves focusing upon societal issues, occupations and careers in science disciplines and using human resources in identifying and resolving local issues (Yager, 1992). The Science/Technology/Society (STS) approach is defined by the National Science Teachers Association as the "teaching and learning of science and technology in the context of human experience" National Science Teachers Association, (NSTA, 1990). Science, Technology and Society (STS) learning activities are designed to engage students in the applications of science through the use of their critical thinking skills and content knowledge. It affords students the opportunity to examine ideas and data related to historical, technological and/or social aspects of science concepts and content. In an STS activity the student has a chance to analyse, evaluate and draw conclusions about scientific research or information gathered from sources outside of their classroom. A strong STS activity demonstrates the valuable role science plays in everyday life. Use authentic sources of information including media clips, newspapers, magazines and advertisements as vehicles to practice reading and writing, assess prior knowledge or as a springboard for students to generate questions about the text and the corresponding content. A contemporary issue without one obvious correct answer often provides a wonderful context for an STS activity. The use of contemporary issues in

science may also provide daily embedded learning opportunities that allow for continuing growth in reading, writing, listening and presenting Lubben *et. al.,* (2005).

The origins of STS approaches have been documented by Bennett (2003), and Bennett and Holman (2003). Ideas underpinning the development of STS approaches have also been documented by Campbell, Lazonby, Millar, Nicolson, Ramsden, and Waddington (1994). Aikenhead (1994) has produced a detailed overview of STS approaches and materials, and how they draw on contexts and applications to develop ideas about Science, Technology and Society. The term 'context-based approaches' appears to have been applied to some of the activities in school science classrooms for a little under twenty years. Context-based approaches have their origins in two types of course, those for less academic pupils at the secondary level, such as Nuffield Science 13-16(Nuffield Foundation, 1980), and those for non-science specialists at the upper secondary or tertiary level, such as Science in Society(Lewis, 1981) in the UK, and Science and Culture(Yager & Casteel, 1968) in the USA. Lubben *et. al.*, (2005).

From the early 1980s, STS approaches started to appear in mainstream science courses and these are now in widespread use in a number of countries. Examples of such materials tend to be found at the secondary and high school level and include, for example, in the UK, Science: the Salters ApproachUniversity of York Science Education Group (UYSEG, 1990–1992), Salters Advanced Chemistry(Burton, Holman, Pilling, and Waddington, 1994) and the SLIP (Supported Learning in Physics Project, 1997). Examples from other countries include ChemCom(American Chemical Society [ACS], 1988) in the USA, PLON(Dutch Physics Curriculum Development Project, 1988) in the Netherlands, and STEMS (Science, Technology Environment in Modern Society) in Israel (Tal,Dori, Keiny & Zoller,2001) in Lubben *et. al.,* (2005). The term

"environment-based education" (EBE) is used to focus attention on the numerous benefits that arise from using the environment more broadly as a learning tool in school programs. While environmental education focuses on building a base of environmental knowledge and skill to be applied to environmental stewardship, environment-based education uses a popular subject matter to improve students' learning skills and create a wider learning context for students, teachers, and the community. Environment-based education emphasizes interdisciplinary integration of subject matter, problem- and issue-based learning experiences, team teaching, learner-centered instruction, constructivist approaches, and self-directed learning (www.seer.org).

Science, Technology Society Strategy as defined by Yager, (2004) is the teaching and learning of science in the context of human experiences including technological application in science which brings about relevance of science and makes learning more meaningful. STS originated from science education move as an outlook that emphasised the teaching of scientific and technological developments in their cultural, economic, social and political context. In view of science education, students are encouraged to engage in issues pertaining to the impact of science on everyday life and make responsible decision about how to address such issues (Solomon, 1993 and Aikenhead, 1994). STS Strategy of teaching involves a combination of several teaching methods in science. For example group discussion, fieldtrips, discovery, practical, brainstorming, among others; all in the context of human experiences aids technological application (Yager, 1993). With this approach, students produce solutions to the problem- which they can share with the society to bring about scientific enlightenment where the school is situated from their findings.

Yager, 1993 stated the following steps are involved in the STS Strategy:

i. Identification of problems with local interest and impact,

ii. Use of local resources to locate information that can be used to solve the problem,

iii. Active involvement of students in seeking information that can be used. The teacher provides resources from which information can be derived from, but should be involved in directly giving out the information to the students, eg. Text books, charts, pictures, etc.

iv. Students produce solution to the problem which they can share with the society to bring about scientific enlightenment in the society where the school is situated. From other findings generalisations could be made towards solving the problem at stake.

Using this approach makes the students scientifically literate, capable of identifying and if possible solving some societal problems. This further makes learning of science exciting, and students no longer view science context as a thing which they must learn only for examination purposes. This strategy was used for the experimental group in this study the STS jurisprudential model adapted from Pederson (1992). The model involved six stages;

1. **Orientation Phase:** This phase involves introducing the students to the topics. The students are prompted to search for information or knowledge on the topic under study. for example, on the topic 'organisms and their environment' the researcher asks the students questions such as:

   'What are plants and animals and where are they found?

   'Can you explain if there is any existing relationship between them?

2. **Identification and Definition Phase:** Students at this phase were allowed on their own to go for a wide search of information or knowledge on the topic being studied. Students are to engage in a brainstorming search for possible answers to

the questions raised in phase 1 on the studied topic. Students look for information, observe specific phenomena and possibly experiment with materials to enable them identify and define the parameters of an investigation or the topic being studied.

3. **Synthesis Phase:** At this phase, students would come up with designs in form of chart graphs or write ups for presentation as possible solution to the question raised in phase 1 on the topic being studied.
4. **Interaction Phase:** In this phase students were involved in a mock public meeting. Students here come up with their respective answers, findings or solutions on the topic being studied for sharing with other groups. This is the time for communicating their individual and group findings, interacting with their fellow students i.e. sharing ideas in a co-operative manner. This could be oral or written reports.
5. **Clarification Phase:** In this phase, studentscome together collectively and cooperatively to identify and clarify possible solutions or answers to the searching questions raised in Phase I with the teacher. Figure 3.1 shows an STS Jurisprudential Model which would be adapted for this study. The teacher starts with the social implications of the topics, through the ion concepts and facts about the topic. Finally, the teacher then re-emphasises the scientifically correct ideas about the topics.
6. **Action Phase:** Here, decision or action is taken. Here students rely on information they gain from debating issues with each other and from their own search shared information from other groups and information gained through the STS classroom for decision making or action taking. The course of action students follow will be decided on after a consensus clarification on the topic is reached.

Literature review shows that constructivism is often associated with the variety of educational and pedagogical approaches in the literature of STS education (Mathews, 1997). Yager, (2001) for example, has placed STS as a paradigm shift within the broader learning theory of constructivism. He wrote that teaching techniques that aid students in formulating meaning for themselves have been suggested and evaluated, particularly by educators in STS and that "such teaching strategies are now called constructivist teaching, even though that term is usually reserved for a way of describing human learning. STS by definition requires such teaching".

Aikenhead, (1992) defined constructivism as a characteristic for developing STS textbook materials. He stated that STS science transfers the focus from an academic scientist's knowledge transmission to the student's knowledge construction. This student oriented perspective emphasizes "the basic facts, skills, and concepts of traditional science, but does so by embedding that science content in social technological contexts meaningful to students". Hence, it deals with practical issues in the relationship between constructivism and STS analysis and its impact on student-centeredness and higher order thinking. It is clear from Yager's discourse that his linking of STS to constructivism is largely related to students being practically involved in the process, and not necessarily because STS is not difficult for students to integrate into their conceptual structures. Yager(2001) did not specifically attempt to explain students' experiences with STS as a way to make conceptual representations of the world and in fact took a pedagogical constructivism stance (Makki, 2008). Moreover, Lutz (1996) stated that STS can be seen as a type of conceptual change and explained that conceptual change is most likely to occur "when current issues are under investigation, and result in a perceived need for a more adequate explanation or

viewpoint than that which the observer currently holds". From the points mentioned, the merits of STS Instructional Strategy include;

i. student-centred learning
ii. multi-sensory stimulation
iii. multi-path progression
iv. multi-media
v. collaborative work
vi. information exchange
vii. active-inquiry based
viii. encourages critical thinking
ix. informed decision making
x. proactive planned authentic, real world context

These advantages of STS are the direct disadvantages of chalk and talk strategy of teaching,Okorafo (2003) carried out a research on the effect of STS on achievement in chemistry; she noted that STS Instructional Approach could effectively enhance the understanding of chemistry concepts in student and subsequently improve their performances significantly in the subject more than the traditional approach. This study therefore adopts the STS Instructional strategy to teach slow learners ecological concepts at senior secondary school level to find out its impact on their academic performance and retention.

2.4.2 STS Instructional Strategy and Academic Performance

Yager and Akcay (2008) carried out a research to determine whether Science, Technology, and Society (STS) learning increases student concept mastery, general science achievement, use of concepts in new situations, and attitudes toward science in middle school classrooms. The study involved two teachers and fifty-two students in

grades 6 through 8. Two sections of middle school science were taught by two long time teachers where one used an STS approach and the other retained a typical use of the textbook as a class organizer. Each teacher administered the same pre- and post-assessments. Major findings indicated that middle school students experiencing the STS format with constructivist teaching practices: (1) learned basic concepts as well as students who studied them directly from the textbook, (2) achieved as much general concept mastery as students who studied in a textbook dominated way, (3) applied science concepts in new situations better than students who studied science in a more traditional way, (4) developed more positive attitudes about science, (5) exhibited creativity skills that were more individual and occurred more often, and (6) learned and used science at home and in the community more than students in the typical textbook dominated section. Further, the STS approach coincided well with the kind of teaching across the curriculum that is (recommended as) central to teaching in middle schools.

2.4.2.1 Use of Environment-Based Education in Teaching

Increasingly, deficiencies in U.S. education are addressed by establishing student achievement standards that demand higher levels of accountability and mandatory testing. In 1999, the North American Association for Environmental Education (NAAEE) released its own set of standards, Excellence in Environmental Education — Guidelines for Learning (K-12). NAAEE correlated these standards with national standards for arts, sciences, civics and government, economics, language arts, geography, history, mathematics, science and social studies. Several states are engaged in similar efforts.

Environment-based education is a broad-based strategy for improving teaching and learning, but it has not been widely accepted as such, nor is it fully recognized as being

useful in bringing a student-centred approach to standards-based learning. In one recent examination of this question, Kearney (1999) finds that most teachers do not recognize all the educational improvement opportunities that environment-based studies routinely present. This could change as a growing body of evidence links environment-based education to improved test scores and grade level achievement. Klein (1995) and Volk and McBeth (1998) reported that students who experience issues-based EE make significant cognitive and skill gains, with notable improvements in levels of measurable achievement. For example, students at Hawley Environmental Elementary School (Milwaukee, Wisconsin) exceeded the state average on both state tests and nationally-normed assessments, scoring higher than all other schools in Wisconsin with similar socio-economic status (U.S. Department of Education, 1999) Environment-based education helps teachers meet standards across multiple disciplines within a single curriculum. EBE's emphasis on higher-order thinking has already been shown to increase academic achievement in reading, math, science, and social studies. Its focus on the immediate environment and the local community makes learning relevant, interesting, and compelling. When learners are engaged, both achievement and discipline improve, thus helping to create safer schools.

A number of recent studies have documented how young people benefit from environment-based education. A companion report to this one, Environment-Based Education: Creating High Performance Schools and Students (NEETF, 2000) provided case studies with anecdotal evidence as well as test score results for seven schools that have adopted EBE. The most comprehensive work in this area has been done by the State Education and Environment Roundtable (SEER), an organization formally advised by 12 state education departments (www.seer.org). Its 1998 study describes how 40 schools have reaped remarkable academic, attitudinal, and behavioural results by using

the environment as an integrating strategy for applying science, mathematics, social studies and language arts concepts (Lieberman and Hoody, 1998).

The SEER study provides a useful benchmark for understanding the role of environment-based education in academic performance and educational reform .Importantly, enthusiasm and the desire to learn and teach increased in each of the schools studied. The SEER study also found that student performance in each of the schools improved regardless of socio-economic factors. Many of the schools in the SEER study turned to the environment as an integrator when other more conventional approaches had failed .A similar thing happened in 1995 at the Kramer Middle School in Washington, D. C. With low test scores and student discipline, Kramer became known as a "problem school." Parents and teachers were sceptical that its problems could be reversed by becoming an environmental middle school. However, with a principal's leadership and a commitment from the community, student academic achievement improved and discipline problems diminished. Other schools have had similar experiences. Schools in trouble can — on their own — turn to the environment to achieve success.

It is the rare school that makes the level of commitment to environment-based integration that Kramer Middle School or the SEER study schools were able to make. Still, it is clear that any school can have a successful EIC program if school leaders and students are up to the challenge. Support from parents for environmental education is at an all-time high, receiving a remarkable 95% approval rating in a recent survey conducted by NEETF and Roper Starch Worldwide (NEETF, 2001). Parental attitudes, combined with the widespread recognition of the need for change, make this an outstanding time to bring the environment into the mainstream of K-12 education.

Research on environment-based education confirms that it is academically rigorous and pays off in higher test score. It ensures that students do not simply learn about science, they perform science (Kennedy, 1999) .They identify practical and feasible solutions to environmental problems through research and experimentation. Finally, they implement their solutions working independently or in student teams.

Traditional instruction such as lecturing, allows for broad content coverage, and there are times when it may be the most practical approach. But problem-based learning, a key aspect of environment-based education, increases conceptual understanding, retention, and self-directed learning (Leinhardt, Stainton, and Bausmith, 1998; Dods, 1997; Gallagher, 1997; Goodwin and Adkins, 1997). The STS Instructional Strategy adopted in this study is environmental based which involves the active participation of slow learners in the construction of knowledge using resources from the environment. Ecology as a biological concept to be taught is also environmental based, specifically this study seeks to determine the impact of STS instruction on the academic performance and retention of slow learners in ecological concepts at senior secondary school level to see whether it will enhance their performance or not.

2.5 Slow Learners

A slow learner can be described as a student who has the ability to learn necessary academic skills, but at a rate and depth below average when compared to their peers. In order to grasp new concepts, a slow learner needs more time, a number of repetitions, patience and often more resources from teachers to be successful. In children with this condition, reasoning skills are typically delayed, which makes new concepts difficult to learn and grasp. (Verma, 2013).

According to experts, children who for various reason, fall behind in their school work and require special teaching are called (educationally subnormal) E.S.N."Slow learners are children who are doing poorly in school, yet are not eligible for special education; their intelligence test scores are too high for consideration as a child with mental retardation" (Mercer, 1996) (MacMillan, Gresham, Bocian, & Lambros, 1998).
Although slow learners may have special educational needs, they do not fit neatly into the special education system (MacMillan, Gresham, Bocian, & Lambros, 1998).

In a research carried out by Khan,(2008)on Slow Learners who found out among the factors stated that could cause slow learning included teaching method;Teaching method is the most important factor in slow learning; a trained teacher can understand the problem of the student and remove that problem by a better teaching style, which suites the students need and mind. A good teacher will always use different methods in class so every student understands and learns. On the other hand those teachers who use one method of teaching create slow learners in the class because every student learns in a different style and method.

Balado (2006) pointed some salient characteristics of slow learners as; they have poor interpersonal relationship, feel difficulty to follow multistep instructions,and are not futuristic, having short term goals show on work, and having poor self-image.There are different reasons for slow learning. Sometimes it is due to their mental ability. Sometimes it is due to their background, illiterate parents, cultural problems, avoiding by the parents in early childhood between ages 2 to 6 years, sometimesit's due to mental illness. These are different outcomes of the slow learner (Hughes, 1973).

Slow learners are too often interpreted as meaning "being unable to learn". The reasons for slow learners' learning difficulties can vary greatly. While in some cases, a person's

cognitive abilities or neurological structure might set rather narrow boundaries to his/her learning processes, in another case, a person might experience learning difficulties due to acute but temporary emotional strain or traumata. Thus, learning difficulties are not necessarily a sign of a lower intelligence level – or in other words, slow learners are not necessarily less intelligent than other people of their age group, though this is a common assumption. What, however, being a slow learner means is that the student is unable to learn something in the amount of time assigned for the actual learning. The mistaken notion is that the major factors promoting successful learning are beyond the control of the learner and teacher. Teachers, however, can help students improve their rate of retrieval by using instructional strategies that assist the learner's brain in deciding how and where to consolidate the new learning in long-term memory. (Sousa,2005).

The rate at which a student learns depends upon his learning ability. Slow learners can remember just as well as fast learners, provided they have learned the material equally well. The reason a bright student may succeed better in examinations is that he/she has learned the subject matter more effectively within the time available. If, however slower students spend enough time on their studies, they can retain just as much as the faster student can. Research shows that both rate of learning and rate of retention can be improved with practice. A Research done on slow learners (borderline intelligence) shows that these individuals have low achievements and comparably low IQ scores (70–85). These individuals make up approximately 14% of the population, larger than the group of children with learning disability (LD), mental retardation and autism combined. They disproportionately account for nearly every major problem within education & society like school dropouts, illicit drug users, violent offenders, alcohol abusers, and gang & hate group members etc. **(**Masi,Marcheschi, &Pfanner, 1998).

2.6 How can Slow Learners be helped?

The teacher has a pivotal role in the teaching and learning process. The profound and longer lasting effect of teachers attitude leave imperishable imprints on the students personality. The teacher should always consider each student as an individual. Students have their own personal needs and must be addressed accordingly. In a study that was carried out by Chauhdary, and Hussain (2012), on is the academics of the child influenced by the teachers; a case of Pakistani school teachers, the attitude of teachers towards slow learners academic achievement was examined. The sample was 300 teachers working in public sector elementary schools of Lahore district. A questionnaire of 20 items was prepared for the teachers that were used for collection of data for the study. The data was analysed and the results showed that majority of the teachers agreed that slow learners should be grouped in the class by their abilities and the class size should be small. Data showed that teachers were of the view that slow learners needed interactive teaching methodology and curriculum contents should meet the needs and interest of the slow learners in the class. They recommended that the strategies need to be changed to bring positive results in the academic performance of slow learners.

In a study by Borah (2013) on Slow Learners, she gave some proven ideas to help slow learners such as;

- High school opens the door to vocational training where they often excel. Work study programs give them a purpose for going to school.
- Work with your school's M-Team (Management Team) to develop an IEP (Individual Educational Plan) for the child.
- Do not spend the entire time making the child's study. Don't nag. Let them have a life outside of school with activities they enjoy.
- A Slow Learner might repeat one grade level for academic or social reasons.

Repeating more than one grade is a disaster for their self-esteem.

- Be patient but consistent.

She also gave examples of interventions for slow learners which included;

- Environment: Reduce distractions, change seating to promote attentiveness, have a peer student teacher, and allow more breaks.
- Assignments: Make them shorter and with more variation, repeat work in various forms, have a contract, give more hands-on work, have assignments copied by student, have students use "three transfer" method.
- Assessment: Use shorter tests, oral testing, redoing tests, short feedback times, don't make students compete.
- What to avoid: Don't use cooperative learning that isolates the student and places him or her in a no-win situation or standardized tests. Definitely don't ignore the problem.
- What to encourage: Grouping with a patient partner. Learning about the child's interests. Placing the student in charge. Mapping, graphic organizers,and hands-on work. Using Bloom's taxonomy of tasks to make the assignments more appropriate.

According to Shaw (2010), Strategies to support Slow Learners include;

Use concrete instruction, Provide opportunities for repetition and frequent practice of discrete skills applied to different challenges, Help students develop basic time management and organizational skills, Break down lessons and tasks into short discrete elements, Use a variety of hands-on activities and computer-assisted instruction to reinforce learning, Expect and allow for success, Reward genuine effort, Provide a variety of ways to demonstrate competence, Pair students with peer mentors, Link

academic learning to real-world experiences, Encourage the students' involvement in activities that they enjoy and at which they can succeed.

This study intends to see whether an impact can be made in the performance and retention of ecology concepts learnt by slow learners using the STS Instructional Strategy and how their performance will be compared to their counterparts taught using the lecture method.

2.7 Effects of Teaching Method on Academic Performance of Slow Learners in Science

Studies have shown that academic performance of students in science is related to the teaching method (Ugwuanyi, 1998 in Inyang, 2003). Mohammed and Jongur, (2008) reported that the classroom teaching which is still dominated by "chalk and talk" method results in the poor performance in S.S.C.E. Biology examinations. As such biological concepts are not understood by students due to this ineffective instructional strategy (Moemeke and Omoifo, 2003; in Kassim, 2007).In their research, relative effects of programmed instruction and demonstration methods on student's academic performance in science; Uhumuavbi and Mamudu, (2009) found that exposing students to Programmed Instruction method improved performance in science.

They also found out that exposing female students to demonstration method yielded a better performance than their male counterparts. Demonstration method has been used extensively in the sciences (Tretter and Jones, 2003) and to a lesser extent in engineering. For instance, Lee (2004) carried out a study on students' performance in sciences using a demonstration method. In his study, he reported that students were able to identify some difficulties they faced in learning science when they were given problems to solve. Wilson, (2004) investigated the effect of two teaching methods on Student's cognitive achievement and problem solving skills in biology. He showed that

the treatment groups performed significantly better than the control group. Demonstration method has no substitutes for laboratory exercise or for learning proper techniques of handling laboratory equipment, but are effective means of supplementing and clarifying the material being taught.

Nwachukwu (2005) investigated the effect of use of cooperative and competitive interaction strategies in teaching chemistry on Nigerian secondary schools. The research revealed that the two strategies are superior to the conventional practices in Nigeria. In fact, the female students outperformed the males in cooperation whereas the males outperformed the females in competition. Also, Chukwneke and Nwachukwu (2006) investigated the use of concept mapping in teaching biology in Nigerian Secondary schools. The study revealed that use of concept mapping enhanced the acquisition and retention of biology better than the conventional practices. Ogunbowale (2001) points out that the broad scope of the science curriculum and emphasis on quantity of content coverage are the major constraints on inquiry approaches in science teaching and learning in Nigerian schools. However, the literature suggests that when teachers teach less content, they teach it better by introducing ideas in a variety of ways and thus encourage students' learning (Rutherford & Ahlgren, 1990; Wenning, 1997).

This study intends to seek a new avenue in the improvement on the academic performance and retention of concepts learnt by students of biology with the use of STS Instructional Strategy.

2.8 Retention of Learned Concepts in Science

Retention according to Learning Theories Knowledge base, (2010) is remembering what you paid attention to. It includes symbolic coding, mental images, cognitive organisation, symbolic rehearsal, motor rehearsal. Bichi, (2002) defined retention as the

ability to retain and consequently remember things experienced or learned by an individual at a later time. When teaching is characterised by rote learning, and the facts thus learned are not long retained, nor do they seem to have much effect in changing behaviour (Akinbobalola and Folashade, 2009). However when it is organised and meaningful, in which students apply principles, solve problems and interpret experimental data, learning becomes effective and the facts thus learned are retained with the passage of time. In essence anything that affects 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. When a material is forgotten, it means it has not been retained and hence cannot be remembered at a later period.

Olorukooba (2001) compared the effects of cooperative instructional and traditional method of instruction on academic achievement and retention of concepts in chemistry. Data collected after teaching the experimental group with the cooperative instructional strategy and the control group with the traditional method were analysed using t-test and the Mann Whitney U. statistics. Results from the analysis of data showed that the experimental group performed significantly better in the achievement test than the control group. In a similar study, Bichi (2002) found that problem-solving strategy is more effective than traditional teaching method with reference to performance and retention ability.

Ezema and Dung (2003) compared the effectiveness of concept mapping and guided discovery teaching strategies on students' retention of some chemistry concepts. Their findings showed a significant difference between the concept mapping and guided discovery posttest scores in favour of concept mapping. They also found that concept

mapping method enables students to have better understanding of concepts taught and retain more knowledge of chemistry concepts than guided discovery method. It is very important for students to retain the knowledge and skills learned; otherwise the knowledge and skills taught would have no later significance. Retention goes hand in hand with forgetting. Ritter, Baxter, Kim and Srinivasmurthy (2013) argued that wherever learning is considered to be important, retention should also be taken into consideration.

Bichi (2006) investigated the effects of a constructivist teaching strategy, the problem-solving method and the traditional method on secondary school student's achievement in evolution. A total of 104 senior secondary three level Biology students were used. The subjects were grouped into two, an experimental group and a control group. Data collected was analysed using t-test analysis and it showed that the experimental group achieved significantly better than the control group.

Chianson, Kurumeh and Obida (2010) investigated the effects of cooperative learning method in order to find out the retention level of students in circle geometry. The findings of the study confirmed that the students who were taught using cooperative learning method were able to retain the concepts of circle geometry more than those students who were taught using the conventional approach. In essence conventional or traditional approach to teaching is not very effective in aiding retention. From the discussion so far retention is affected by students understanding, importance of the material learned (relevance), and being able to interpret and apply the information.

This study intends to find out the retention ability of slow learners taught ecological concepts using STS instructional strategy and those taught using lecture method.

2.9 Effect of Teaching Method on Retention

The Jurisprudential Model for STS study (JPM-STS) was implemented in a high school chemistry class (Pedersen, 1990). Ninety-five high school chemistry students were assigned as intact classes to the treatment. Half of the students experienced chemistry in the form of lecture and laboratory. The other half of the students were split up into groups of four and teams of two. Each team was assigned one side of an issue (either pro or con). All students spent six weeks studying the material and all materials were made available to all students. The differences between achievement in chemistry, attitudes toward science, anxiety towards science, and problem solving perceptions were examined.

The results of this study provide some important information concerning the use of STS issues in the classroom. Attitudes were significantly different in the STS group as compared with the traditional setting. Students found the study of science within the JPM-STS realm more interesting than conventional means of dispensing information. This supports Yager's, (1990) conclusions which indicate that students involved in the study of STS issues have more positive attitudes toward science. Anxieties towards the science that the students took were also significantly different (Pedersen, 1990). Students in the JPM-STS classes were less threatened by the science that they were studying. The sharing of information, working in cooperative groups, not being preoccupied with the fear of knowing all, and being provided specific tasks in the learning sequence may have all contributed to the reduction of anxiety. Pedersen, (1990) also found that the students in the JPM-STS group had better perceptions of themselves as problem solvers. Indications were that the traditionally taught students were not as confident in their own abilities to solve personal problems.

Among the four variables examined, only achievement was found to have no difference between the two groups examined. The study of STS issues (via JPM-STS) provided the students with similar knowledge to achieve on teacher-made objective tests.

Even though achievement was similar in both groups, one must ask about the form of testing. It would seem that the testing of the STS students via conventional methods would contradict the overall philosophy of STS study. Although learning content is an important component of STS, it is not by any means the only component.

According to Pradeep, (2005) based on her study on using a STS approach said the STS approach to teaching science has a very clear benefit to the way that science is taught (and hopefully learned). By making science a student-generated problem-based endeavour, it becomes more interesting and relevant for students. If students take ownership of the learning process, they are more inclined to pursue a topic in greater depth and retain the knowledge longer.

In a study carried out by Yager, Choi, Yager and Akcay, (2009) on A Comparison of Student Learning in STS vs. Those in Directed Inquiry Classes showed the results of the semester long teaching, which was the focus of the study, permittedthe following conclusions:

1) Students learn as many (occasionally more) basic conceptswhen approached via an STS pathway.

2) Students learn more and more useful scienceprocess skills with STS approaches than occur generally in more traditional classroomsand hence one might expect it to favour the students in Non-STS Classrooms.

3) Studentsbecome even more creative as they study in an STS mode. Creativity can be defined as asking questions about the objects and events in the natural world as opposed to "going through" a textbook or required curriculum.

4) Students develop more positive attitudes about science the more they study science with an STS approach. (In typical classrooms attitudes become more negative the longer science is studied in schools!).

5) Students learn better how to apply science concepts and skills in new contexts than when science is experienced with an STS teaching approach

2.10 Gender and Academic Performance in Science Education

Gender in science is the classification of the role of male and female in science. According to the World Health Organisation (WHO, 2010), gender refers to the socially constructed roles, behaviour, activities and attributes that a particular society considersappropriate for men and women. The distinct roles and behaviour may give rise to gender inequalities, i.e. differences between men and women that systematically favour one group (WHO, 2010). Hesse-Bieber and Carger(2000), defined gender as the societal meaning assigned to male and female. They further stated that "each society emphasises particular roles that each sex should play, although there is wide latitude in acceptable behaviours for each gender".Gender difference according to Wikipedia, (2010) is a distinction of biological and/or physiological characteristics typically associated with either males or females of a species in general. In the study of humans, socio-political issues arise in classifying whether a sex difference results from the biology of gender.

Barton (1998) observed that one of the most popular and most powerful phrases connected to science education reform in the last decade has been "Science for all". Women in science came into lime light during the United Nations(UN) decade for

women (1976-1985), which addressed women development. The UN activities exposed the low representation of women in science and the challenges confronting women in choosing and performing well in science related fields, (Oakes, 1990; Hanson, 1996; Hammrich, 2000).

Gender differences in education have been shown by various researches that since the 20th century, girls have been increasingly likely to attend school and college (Wikipedia,2010). Worldwide, men are more likely to be literate, with 100 men considered literate for every 88 women. Wikipedia, (2010) stated that in some countries the difference is even greater, for example, in Bangladesh only 62 women are literate for every 100 men.

A lot of studies have been carried out on gender issues such as that of Familokun (1997), who stated that males performed better than females in science. In their research findings, Uhumuavbi and Mamudu, (2009) found out that there was a difference in the performance of male and female students. Female students who were exposed to demonstration method in teaching science performed better than their male counterparts that were equally exposed to the same method.This finding is in contrast to the findings of McKeon and Comber (2003) whose research studies pointed out that female gender performance in science is not fully encouraging. They concluded in their studies that women express lack of confidence in science subjects, which has been lingering for years.

Chin-Chau (1997) investigated the effect of classroom goal structures on children's goal orientation, mathematics achievement and intrinsic motivation. He also assessed gender effects, and the interaction effects between goal structure and gender in these learning situations on the variables related to mathematics learning. The results showed no

significant gender effects on the variables of goal orientation, mathematics achievement, intrinsic motivation, and beliefs about failure.

Drzewiecki and Westberg (1997) carried out a survey on high school students to better understand how students' attitudes toward 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 females' attitude toward mathematics. A 2x2 analysis of variance indicated that there were no significant main effect for gender and instructional methods.

Ogunkola & Bilesanmi-Awoderu (2000) carried out a research on the effectiveness of laboratory-based and lecture methods on students' achievement in Biology and employed a 2x2x2 non-randomized control group pretest-posttest quasi-experimental factorial design, using Analysis of covariance (ANCOVA) to analyse the data collected; they found that students' achievement 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' achievement in Biology using Analysis of Covariance to analyse the data collected; she found that there was no significant main effect of gender on students' achievement in Biology. ViAnn, (2004) investigated differences and the effects of cooperative learning in mathematics classroom setting. The researcher used quasi-experimental design to compare a control section using individualized learning method with three treatment sections using cooperative learning strategy based on the Learning Together model of

Johnson and Johnson (1991). The results revealed no significant gender-related differences, but females achieved slightly higher grades than males.

Pandian (2004) investigated the effects of cooperative computer-assisted learning method on male and female students' achievement in biology. The students were randomly grouped into cooperative computer assisted learning and traditional method groups. The analysis of results indicated that gender did not express any significant influence on biology achievement. However, male and female students in the cooperative computer-assisted instruction group showed remarkable post-test mean differences over their respective counterparts who learned the same biology concepts through traditional method.

Samuel & John (2004) examined how the cooperative class experiment (CCE) teaching methods affect students' achievement in Chemistry. They found that there was no significant difference in gender achievement between the experimental and control groups, but girls had a slightly higher mean score than boys did. More so, 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 achievement between boys and girls exposed to CCE method, both performed significantly better than those taught through conventional lecture method. Other research has also shown a decline in the differences between the genders in the past few decades on standardized test, suggesting that the more exposure that women are getting to math and science classes, the better their scores (Hyde & McKinley, 1997).

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. Work by Eccles, Lord, Roeser, Barber, and Jozefowicz (1997) found that gender differences inenrolment in advanced mathematics courses in high school are mediated by gender differences in expectations for success in math and physics and perceived value of competence in math. Aguele & Uhumniah (2008); Billings (2000); Croxford (2002), found, in their studies at various times, that male students achieved significantly better than female students in science education.

The conclusion drawn by the above researchers could have been attributed to the sex role expectation in most societies, which do not give females the opportunity to exercise mental capabilities in certain area of learning. The better performance of female students exposed to demonstration method in the teaching of science could be attributed to the fact that male students believe that the harder sciences like physics, chemistry and mathematics are meant for them as many of them aspire to go into such professions like engineering, meteorology, architecture etc. For this reason, some of them do not like science subjects with much seriousness but just to complete the number of credit passes required for admissions into higher institutions. In addition to this, the studies of Doherty, (2004) shows that female students feel more at home with science subjects like biology, health science which would lead them into such professions like nursing, teaching, health workers to mention a few which they believe would suit them for the performance of the dual duties of workers and housewives or midwives.This study intends to find out whether the use of STS Instructional Strategy in teaching ecological concepts to slow learners is gender related in relation to their performance and retention of learned concepts.

2.11 Overview of Similar Studies

Science involves active participation of the learner in the learning process, that is, Science is activity-oriented and any teaching that neglects the activity/process aspect of science rather promotes rote learning. STS Strategy has been reported to be very effective in class room instruction as it addresses areas of controversy, economic, social and political concern, such as health or the environment (Hughs, 2002).

In a study carried out by Muhammad, (2009) to determine the effects of STS Instructional Strategy on students' academic achievements and attitude in integrated science at the junior secondary school level using 60 subjects divided into two groups- an experimental and a control group involving pre and post-tests using two instruments; the Integrated Science Achievement Test (ISAT) and Integrated Science Attitude Questionnaire (ISAQ). Her findings revealed that the experimental group exposed to STS Instructional Strategy performed significantly better than the control group exposed to the traditional method. Also, the experimental group retained learning significantly better than the control group. The experimental group showed significantly more positive attitude towards Integrated Science learning when compared to the control group, and lastly, she found out that there was no significant difference in the mean academic achievement scores of boys and girls within the STS group.

Olorukooba and Lawal (2010) investigated the effects of Science Technology and Society (STS) approach and lecture method on academic achievement and development of creative traits of Junior Secondary School integrated science students. The sample consisted of 87 students, Integrated Science Achievement Test (ISAT) with reliability of 0.86 and t test statistical analysis were used. The results indicated that students exposed to STS approach performed significantly better than those exposed to lecture method; hence STS produced a higher effect on students' performance.

There are studies showing an improved understanding of concepts closely associated with the teaching context of an STS intervention. For example Ribah, (2011) carried out a research to investigate the effects of Problem Solving InstructionalStrategy on Academic Achievement and Retention in Ecology among Senior Secondary School students with different cognitive preferences in four Senior Secondary Schools in Zaria Education Zone. Two hundred forty students (240) constituted the subjects for the study. A randomly selected sample of one hundred and twenty students who constituted the experimental group were taught using Problem Solving Instructional Strategy, while the remaining 120 students that constituted the control group were taught using the lecture method Instructional Strategy(LMIS). Two Secondary Schools served as the experimental group, while the other two served as the control group respectively. The study adopted the quasi experimental control group pretest, posttest design. Two instruments were used in this study for data collection, namely, the Cognitive Preference Test (CPT), and Ecology Achievement Test (EAT) in Ecology. The CPT was adopted from Heath (1964), while the (EAT) was developed by the researcher. A pretest was administered before the treatment to establish the equivalence of the experimental and control groups using Problem Solving Instructional Strategy (PSIS), while the control group was exposed to the Lecture Method Instructional Strategy (LMIS). The topics covered were basic ecological concepts, major biomes of the world, population studies and ecological factors. These topics have been established by researchers as being very difficult to learn in ecology. Seven null hypotheses were subjected to statistical analyses involving the use of t-test. ANOVA was used to test for the difference in the level of significance in the mean scores of the experimental groups of Recall, Application, Principles and Questioning in favour of the experimental groups in these fields. The result of the study showed among others that there was significant

difference between the posttest mean scores of the experimental and control group of recall variable in favour of the experimental group. Significant differences exist between the posttest mean scores of the experimental and control groups in Application variables in favour of the experimental group. There was significant difference between the posttest mean scores of the experimental and control groups in principles, in favour of the experimental group. Posttest mean scores of the experimental and control groups in principles variable were statistically different in favour of the experimental group. Posttest mean scores of the experimental and control groups in Questioning variable were also statistically different in favour of the experimental group. The posttest mean scores of the experimental and control groups were found to be statistically significant in favour of the experimental group in Retention of the ecology concepts. Seven recommendations were made in the study, one of which was that the study of ecology results in the accruing of many benefits to mankind; therefore the study of ecology is viewed to be very important in Secondary Schools. It was therefore suggested that a wider coverage, patronage and publicity should be accorded the study of Ecology in the school curriculum syllabus, and all facets of human endeavour.

Dambana (2011) conducted a study to find the effects of STS Instructional Strategy on NCE student's academic performance in selected genetic concepts.The study sample consisted of 100 students consisting of 59 male and 41 female students. The control group was taught using the traditional lecture method while the experimental group was taught using the STS Strategy which was based on the jurisprudential model of Pederson (1992). Both groups were pre and post tested using the instrument – the Genetic Concepts Achievement Test (GAT). The findings of his study include; the experimental group exposed to STS Strategy performed significantly better than the control group (exposed to traditional method of instruction). There was no statistically

significant difference between the performance of male and female students taught using STS approach, which showed that STS is gender friendly.

In a study by Agbenyeku, (2012) to examine the effect of advance organisers on the performance and retention of ecology concepts among senior secondary school students in Giwa educational zone with a population of 145 students using intact classes, the subjects were assigned to experimental and control groups through random sampling by balloting. A quasi experimental non-equivalent control group of pretest, posttest and delayed post posttest design was used. The subjects were taught for 6 weeks using advance organisers and lecture method for the experimental group and lecture method only for the control group. Ecology Concept Achievement Test was used as the instrument for the pretest, posttest and delayed post posttest (ECAT). Four null hypotheses were tested; t test statistics was used to determine the level of significance of the two groups at $P \leq 0.05$. The major findings indicated that there is a significant difference in the mean academic performance scores of the experimental and control groups, also there is a significant difference in the retention level of students taught using advance organisers compared to those taught using lecture method only. Based on the findings of the research it was recommended that there should be training and re-training of biology teachers in using and designing advance organisers.

In a research titled “an examination of the extent to which school outdoor activities could enhance senior secondary two students’ achievement in ecology”, Achor and Amadu (2015) examined the extent to which school outdoor activities could enhance senior secondary (SS) two students' achievement in ecology. Non randomized pre-test, posttest control group Quasi-experimental design was adopted. A sample of 160 SS II students from 4 co- educational schools inJalingo metropolis, Taraba State Nigeria was

used. A 40 item instrument called EcologyAchievement Test (EAT) developed by the researchers with reliability co-efficient of 0.95 using Kunder- Richardson formula 21 was used for data collection. The schools were grouped into 2; theexperimental group was taught using school outdoor activities while the control group was taughtusing lecture method. Intact classes were used in all the schools. Students were pre tested, treated for6 weeks and Post tested. Data collected were analysed using mean, standard deviation to answer theresearch questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05level of significance. The result shows that there was a statistically significant difference between the mean achievement scores of students taught using outdoor activities and those taught using lecture method. There was no statistically significant difference between the mean achievement scores of boys and girls exposed to school outdoor activities. Similarly, there was no statistically significant interaction effect of method of teaching and students gender on their achievement in ecology. It was recommended among others that teachers should use school outdoor activities strategy in teaching ecological concepts in biology and seminars,workshop,conferences, in-service trainings, annual teachers vacation courses and refresher courses should be organized to train them.

From previous studies, specific studies on STS and academic performance with particular reference to ecological concepts among slow learners in biology are limited; hence the need to carry out this study to see and compare the obtainable results in comparison to previous researches.

2.12 Implication of Literature Reviewed on the Present Study

The literature reviewed shows that there is a need for a change in the approaches and methods of teaching sciencesfrom a teacher centred to a student centred approach (especially in biology). Some studies on how students learn science in schools

wereexamined, the use of innovative strategies such as cooperative learning, problem solving and constructivism in comparison to lecture method were reviewed(Okeke, 1995;Eguabor, 1997; Nwosu and Nzewi, 1998, and Oyegebu, 1999. Also teaching methods used in teaching subjects such as Biology, Physics and Chemistry in relation to academic performance in science were reviewed; (Hamilton-Ekeke, 2007, Azoro, Onoja, and Egeruoh, 2011).Gender related issues in relation to academic performance in the sciences were studied.

Related literature reviewed for the purpose of this study revealed thatthe use of STS Instructional Strategyenhanced students' performance as well as retention of concepts learned in science. The use of lecture method has been seen in the reviews not to be of much help to the learners in enhancing their performance and retention abilities.

In addition STS Instructional Strategy has been found by Mohammad (2009), and Dambana (2011), to have effects on such variables as attitude and gender. These variables have been shown to have effects on learning.

Most of the studies conducted previously focused on whole class without regard for slow learners in biology; therefore this study stands out from all the other previous researches in nature of its homogeneity asmost researches cited had heterogeneous subjects. Therefore, there is the need to investigate the impact of using STS Instructional Strategy on the academic performance and retention of ecology concepts among slow learners in Kaduna, Nigeria so as to add to the existing body of knowledge in this area.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This studyinvestigated the impact of STS Instructional Strategy on the Academic Performance and Retention of Ecology Concepts among Slow Learners in Senior Secondary School Students, in Kaduna Inspectorate. The chapter is discussed under the following sub-headings;

- Research Design
- Population for the Study
- Sample and Sampling Procedure
- Selection of Topics for the Study
- Instrumentation
- Pilot Study
- Administration of Treatment
- Data Collection Procedure
- Data Analysis

3.2 Research Design

The design of this study involvedquasi experimental researchdesign involving pre-testposttest and post-posttest. This design was used as advocated by Kerlinger (1973), and Tuckman (1975) because of the advantages of the design such as identifying differences between the groups involved at the beginning of the study, and also the design serves as an indicator on whether or not a particular teaching strategy is superior to the other. A pretest was carried out to find out if the two groups were comparable

before commencement of the treatment.After 6 weeks of teaching the two different groups,

using STS Instructional Strategy for the experimental group and Lecture Method for the control group, a posttest wasadministered to the two groups.The scores from the test were analysed using descriptive statistics to determine the effects of using different teaching strategies on academic achievement. The post-posttest was used to determine thelevel of retention of the concepts taught. The post-posttest wasadministered two weeks after the posttest to find out the retention ability of the two groups. This duration of two week interval was given to allow for a time frame for concept recall.

The design of the study is represented in Figure 3.1

EG----------➔ O_1----------➔X_1----------➔O_2----------➔O_3

CG----------➔O_1 ----------➔X_0----------➔O_2----------➔O_3

Figure 3.1 Research Design Illustrations

Where;-

EG = Experimental Group

CG = Control Group

X_1 = STS Instructional Strategy

X_0= Lecture Method

O_1 = Pretest

O_2 = Posttest

O_3 = Post posttest

3.3 Population for the Study

The population of the study comprised of 190 year two(SS11) science students in the two co-educational public schools of Kaduna inspectorate zone in Kaduna. This population was used in accordance to Kerlinger (1973), Fraenkle and Wallen (2000).

The SSII students were selected for this study because they have adequate background knowledge in biology,and are less busy than SSIII students who are in their final stage, preparing for exams. The schools in the population usedfor this study are presented in Table 3.1.

Table 3.1: Population of the Study

No.	Name of School	Type of School	Location	Gender		Total number of SSII Students
				Male	Female	
1.	G.D.S.S. U/Sarki	Co-educational	U/Sarki	30	50	80
2.	Kaduna Capital School	Coeducational	Malali	45	65	110
	Total			**75**	**115**	**190**

Source: Educational Resource Centre, Kaduna (2011)

3.4 Sample and Sampling Procedure

The sample of the study comprisedof all the identified slow learners in the two co-educational schools. The slow learners were identified and purposively selected from their teachers three consecutive exam records in Biology. Among 190 SSII Science students in both schools, 50 students who consistently scored below average in three consecutive exams were selected and referred to as slow learners for the purpose of this study. This is because Shanmukhappa (1978) Ofonime (2007) described slow learners as learners whose academic achievement are judged below average in 3 consecutive examinations.Details of the sample are as shown in Table 3.2. The use of 50 students as sample size was used in line with the central limit theorem that recommended a minimum of 30 subjects as adequate sample size for experimental studies of this nature as stated by Kerlinger (1973), Fraenkle and Wallen (2000) and Sambo (2008).

Table 3.2: Sample of the Study

S/No	Group	No. of Students Present	No. of Slow Learners Males	Females	Total
1.	Experimental	80	08	12	20
2.	Control	110	12	18	30
	Total	**190**	**20**	**30**	**50**

Assignment to experimental and control group was done by a simple toss of a coin, with a school assigned to head and the other tail. The school with head was the experimental group while that of tail, the control group.

G.D.S.S U/Sarki- Experimental Group, Kaduna Capital School- Control Group.

3.5 Selections of Topics for the Study

The topics selected for the study are;

i. Ecology of organisms and their habitats
ii. Ecological decomposition in nature
iii. ecological management
iv. tolerance and adaptation in Ecology
v. pollution in Ecology

Ecology covers 45.17% of the entire Biology Curriculum and is found to be neglected by teachers during the teaching activities (Eguabor, 1997).Thereasons for selecting the above topics were because students perform poorly in ecologyand resources used for the study can easily be obtainedfrom the environment, which gives for active participation of learners and also the direct influence on human social life.

3.6 Instrumentation

The instrument for data collection was Biology Performance Test (BPT) for pretest posttest and post-posttest.

3.6.1 BPT (Biology Performance Test)

The instrument comprised of thirty (30) multiple choice items based on the concepts that were taught.The instrument was developed by the researcher based on SS_2 syllabus on the area of the topics taught. Each question carries one mark with a sum total of 30 marks for the BPT.

*3.6.1.1.*Validation of BPT

The instrument was subjected to face and content validation by three senior lecturers of PhD status in Science Education Department of Ahmadu Bello University, Zaria, and two teachers with at least 5 years' experience who teach biology in senior secondary school. The teachers critically examined the appropriateness of the items of the instrument using test blueprint and item analysis. The test items were carefully drawn to ensure that the items fell within the specific areas that have been selected for the purpose of the study.These experts among other things, critically assessed BPT with respect to these criteria:

a.whether or not the statements in the tests were clear, readable, hard or too simple for SSII students;

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

c.gave suggestions and criticisms that were helpful in improving the quality of the test items. Their suggestions were taken into consideration in the final

formulation of the test instrument before administration. Among the 40 questions submittedcorrected and approved, 30 were selected.

The detail of item specification for BPT based on selected topics is shown in Table 3.3

Table 3.3: Table of Specifications (Test Blue Print)

Objective/ Content	Weight	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
	%	20%	20%	20%	10%	10%	20%	100%
Organisms and their habitats	20	0	1	1	1	1	1	5
Decomposition in nature	20	1	0	1	1	1	1	5
Ecological management	20	1	1	0	1	1	1	5
Tolerance	10	1	1	1	0	1	1	5
Adaptation	20	1	1	1	1	0	1	5
Pollution	10	1	1	1	1	1	0	5
Total	**100**	**5**	**5**	**5**	**5**	**5**	**5**	**30**

Source:(Adapted from Obeka, 2009)

3.7 Pilot Testing

The instrument for the study BPT was pilot tested using the SSII students of G.S.S. Rigachikun. This school is not part of the population used for this study. The instrument was administered twice with an interval of two weeks using 25 students from a school in the population but not part of the study. The pilot study was done to;

i. find out the characteristics of BPT items through item analysis.

ii. determine the appropriateness of the length of time required to take the test.

iii. determine the appropriateness of the wording of the BPT.

iv. find the reliability of the BPT.

3.7.1 Reliability of the Instrument

The reliability of the performance test was determined by administering the instrument for a pilot test to students who were not a part of the study. The reliability of the instrument was measured by using test-retest method. The researcher administered the same test twice at an interval of two weeks as stated by Tuckman (1975). PPMC-Pearson Product Moment Coefficient statistical formula was used to analyse the results. A reliability coefficient of 0.86 was established.

3.7.2 Item Analysis of BPT

Item analysis was carried out on the data generated from the pilot study in order to determine the facility and discrimination indices. The facility index (FI) of each item of BPT was calculated using the formula: FI= R/T

Where R= number of correct responses

F= total number of students

Wiseman (2002) recommended values within the range of 0.30 to 0.70 for good test item values in assessing achievement. The ranges of 0.30 to 0.65 were chosen for the study. Items whose FI were within these ranges were selected.

The discrimination index of each item of BPT was calculated using scores of the top twenty seven per cent (27%) and bottom twenty seven per cent of the total respondents. This was calculated using the formula given by Furst in Olorukooba (2001). Details of the result are in Appendix IV.

3.8 Treatment of Experimental Group

The researcher taught the experimental group students in the schools selected using the STS method. The lesson plan prepared by the researcher for the STS instructional

strategy was carried out step by step on the selected topics using the STS jurisprudential model adapted from Pederson (1992). The model involved six stages;

1. **Orientation Phase:** This phase involves introducing the students to the topics.The students are prompted to search for information or knowledge on the topic under study. for example, on the topic 'organisms and their environment' the researcher asks the students questions such as:

   'What are plants and animals and where are they found?

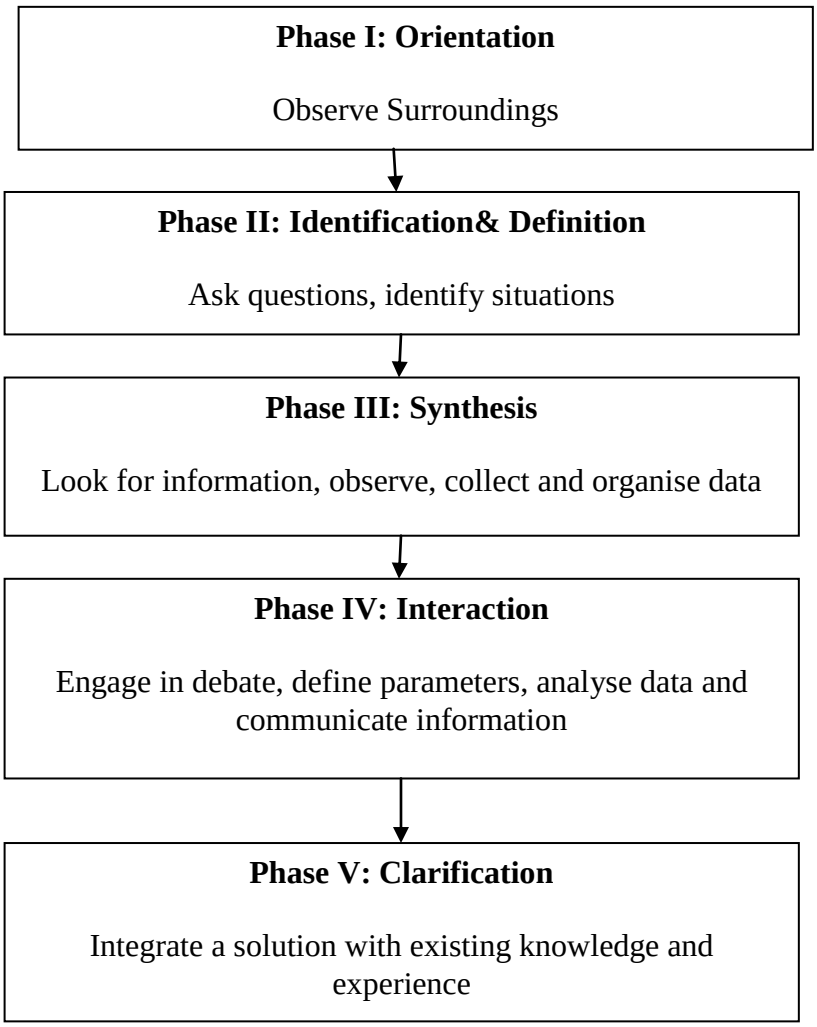
   'Can you explain if there is any existing relationship between them?

2. **Identification and Definition Phase:**Students at this phase were allowed on their own to go for a wide search of information or knowledge on the topic being studied. Students are to engage in a brainstorming search for possible answers to the questions raised in phase 1 on the studied topic. Students look for information,observe specific phenomena and possibly experiment with materials to enable them identify and define the parameters of an investigation or the topic being studied.

3. **Synthesis Phase:** At this phase, students would come up with designs in form of chart graphs or write ups for presentation as possible solution to the question raised in phase 1 on the topic being studied.

4. **Interaction Phase:** In this phase students were involved in a mock public meeting. Students here come up with their respective answers, findings or solutions on the topic being studied for sharing with other groups. This is the time for communicating their individual and group findings, interacting with their fellow students i.e. sharing ideas in a co-operative manner. This could be oral or written reports.

5. **Clarification Phase:** In this phase, studentscome together collectively and cooperatively to identify and clarify possible solutions or answers to the searching questions raised in Phase I with the teacher.The teacher starts with the social implications of the topics, through the ionconcepts and facts about the topic. Finally, the teacher then re-emphasises the scientifically correct ideas about the topics.
6. **Action Phase:** Here, decision or action is taken. Here students rely on information they gain from debating issues with each other and from their own search shared information from other groups and information gained through the STS classroom for decision making or action taking. The course of action students follow will be decided on after a consensus clarification on the topic is reached. Figure 3.2 shows an STS Jurisprudential Model which would be adapted for this study.



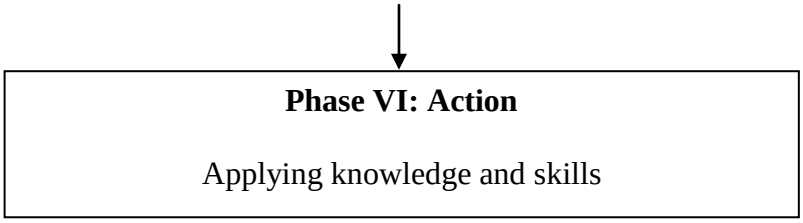


Figure 3.2 Flowchart of STS Jurisprudential Model

Source; (Adapted from Pederson, 1992)

3.8.1 Teaching the Control group

The method of instruction in the control group was the lecture method which is predominantly the method used in teaching by most of the teachers in the schools. Lesson plans prepared by the researcher on the selected topics was taught to this group for six weeks. During the lesson questions were asked by the teacher as they were shown a chart consisting of different habitats and some adaptive features of organisms. Notes were given to the students on ecological management and pollution in ecology.

3.9 Procedure for Data Collection

The researcher administered the BPT as a pre-test to both control and experimental groups before subjecting the students to teaching using the chosen concepts in ecology. After the pre-test, concepts in ecology were taught to the two groups for six weeks, after the six weeks a posttest was administered and collected from the two groups, after two weeks post-posttest was conducted and data required for analysis were collected. The researcher marked the scripts based on the marking scheme with a total of 30 marks. Male and female scores were separated and recorded accordingly. The recorded scores were collated based on the two groups performances and was subjected to data analysis.

3.10 Data Analysis

The research questions that guided this study were;

i. What is the difference in the mean academic performance scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught with lecture method?

ii. What is the difference in the mean scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using lecture method on the retention ability of ecological concepts taught?

iii. What is the difference between the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy?

The null hypotheses that guided this study were;

HO_1 There is no significant difference between the mean academic scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture method.

HO_2There is no significant difference between the retention ability of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture Method.

HO_3There is no significant difference between the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy.

The research questions were analysed using mean and standard deviation, while t-test statistical tool was used to test the hypotheses stated in this study at significance level of $P \leq 0.05$.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This study was carried out to investigate the impact of Science-Technology and Society (STS) Instruction on Performance and Retention of Ecology among Slow Learners in Kaduna. The analysis involved statistical testing of the hypotheses stated in chapters one and three from the results of the data collected. The level of significance adopted for which formed the basis for retaining or rejecting each null hypothesis was stated at P $\leq$ 0.05 level. The statistical tool used was t-test while the research questions were analysed using mean and standard deviation.

4.2 Analysis of Results

For the purpose of data collection, the Biology Performance Test (BPT) was used to measure subject performance in the pre-test, posttest, andpost-posttestfor the experimental and control groups. The data obtained in the course of the study were;

i. Performance score from posttest for both experimental and control groups
ii. Performance scores from post-posttest for both experimental and control groups

Research Question One: What is the difference between the academic performance scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught with lecture method?

To answer question one, a descriptive statistics of mean and standard deviation was used. The detail of the result is presented in Table4.1a

Table 4.1a: Descriptive statistics(mean& standard deviation) results of academic performance between experimental and control groups in the Posttest

Variables	N	$\overline{X}$	SD	Mean Difference
Experimental	20	19.04	6.11	1.44
Control	30	17.60	4.47	

The results in Table 4.1a shows that the experimental group with mean of 19.04 performed higher than the control group with mean of 17.60, with the mean difference of 1.44.To test whether the difference is significant or not, null hypothesis one was formulated and tested using t-test statistic.

Hypothesis One:

HO_1 There is no significant difference between the mean academic scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture method.

To test this hypothesis the posttest scores of the experimental and control groups were compared using t-test statistics. Table 4.1b shows the results obtained.

Table 4.1b: t-test Analysis of Posttest Mean Scores of Experimental and Control Groups

Variables	N	$\overline{X}$	SD	Df	t-cal	t-crit	P
Experimental	20	19.04	6.11	48	4.62	1.96	0.04
Control	30	17.60	4.47				

$\alpha \leq 0.05$

The result presented in Table 4.1b showed that the P-value is 0.04 which is less than the level of significance at $\alpha = 0.05$ with df = 48. This means that there is significant difference between the posttest scores of slow learners exposed to STS Instructional

strategy and those exposed to lecture method and hence, the null hypothesis is rejected. This implies that the experimental group taught ecological concepts using STS instructional strategy performed better than the control group taught the same ecological concepts using lecture method.

Research Question Two: What is the difference between the mean scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using lecture method on the retention ability of ecological concepts taught?

To answer question two, a descriptive statistics of mean and standard deviation was used. The detail of the result is presented in Table 4.2a.

Table 4.2a: Descriptive statistics (mean &standard deviation) results between experimental and control groups in the Post- Posttests

Variables	N	$\overline{X}$	SD	Mean Difference
Post-posttest of Experimental	20	19.60	6.25	1.32
Post-posttest of Control	30	18.28	4.47	

From the Table 4.2a, the performance in retention ability of the control group with mean score of 18.28 and standard deviation of 4.47 is lower than the performance in retention ability of the experimental group with mean score of19.60 and standard deviation of 6.25, with the mean difference of 1.32.

To find out if the difference of the impact of STS instructional strategy on retention ability of slow learners as shown in Table 4.2a is significant or not, null hypothesis two was formulated and tested using t-test statistics.

Hypothesis Two:

HO_2 There is no significant difference between the retention ability of slow learners taught ecologicalconcepts using STS Instructional Strategy and those taught using Lecture Method.

To test this hypothesis, the post-posttest mean scores of the experimental group exposed to STS Instructional Strategy and the control group taught with lecture method were compared using t-test statistics. Table 4.2b shows the results obtained.

Table 4.2b: t-test Comparison of the Post-Posttest mean scores of experimental and control group lecture method

Variables	N	$\overline{X}$	SD	Df	t-cal	t-crit	P
Post-posttest of Experimental	20	19.60	6.25	48	11.37	1.96	0.00
Post-posttest of Control	30	18.28	4.47				

$\alpha \leq 0.05$

The results presented in Table 4.2 revealed that the P-value of 0.00 which is less than thelevel of significance at α =0.05 with df = 48. This means that there is significant difference between the experimental and the control group. Hence,this implies that the retention ability of slow learners taught ecological concepts with STS Instructional Strategy differed greatly from the retention ability of their counter parts taught the same ecological concepts using lecture method. Hence, the null hypothesis is rejected.

Research Question Three: What is the difference between the academic performance of male and female slow learners taught ecological concepts using STS Instructional Strategy?

To answer question three, a descriptive statistics of mean and standard deviation was used. The detail of the result is presented in Table 4.3a.

From Table 4.3a, the performance of females in the experimental group with mean score of 20.40 and standard deviation of 5.77 is higher than the performance of their

male counter parts with mean score of 17.00 and standard deviation of 6.34, and a mean difference of 3.40.

Table 4.3a: Descriptive statistics (mean & standard deviation) of the Posttest Mean Scores of Slow Learners in Experimental group

Variables	N	$\overline{X}$	SD	Mean Difference
Posttest of Male Experimental	08	17.00	6.34	3.40
Posttest of Female Experimental	12	20.40	5.77	

To find out if the difference between the academic performance of male and female slow learners taught ecological concepts using STS Instructional Strategy as shown in Table 4.3a is significant or not, null hypothesis three was formulated and tested using t-test statistic.

Hypothesis Three:

HO_3There is no significant difference between the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy. To test this hypothesis, the posttest mean scores of male slow learners exposed to STS Instructional strategy and their female counterparts were compared using t-test statistics. Table 4.3b shows the results obtained.

Table 4.3b: t-test Analysis of the Comparison of the Posttest Mean Scores of Slow Learners in Experimental group

Variables	N	$\overline{X}$	SD	Df	t-cal	t-crit	P
Posttest of Male Experimental	08	17.00	6.34	18	0.41	1.96	0.53
Posttest of Female Experimental	12	20.40	5.77				

$\alpha \leq 0.05$

From the results presented in Table 4.3, it shows that the P-value is 0.53 which is greater than the level of significance at $\alpha = 0.05$ with df = 18. This means that there is no significant difference in the mean academic performance scores of male and female slow learners exposed to STS Instructional Strategy, hence the null hypothesis is retained. This implies that the performance level of male slow learners exposed to STS Instructional Strategy is the same with their female counterparts.

4.3 Summary of Findings

The findings of the study are summarised as follows;

1. There is significant difference between the posttest scores of slow learners exposed to STS Instructional strategy and those exposed to lecture method in favour of the experimental group.
2. There is significant difference between the ability of retention in slow learners taught ecological concepts using STS Instructional Strategy and those taught using lecture methodin favour of the experimental group.
3. There is no significant difference in the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy. STS is therefore gender friendly.

4.4 Discussion of the Results

The objective of this study was to investigate the impact of the use of STS Instructional Strategyon the Academic Performance and Retention of Slow Learners taught ecological concepts in Senior Secondary Schools in Kaduna. For this purpose the Biology Achievement Test was used to collect data on their performance. The data collected was analysed using t-test statistics at $P \leq 0.05$ level of significance, to test the hypotheses formulated. The results are discussed below.

Hypothesis one states that there is no significant difference between the mean academic scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture method. The result of testing hypothesis one showed that there is significant difference between the posttest scores of slow learners exposed to STS Instructional strategy and those exposed to lecture method. This result shows that the experimental group exposed to STS instructional Strategy performed better than their counterparts that were taught using the lecture method. The result is in accordance with that of Yager and Akcay (2008), who carried out a research to determine whether Science, Technology, and Society (STS) learning increases student concept mastery, general science achievement, use of concepts in new situations, and attitudes toward science in middle school classrooms.The findings indicated that middle school students experiencing the STS format with constructivist teaching practices: (1) learned basic concepts as well as students who studied them directly from the textbook, (2) achieved as much general concept mastery as students who studied in a textbook dominated way.This is also in line with the findings of Pederson (1992), who carried out his study using the Jurisprudential Model-STS, from among the four variables examined; only achievement was found to have no difference between the two groups examined. The study of STS issues (via JPM-STS) provided the students with similar knowledge to achieve on teacher-made objective tests.The findings of this study are also in line with that of Okorafo, (2003), who carried out a research on the effect of STS on achievement in chemistry; she noted that STS Instructional Approach effectively enhanced the understanding of chemistry concepts in students and subsequently improved their performances significantly in the subject more than the traditional approach. The STS Instructional Strategy in this study was able to increase concept mastery of the slow learners thereby making them to perform better in their posttest results.

There is no significant difference in the retentionability of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture Method. The result of testing hypothesis twoas seen in Table 4.2 showed that there is significant difference between the ability of retention in slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture Method.This result is in line with that of Olorukooba (2001), Bichi (2002, 2006),Ezema and Dung (2003), Pradeep (2005), and also Chianson, Kurumeh and Obida (2010). These were studies that compared different instructional strategies in comparison to lecture method of instruction in relation to retention ability of the groups involved. All the results had significant differences higher in the instructional strategy used in each particular study compared to the lecture method of instruction. This study has shown the same result in that, the retention ability as well as concept mastery was also enhanced by the STS Instructional Strategy used on slow learners. This may be due to the fact that the students were opportuned to be in contact with their learning environment.

There is no significant difference between the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy. The result of testing hypothesis three as seen in Table 4.3 showed that there is no significant difference between the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy. Girls in this case slightly retained better than boys and this supports Samuel & John (2004) who examined how the cooperative class experiment (CCE) teaching methods affect students' achievement in Chemistry. They found that there was no significant difference in gender achievement between the experimental and control groups, but girls had a slightly higher mean score than boys did. More so, 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 achievement between boys and girls exposed to CCE method, both performed significantly better than those taught through conventional lecture method. From the results shown it can be assumed that STS Instructional Strategy is gender friendly. This finding agrees with that of Dambana (2011),Muhammad (2009), Bichi (2008), Mari (2007), Usman (2000), and Oke (2004) who found no significant difference between boys and girls science achievement in activity based methods of instruction such as STS. The result indicates that STS instructional strategy is gender friendly. This study has given open opportunities to both genders even though the females performed slightlybetter than the males in the STS group in their post test scores. The findings in this research stand out as compared to others that have been carried out which are heterogeneous in nature of ability levels, in this study, the impact of STS instruction on performance and retention of ecology among slow learners was investigated, which is homogeneous in nature and has given positive results.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study investigated the impact of STS Instructional strategy on academic performance and retention of ecological concepts among slow learners in senior secondary school.This chapter gives a summary of the study, methodology used, the conclusions made from the study, and the recommendations based on the findings from the study are presented.

5.2 Summary of the Study

The study examined the impact of STS Instructional strategy on academic performance and retention of ecological concepts among slow learners in senior secondary school. The variables involvedin this study are:

a. Performance

b. Retention

c. Gender differences

The study population was restricted to the one hundred and ninety (190) SSII science students of the two co-educational schools in Kaduna metropolis. From this population a sample size of 50 students (20 males and 30 females) who represent slow learners as identified from their teacher's record were purposively selected. It involved teaching ecological concepts using an adapted model of STS instructional strategy of Pederson (1992) to the experimental group.The objectives of this study were to:

i. determine the effect of STS Instructional Strategy on students' academic performance in S.S.S. biology;

ii. investigate if the use of STS Instructional Strategy enhances retention of learned ecological concepts among senior secondary students.

iii. assess if gender differences exist between performance scores of slow learners taught using STS Instructional Strategy.

Three Research Questions corresponding hypotheses were formed for the study as follows;

i. What is the difference between the academic performance scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught with lecture method?

ii. What is the difference between the mean scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using lecture method on the retention ability of ecological concepts taught?

iii. What is the difference between the academic performance of male and female slow learners taught ecological concepts using STS Instructional Strategy?

The null hypotheses formulated for this study for testingat 0.05 level of significance were;

HO_1 There is no significant difference between the mean academic scores of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture method.

HO_2 There is no significant difference between the retention ability of slow learners taught ecological concepts using STS Instructional Strategy and those taught using Lecture Method.

HO_3 There is no significant difference between the mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy.

The study nature was quasi experimental- control design, using STS and lecture method respectively. The concepts selected for the study were

i. organisms and their habitats
ii. decomposition in nature
iii. ecological management
iv. tolerance and adaptation
v. pollution

The lessons were planned based on the scheme of work for these concepts as outlined in the SSII biology syllabus.Six weeks intensive teaching was conducted by the researcher, after which a posttest was administered. A postposttest was administered four weeks after the posttest to test the retention ability of the concepts learnt after instruction. Data was collected using the biology performance test (BPT) made up of 30 multiple choice questions, and was analysed using t-test statistical tool to test hypothesis 1-3. The results and discussion are reported in chapter four.

5.3 Summary of Findings

The findings revealed the following:

1. Slow learners taught using STS performed better than those taught using lecture method.
2. Retentionability of slow learners taughtconcepts using STS Instructional Strategy was better than those taught using Lecture Method.
3. The mean academic scores of male and female slow learners taught ecological concepts using STS Instructional Strategy had no difference.

5.4 Conclusions

From findings of this study, it is concluded that STS Instructional strategy can be used effectively to teach slow learners ecological concepts in secondary schools as the strategy gave positive impacts on their performance and retention of concepts learnt, and alsoit was found to be gender friendly.

5.5 Recommendations

From the findings of this study, the following recommendations are made:

1. The teaching of concepts in science and biology at the senior secondary school level in particular should be done in such a way that slow learners are able to effectively learn and retain concepts taught to them. The use of STS Instructional strategy seems to have the potential to attain this goal. It can therefore be used in teaching concepts in biology at the senior secondary school level to enhance academic achievement.
2. The use of lecture method of teaching has been found to be relatively in adequate in comparison to STS Instructional strategy in this study, with respect to performance and retention in the learning of ecology concepts among slow learners in biology.Science teachers at the senior secondary school level should be cautious of the teaching methods they employ in teaching to bring about the wanted and desired results of better achievements and retention of knowledge by all students.
3. There should be proper training and re-training of biology teachers at the senior secondary school level in different forms such as workshops, seminars and conferences to focus on how to use STS Instructional Strategy for the teaching of Biology concepts. The government or relevant professional bodies like Science Teachers Association (STAN) could do this.

4. Science curriculum developers and educators should produce text books and teachers guides based on STS model of teaching and learning strategy at the senior secondary school level.

5.6 Limitations of the Study

The limitations observed in the course of this study include:

i. The sample size used in this study was 50 slow learners; a larger sample size might give better generalizable results.

ii. The conclusion reached about the impact of STS Instructional Strategy on the academic achievement and retention of ecological concepts among slow learners in this study is only limited to some ecological concepts.

5.7 Contributions to Knowledge

This study has shown that;

1. Slow learners that were taught ecological concepts using the STS Instructional Strategy adapted by the researcher and modified in this study did well and were able to perform better than their counterparts in the control group.
2. Most research reports in science education at secondary school level make use of students with heterogeneous abilities without considering the slow learners. Based on the findings above, slow learners need to be carried along in all aspects of science education. The study has contributed to existing body of knowledge in paving a way in which slow learners can be assisted in teaching and learning.
3. STS Instructional Strategy adapted and modified by the researcher has societal relevance, so it enhanced knowledge making learning to be meaningful and applicable. Such areas of societal relevance include greenhouse effect, global warming and depletion of the ozone layer.

4. This study has shown that slow learners can be helped to achieve if taught using the context of human experiences which are real and not abstract; in applying knowledge and skills in life.

5.8 Suggestions for Further Studies

1. Similar studies on slow learners should be carried out focusing on the teaching of other science subjects using STS Instructional strategy with a view to finding out if similar or different results as in this study may be obtained.
2. This study can be extended to the tertiary level of education to investigate if level has an effect on the variables that this study dealt with.
3. This type of study could be carried out in other topics in genetics, evolution, and areas not treated in ecology to find out the outcome of the results in biology teaching.

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APPENDIX I

BIOLOGY PERFORMANCE TEST (BPT)

SECTION A: Bio Data

Preamble;

Name of School:.....

Class:.....

Sex: Male ☐ Female ☐

Age:.....

Time Limit: 40 mins

SECTION B: Items on ecological concepts

Instructions:

A. Answer all the questions

B. Each question is followed by four options lettered A toD. Find the correct option and shade in pencil on your answer sheet for each question. The number for the answer should correspond with the question number. Give only one answer per question.

1. The substances recycled in the soil by the activities of micro-organisms during the decay of dead organisms are first utilised by the
   a. carnivores
   b. herbivores
   c. scavengers
   d. autotrophs
2. Which of the following associations can upset the balance in nature?
   a. Epiphytism
   b.parasitism
   c. symbiosis
   d. saprophytism
3. Which of the following statements is not correct about the ecological effects of agricultural activities?
   a. The use of herbicides and pesticides in farms can cause pollution
   b. Bush burning encourages desertification
   c. Excessive use of fertilisers in farms may have harmful effects

d. Monocropping is one of the cultural methods of controlling pests

4.Epiphytes are plants which:

a. are in symbiotic association with higher plants
b. are parasites of higher plants mainly in rain forests
c. live on top of others and abound in rain forests
d. dominant vegetation in a rain forest

5. Which of the following is not released during decay of living matter?

a. ammonia
b. oxygen
c. Carbon dioxide
d. Heat energy

6. Which of the following organisms will not bring about decomposition?

a. Earthworm
b. Bacterium
c. Mould
d. spirogyra

7. Which of the following substances is not recycled in an ecosystem?

a. Carbon
b. Energy
c. Water
d. Nitrogen

8. Which of the following physical factors is likely to affect the distribution of plants in a pond?

a. Light
b. Humidity
c. Wind
d. Temperature

9. Which of the following is an effect of carbon monoxide on man?

a. Irritating the skin
b. Reducing oxygen carrying capacity of blood
c. Causing gene mutation
d. Destroying white blood cells

10. The physical and chemical factors which affect the life of an organism in an environment is described as

    a. Biotic
    b. Edaphic
    c. Abiotic
    d. Physiographic

11. Which of the following is not applicable to the circulation of water in nature?

    a. Water removed from oceans are permanently lost
    b. Water constantly evaporates from the seas, rivers, lakes and soil
    c. Water vapour rises, cools, condenses and precipitates as rain and dew
    d. Water is absorbed by plants and animalsfrom their external environment

12. The morphological, physiological and behavioural characteristics which enable an organism to survive in its environment is called

    a. Heredity
    b. Ecology
    c. Competition
    d. Adaptation

13. Which of the following best describes the adaptation of the earthworm to its habitat?

    a. Living in burrow during the day to prevent desiccation
    b. Burrowing into soft soil to store food
    c. Possession of segmented body to reduce movement
    d. Possession of a few bristles for defence

14. Micro-organisms which breakdown dead organisms and absorb their contents are called

    a. decomposers
    b. consumers
    c. parasites
    d. commensals

15. Which of the following can cause desert encroachment?

    a. afforestation
    b. irrigation
    c. establishment of game reserves
    d. overgrazing

16. Desert plants are usually called
    a. hydrophytes
    b. mesophytes
    c. xerophytes
    d. sporophytes
17. A situation whereby some mammals remain inactive throughout dry and hot seasons is known as
    a. aestivation
    b. dormancy
    c. burrowing
    d. incubation
18. Ecology is defined as:
    a. The study of animal and plant resources
    b. The branch of biology which studies plant and animal relationships with their natural environment
    c. The science of plant and animal varieties in an environment
    d. The study of the environment and the living things that are in it
19. Major pollutants of the atmosphere are:
    a. Chemical wastes of factories
    b. Exhaust fumes of cars and lorries
    c. Untreated sewage
    d. domestic wastes
20. Which of the following water pollutants may contain organisms that cause dysentery?
    a. pesticides
    b. sewage
    c. industrial wastes
    d. fertilisers
21. In an association between an alga and a fungus, the algaphotosynthesises for the colony while the fungus absorbs and stores water for the colony. This is an example of
    a. parasitism
    b. predation
    c. commensalism
    d. symbiosis

22. Which of the following is not an adaptation of plants or animals to desert environment?
    a. Well-developed tap root system
    b. Small leaves with thick epidermis
    c. Metabolic waste in the form of uric acid in some animals
    d. Broad leaves for storage
23. Which of the following plants can enter into a symbiotic association with a bacterium which improves the soil?
    a. Tomato
    b. Yam
    c. Bean
    d. Okra
24. Which of the following does not illustrate adaptation to the environment?
    a. Colour changes by chameleon
    b. Streamline shape of fishes
    c. Light bones in birds
    d. Development of big muscles by a weight lifter
25. The process whereby microorganisms can convert atmospheric nitrogen into nitrogenous compound is known as
    a. Nitrogen cycle
    b. Nitrogen fixation
    c. Denitrification
    d. Decomposition
26. The failure of a species to adapt to any environment leads to
    a. Domination
    b. Competition
    c. Extinction
    d. Adaptation
27. One of the most important characteristics of desert plants is the possession of
    a. very thin leaves
    b. poorly developed roots
    c. special water storage tissues
    d. exposed stomata

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

    a. Make the soil black
    b. Increase the mineral salt content
    c. Provide food for all living organisms
    d. Increase the acidity of the soil

29. Which of the following describes sewage?

    a. Decaying organic material
    b. Water-borne domestic and industrial wastes in drains
    c. Gaseous products such as carbon monoxide and hydrogen sulphide
    d. Water containing different types of bacteria and viruses

30. Reptiles are able to survive hot environments due to

    a. long tails
    b. presence of gular fold
    c. presence of claws
    d. presence of rough body covered with scales.

APPENDIX II
BIOLOGY PERFORMANCE TEST (BPT)ANSWER SHEET

Name of School:.....

Class:.....

Sex: Male ☐ Female ☐

Age:.....

1.	=A=	=B=	=C=	=D=	16.	=A=	=B=	=C=	=D=
2.	=A=	=B=	=C=	=D=	17.	=A=	=B=	=C=	=D=
3.	=A=	=B=	=C=	=D=	18.	=A=	=B=	=C=	=D=
4.	=A=	=B=	=C=	=D=	19.	=A=	=B=	=C=	=D=
5.	=A=	=B=	=C=	=D=	20.	=A=	=B=	=C=	=D=
6.	=A=	=B=	=C=	=D=	21.	=A=	=B=	=C=	=D=
7.	=A=	=B=	=C=	=D=	22.	=A=	=B=	=C=	=D=
8.	=A=	=B=	=C=	=D=	23.	=A=	=B=	=C=	=D=
9.	=A=	=B=	=C=	=D=	24.	=A=	=B=	=C=	=D=
10.	=A=	=B=	=C=	=D=	25.	=A=	=B=	=C=	=D=
11.	=A=	=B=	=C=	=D=	26.	=A=	=B=	=C=	=D=
12.	=A=	=B=	=C=	=D=	27.	=A=	=B=	=C=	=D=
13.	=A=	=B=	=C=	=D=	28.	=A=	=B=	=C=	=D=
14.	=A=	=B=	=C=	=D=	29.	=A=	=B=	=C=	=D=
15.	=A=	=B=	=C=	=D=	30.	=A=	=B=	=C=	=D=

APPENDIX III
MARKING SCHEME OF BPT

1. d	6. d	11. a	16. c	21. d	26. c
2. b	7. b	12. d	17. a	22. d	27. c
3. c	8. a	13. a	18. b	23. c	28. b
4. c	9. b	14. a	19. a	24. d	29. b
5. b	10. c	15. d	20. b	25. b	30. d

1 mark× 30 — TOTAL 30 MARKS

APPENDIX IV

ITEM ANALYSIS OF BPT

S/N	$F = \frac{R}{T}$	$D = \frac{\frac{Ru-Rl}{1N}}{2}$
1	0.63	0.46
2	0.60	0.40
3	0.43	0.33
4	0.40	0.26
5	0.37	0.33
6	0.33	0.26
7	0.60	0.66
8	0.66	0.60
9	0.63	0.33
10	0.66	0.80
11	0.50	0.33
12	0.57	0.33
13	0.33	0.26
14	0.66	0.40
15	0.83	0.46
16	0.53	0.53
17	0.33	0.40
18	0.47	0.40
19	0.57	0.33
20	0.37	0.33
21	0.47	0.26
22	0.47	0.40
23	0.33	0.40
24	0.33	0.40
25	0.43	0.33
26	0.33	0.26
27	0.43	0.46
28	0.57	0.33
29	0.40	0.26
30	0.37	0.33

APPENDIX V
LESSON PLAN USING THE STS INSTRUCTIONAL STRATEGY

EXPERIMENTAL GROUP

LESSON1. **WEEK I**

Mode of Teaching - STS Instructional Strategy

Group - Experimental

Subject - Biology

Topic: Ecology

Sub-Topic: Organisms and their habitats

Time – Double period (80 minutes)

B/Objectives: By the end of the lesson, the students should be able to;

1. Define terms related to ecology
2. List ecological components
3. Discuss ways on improving the ecological balance in nature

Previous Knowledge: Students have learnt about the different phyla in the plant and animal kingdoms. They are also familiar with their characteristics and can distinguish between them.

STEP 1: Orientation Phase;

Teacher introduces the topic ecology by asking some questions based on their previous knowledge

i. What are plants and animals and where are they found?
ii. Is there any relationship between them?
iii. Can the plant or animal survive on its own without resources from its environment?
iv. What elements, components or conditions surround these organisms?

STEP II: Identification and Definition Phase;

Teacher asks the students to go around the area (environment), and then search for answers to the questions that were raised. Teacher allows the students to interact and discuss.

STEPIII: Synthesis Phase;

Teacher asks students to observe their surroundings and asks which branch of biology they can infer to, that we are about to study. Teacher shows them an ant on a tree, a mushroom at the trunk and a toad under a rock.

STEP IV: Interaction Phase;

Students in their groups organise themselves and discuss their findings for presentation and sharing in a cooperative manner. It could take the form of oral or written reports.

STEP V: Clarification Phase;

Students come together to identify possible solutions or answers to questions in phase 1 with the teacher.

- Teacher explains to students that plants and animals depend on their surroundings to obtain materials which enable them to function properly.
- Teacher explains that organisms living in a habitat are influenced by certain factors which vary from habitat to habitat. Such factors include abiotic [non-living] factors such as; climatic factors
  ; topographic/ physiographic factors
  ; edaphic /soil factors
- Teacher explains each factor in detail, relating to the place they are in the environment. Teacher explains that organisms are found in different places living there and they carry out all their basic activities therein. (habitat)

STEP VI: Action Phase;

Students make decisions and take action based on the information gained from the interactions with their mates and the teacher. The action here involves definition of terms, explanations of observations and their conclusions.

Evaluation: Teacher asks students the following questions;

i. Define the following terms - a) ecology b) habitat c)flora d)fauna
ii. Is there any relationship between organisms and their environment? If so, describe.

Conclusion: Teacher asks students to explain in their own words how nature relates with organism

LESSON 2WEEK II

Mode of Teaching - STS Instructional Strategy

Group - Experimental

Subject - Biology

Topic: Ecology

Sub-Topic: Decomposition in nature

Time – Double period (80 minutes)

B/Objectives: By the end of the lesson, the students should be able to;

i. Define decomposition
ii. State gases evolved during the process of decomposition
iii. List micro and macro decomposers
iv. Enumerate the role of decomposers

Previous Knowledge: Students have been around the school dump and have learnt about the major cycles in nature and also their importance.

STEP I: Orientation Phase;

Teacher introduces the topic decomposition in nature by showing them a heap of refuse mainly of plant and animal matter. Teacher asks the students the following questions

i.What process occurs in this dump?
ii. Is it of any benefit to us?
iii.Teacher tells students to observe a decaying piece of log.
iv.What can biodegradable materials be used for?
v.How do these organisms function?

STEP II: **Identification Phase**;

Teacher asks the students in their various groups to examine the heap of refuse and list its component. Also the students should observe its colour(s) and smell(s).Students identify the values and value conflicts as they interact with oneanother.

STEP III:Synthesis Phase;

Teacher leads the students to gather information and ideas on the topic by leading them out to the environment. Teacher explains to the students that where ever there is a collection of trash, garbage, remnants of food etc. which is disposed of on a piece of land, there exist some biochemical processes which occur in that environment.

STEP IV: Interaction Phase;

Students in their groups organise themselves and discuss their findings for presentation and sharing in a cooperative manner. It could take the form of oral or written reports.

STEP V: Clarification Phase;

Students come together to identify possible solutions or answers to questions in phase 1 with the teacher.

- There are a group of organisms which are responsible for the breakdown of dead organic materials which could be of either plant or animal origin.
- These organisms cause the remains of plants and animals to decay. These organisms are called decomposers. They are mainly bacteria and saprophytes.
- Decomposers are grouped into 2classes
    i. Micro-decomposers; which are small microscopic organisms that can cause decay e.g. certain bacteria and fungi.
    ii. Macro-decomposers; which are bigger organisms that can cause decay of dead organic materials, e.g. earthworms, termites, snails, mushrooms, toad stools etc.
- The process of decomposition involves secretion of enzymes by the decomposer onto its food source. Enzymes breakdown complex organic compounds like carbohydrates and proteins into simple soluble inorganic compounds. In the process chemical energy in the organic compound is lost as heat energy. The decomposer absorbs only a little amount of nutrients and energy for its use. The rest of the nutrients are released into the soil, air and water.
- When decomposers die, other decomposers feed on them. The nutrients released are used by plants to manufacture their food.
- Teacher explains the role of decomposers in the ecosystem such as;
    a. Enriching the soil with nutrients required for plant growth.
    b. They contribute to environmental pollution.
    c. It is useful in the making of cheese and yoghurt.

d. They function in recycling nutrients.
e. They help in preventing the accumulation of remains and wastes of livingorganisms on the earth's surface.

- The products released during decomposition include gases such as CO_2, H_2S, NH_4 and H_2O vapour. Others are heat energy and nutrients such as nitrates, sulphates, phosphate ions etc.

STEP VI: Action Phase;

Students make decisions and take action based on the information gained from the interactions with their mates and the teacher. The action here involves the application of the knowledge obtained about decomposers in soil enrichment, possible ways of preventing environment pollution, explanations of observations and their conclusions.

Evaluation: The students should be able to answer the following questions;

1. What is decomposition and what is a decomposer?
2. What are the importance of decomposers?
3. Enumerate products released during decomposition.

Conclusion: Teacher goes over lesson briefly as students make final jottings of summary.

Assignment: Students are to make a heap of compost made up of living matter in their backyard at home. Observe the process of decomposition.

LESSON 3. **WEEK III**

Mode of Teaching - STS Instructional Strategy

Group - Experimental

Subject - Biology

Topic: The organism and its environment

Sub-Topic: Ecological management, tolerance and adaptation.

B/Objectives: by the end of the lesson, the students should be able to;-

i. Recognise some of the different types of associations existing between different species.
ii. Identify beneficial, harmful and neutral forms of associations among organisms.
iii. Deduce the mode of life of a given organism from observed characteristics.
iv. Discuss why living things possess a range of tolerance to environmental factors
v. List the abiotic factors that impose tolerance on organisms
vi. Define adaptation and list examples of adaptation to environmental factors

Previous Knowledge: Students have learnt about decomposition in nature and also the role of decomposers. They have also taken samples of refuse to observe the components, its smell and colour.

STEP I: Orientation Phase;

Teacher introduces the lesson by asking questions based on their previous knowledge such as;

i. Is there any relationship that exists between a decomposer and its environment?
ii. If there is, is it beneficial or harmful?

Teacher introduces the topic on ecological management "Association" by telling the students to observe a plant growing right on another plant in the garden. The teacher asks "what is an association?" Teacher tells the students to examine the type of vegetation around them. . Students are asked what "tolerance" is and lastly what "adaptation" is.

STEP II:Identification phase;

Teacher lists types of associations which include symbiosis, parasitism, mutualism, commensalism etc. Teacher sites examples in relation to plants and animals regarding each association. Teacher asks students to look for examples of such associations which are in the surrounding environment.

STEP III: Synthesis phase;

Teacher leads the students to gather information and ideas on the topic. Students think of possible solutions to the questions in phase 1. Teacher explains what tolerance is and why living things possess a range of tolerance to environmental factors.

STEP IV: Interaction phase;

Students in their groups organise themselves and discuss their findings for presentation and sharing in a cooperative manner. It could take the form of oral or written reports.

STEP V:Clarification phase:

Students come together to identify possible solutions or answers to questions in phase 1 with the teacher.

- Teacher explains adaptation as a modification in response to environmental factors. It occurs both in plants and animals
- Teacher also explains that there are factors which impose tolerance on organisms which are abiotic.
- Teacher gives examples in relation to plants and animals, and shows the students examples found in the environment.
- Teacher explains the two main types of adaptation structural and behavioural adaptations.

STEP VI: Action Phase;

Students identify the benefits of associations, tolerance, and adaptations to various organisms.

Evaluation: Teacher evaluates the lesson by asking students questions based on what had been taught.

1. What is association?

2. Give an example of both a beneficial and harmful association with examples.

3. What is tolerance?
4. What are the factors that impose tolerance on organisms?
5. What is adaptation?
6. Give examples of organisms andtheir adaptations.

Conclusion: Teacher concludes the lesson by summarising the key points and giving students short notes to copy.

Assignment: Draw the structural adaptation found in a named bird.

LESSON 4 **WEEK IV**

Mode of Teaching - STS Instructional Strategy

Group - Experimental

Subject - Biology

Topic: The organism and its environment

Sub-Topic: Pollution

B/Objectives: by the end of the lesson the students should be able to;

i. Define pollution
ii. Name and describe the different types of pollutants and their sources
iii. Enumerate the harmful effects of pollutants
iv. State the effects of detergents, insecticides, artificial fertilisers and herbicides on aquatic and terrestrial organisms
v. Identify poor sewage systems as a source of pollution
vi. Name domestic and industrial wastes that pollute land and water
vii. Identify the decay of organic matter (e.g. dead animals and plants) as a source of pollution

Previous Knowledge: Students have learnt about ecological management, tolerance and adaptation.

STEP I: Orientation Phase;

Teacher introduces the topic pollution byasking the students to look around their surroundings to see if there is anything wrong with it, also teacher takes the students to a nearby stream to observe.

STEP II: Identification Phase;

Teacher after allowing students in their various groups to observe their surroundings asks what effect smoke and dust have in relation to plants and animals, and diseases caused with examples. Students interact with one another

to find solutions for the raised question. Pollution is the addition/ introduction/ release by man of unwanted substances, elements, energy or materialsinto theenvironment in quantities/ amounts which may be harmful/ dangerous/ hazardous to living organism's existence.

STEP III: Synthesis phase;

Teacher leads the students to gather information and ideas on the topic. Students think of possible solutions to the questions in phase 1. Teacher explains the types of pollution; air pollution, water pollution, land/ soil pollution, noise pollution, that the harmful substance or energy which causes pollution of the environment is termed pollutants.

STEP IV: Interaction phase;

Students in their groups organise themselves and discuss their findings for presentation and sharing in a cooperative manner. It could take the form of oral or written reports.

STEP V: Clarification phase;

Teacher listens to the findings of each group and presents it to the whole class for clarification.

- Each of these pollutants have their sources, i.e. they are named after the portion of the environment they pollute e.g. teacher shows the students the carbon being produced by a car and a motor cycle- air pollution. Also the dark black oily substance found in the stream is also a source of water pollution. Untreated sewage is also another pollutant of waters. Pollutant sources of land pollution include refuse, discarded vehicles tins cans and industrial waste.
- Teacher further talks on the sources of each type of pollution such as spraying of crops with pesticides or herbicides, domestic fires – air pollution, its effects such as reduction to visibility within the environment due to fog caused by smoke and dew.
- Effects of water pollution include; restriction of man's resources of water for domestic use, water borne diseases such as cholera, typhoid etc. in land/soil pollution, effects include restriction of man's sources of land for farming and recreational purposes, also the production of unpleasant odour which irritates people.

- Some pollutants are sources of disease germs and breeding ground of disease vectors. Each of these pollutants have their sources, i.e. they are named after the portion of the environment they pollute e.g. teacher shows the students the carbon being produced by a car and a motor cycle- air pollution. Also the dark black oily substance found in the stream is also a source of water pollution. Untreated sewage is also another pollutant of waters. Pollutant sources of land pollution include refuse, discarded vehicles tins cans and industrial waste.

STEP VI: Action Phase;

Students identify how to control or prevent the various types of pollution such as proper environmental education on the use of pesticides and fertilisers, treatment of solid waste and recycling for beneficial uses- (land /soil pollution). Proper treatment of sewage before disposal, and guarding against oil spillage through legislation- (water pollution). Building of industries in places far from residential and commercial areas- (air pollution).

Evaluation: Teacher asks students to define pollution and to state its different types.

Conclusion: Student's form a note summary, as teacher goes over lesson briefly.

Assignment: Teacher asks students to list pollutants involved in causing certain diseases to man such as asthma, bronchitis heart and lung diseases.

APPENDIX VI
LESSON PLAN USING LECTURE METHOD
CONTROL GROUP

WEEK I

Subject: Biology

Class:SS II

Sex:

Topic: Ecology

Sub-topic: Organisms and their habitats

B/Objectives: By the end of the lesson, the student's should be able to;

I. define terms related to ecology
II. list ecological components
III. discuss ways on improving on the ecological balance in nature

Method: lecture

Previous Knowledge: Students have learnt about the different phyla in the plant and animal kingdoms. They are also familiar with their characteristics and can distinguish between them.

Introduction: Teacher introduces the topic ecology by asking some questions based on their previous knowledge

What are plants and animals and where are they found?

Is there any relationship between them?

Presentation: Teacher explains to students that plants and animals depend on their surroundings to obtain materials which enable them to function properly.

Step I: Ecology is the branch of biology which studies plant and animal relationships/interactions with their natural environment or simply, it is the study of organisms and how they interact with their natural environment. There are some important terms/terminologies used in ecology which must be understood

Habitat- this is the place where an organism lives or the type of environment in which an organism exists. E.g. the habitat of water lettuce is stagnant or slow-flowing stretches of fresh water, a crab lives at the rocky sea shore.

Environment- this describes all factors in an organisms surroundings which may affect it, and with which it interacts. The factors include

biotic [living] and abiotic [non-living] factors which may be other living organisms or soil, water climate.

Step II: Teacher gives a list of other terms in ecology such as community, ecosystem, aquatic, terrestrial and defines all the terms.

Step III: Teacher explains that organisms living in a habitat are influenced by certain factors which vary from habitat to habitat. Such factors include abiotic [non-living] factors such as; climatic factors

; topographic/ physiographic factors

; edaphic /soil factors

Teacher explains each factor in detail.

Evaluation: Teacher asks students the following questions;

Define the following terms - a) ecology b) habitat c)flora d)fauna

Is there any relationship between organisms and their environment? If so, describe.

Conclusion: Teacher asks students to explain in their own words how nature relates with organisms.

WEEK II

Subject: Biology

Class:SSII

Sex:

Topic:Ecology – The organism and its environment

Sub-topic: Decomposition in nature (nutrient cycling in nature)

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

I. Define decomposition
II. State gases evolved during the process of decomposition
III. List micro and macro decomposers
IV. Enumerate the role of decomposers

Method:lecture

Previous Knowledge: Students have learnt about the major cycles in nature and also their importance.

Introduction: Teacher introduces the topic decomposition in nature by showing them a heap of refuse mainly of plant and animal matter.

Presentation: Teacher explains to the students that where ever there is a collection of trash, garbage, remnants of food etc. which is disposed of on a piece of land, there exist some biochemical processes which occur in that environment.

Step I: There are a group of organisms which are responsible for the breakdown of dead organic materials which could be of either plant or animal origin. These organisms cause the remains of plants and animals to decay. These organisms are called decomposers. They are mainly bacteria and saprophytes.

Step II: Decomposers are grouped into 2classes

Micro-decomposers; which are small microscopic organisms that can cause decay e.g. certain bacteria and fungi.

Macro-decomposers; which are bigger organisms that can cause decay of dead organic materials, e.g. earthworms, termites, snails, mushrooms, toad stools etc.

The process of decomposition involves secretion of enzymes by the decomposer onto its food source. Enzymes breakdown complex organic compounds like carbohydrates and proteins into simple soluble inorganic compounds. In the process chemical energy in the organic compound is lost as heat energy. The decomposer absorbs only a little amount of nutrients and energy for its use. The rest of the nutrients are released into the soil, air and water. When decomposers die, other decomposersfeed on them. The nutrients released are used by plants to manufacture their food.

Step III: Teacher explains the role of decomposers in the ecosystem such as;

i. enriching the soil with nutrients required for plant growth.
ii. they contribute to environmental pollution.
iii. it is useful in the making of cheese and yoghurt.
iv. they function in recycling nutrients.
v. they help in preventing the accumulation of remains and wastes of living organismson the earth's surface.

The products released during decomposition include gases such as CO_2, H_2S, NH_4 and H_2O vapour. Others are heat energy and nutrients such as nitrates, sulphates, phosphate ions etc.

Evaluation: Teacher asks students the following questions;

i. What is decomposition and what is a decomposer?
ii. What is the importance of decomposers?
iii. Enumerate products released during decomposition.

Conclusion: Teacher goes over lesson briefly as students copy board summary.

Assignment: Students are to make a heap ofcompost made up of living matter in their backyard at home. Observe the process of decomposition.

WEEK III

Subject: Biology

Class:SSII

Topic: The organism and its environment

Sub-topic: Ecological management, tolerance and adaptation.

B/Objectives: By the end of the lesson, the students should be able to;-

i. Recognise some of the different types of associations existing between different species.
ii. Identify beneficial, harmful and neutral forms of associations among organisms.
iii. Deduce the mode of life of a given organism from observed characteristics.
iv. Discuss why living things possess a range of tolerance to environmental factors
v. List the abiotic factors that impose tolerance on organisms
vi. Define adaptation and list examples of adaptation to environmental factors

Method:lecture

Previous Knowledge: Students have learnt about decomposition in nature and also the role of decomposers.

Introduction: Teacher introduces the lesson by asking questions based on their previous knowledge such as;

i. Is there any relationship that exists between a decomposer and its environment?
ii. If there is , is it beneficial or harmful?

Presentation: Teacher introduces the topic on ecological management "Association" by defining what an association is, what "tolerance" is and lastly what "adaptation" is.

Step I: Teacher after defining association lists types of associations which include symbiosis, parasitism, mutualism, commensalism etc. Teacher sites examples in relation to plants and animals regarding each association.

Step II: Teacher explains what tolerance is and why living things possess a range of tolerance to environmental factors. Teacher also explains that there are factors which impose tolerance on organisms which are abiotic.

Step III: Teacher explains adaptation as a modification in response to environmental factors. It occurs both in plants and animals

Teacher gives examples in relation to plants and animals.

Teacher explains the two main types of adaptation structural and behavioural adaptations.

Evaluation: Teacher evaluates the lesson by asking students questions based on what had been taught.

i. What is association?
ii. Give an example of both a beneficial and harmful association with examples.
iii. What is tolerance?
iv. What are the factors that impose tolerance on organisms?
v. What is adaptation?
vi. Give examples of organisms and their adaptations.

Conclusion: Teacher concludes the lesson by summarising the key points and giving students notes to copy.

Assignment: Draw the structural adaptation found in a named bird.

WEEK IV

Subject: Biology

Class:SSII

Topic: The organism and its environment

Sub-topic: Pollution

B/Objectives: By the end of the lesson the students should be able to;

i. Define pollution
ii. Name and describe the different types of pollutants and their sources
iii. Enumerate the harmful effects of pollutants
iv. State the effects of detergents, insecticides, artificial fertilisers and herbicides on aquatic and terrestrial organisms
v. Identify poor sewage systems as a source of pollution
vi. Name domestic and industrial wastes that pollute land and water
vii. Identify the decay of organic matter (e.g. dead animals and plants) as a source of pollution

Method: Lecture Method

Previous Knowledge: Students have learnt about ecological management, tolerance and adaptation.

Introduction: Teacher introduces topic pollution

Presentation: Teacher asks students to look around their surroundings to see if there is anything wrong with it.

Step I: Teacher after allowing students to observe their surroundings, explains what pollution is, stating its different types with examples .pollution is the addition/ introduction/ release by man of unwanted substances, elements, energy or materials into the environment in quantities/ amounts which may be harmful/ dangerous/ hazardous to living organisms existence.

Step II: Teacher gives examples of the types of pollution; air pollution, water pollution, land/ soil pollution, noise pollution. Teacher explains to the students that the harmful substance or energy which causes pollution of the environment is termed pollutants. Each of these pollutants have their sources, i.e. they are named after the portion of the environment they pollute e.g. teacher shows the students the carbon being produced by a car and a motor cycle- air pollution. Also the dark black oily substance

found in the stream is also a source of water pollution. Untreated sewage is also another pollutant of waters. Pollutant sources of land pollution include refuse, discarded vehicles tins cans and industrial waste.

Step III: Teacher further talks on the sources of each type of pollution such as spraying of crops with pesticides or herbicides, domestic fires – air pollution, its effects such as reduction to visibility within the environment due to fog caused by smoke and dew. Effects of water pollution include; restriction of man's resources of water for domestic use, water borne diseases such as cholera, typhoid etc. in land/soil pollution, effects include restriction of man's sources of land for farming and recreational purposes, also the production of unpleasant odour which irritates people. some pollutants are sources of disease germs and breeding ground of disease vectors.

Step IV: Teacher explains how to control or prevent the various types of pollution such as proper environmental education on the use of pesticides and fertilisers, treatment of solid waste and recycling for beneficial uses-land /soil pollution. Proper treatment of sewage before disposal, and guarding against oil spillage through legislation- water pollution. Building of industries in places far from residential and commercial areas- air pollution.

Evaluation: Teacher asks students to define pollution and to state its different types.

Conclusion: Students copy board summary, as teacher goes over lesson briefly

Assignment: Teacher asks students to list pollutants involved in causing certain diseases to man such as asthma, bronchitis heart and lung diseases.