EFFECT OF METACOGNITIVE LEARNING STYLE ON THE ACADEMIC ACHIEVEMENT AND RETENTION OF CONCEPT OF ECOLOGY BY BIOLOGY STUDENT IN MINNA METROPOLIS

BY

OGUGUO, Obiageli
2016/3/64452BE

DEPARTMENT OF SCIENCE EDUCATION
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,
NIGER STATE, NIGERIA.

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A PROJECT SUBMITTED TO THE DEPARTMENT OF SCIENCE EDUCATION, SCHOOL OF SCIENCE TECHNOLOGY EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BARCELOR OF TECHNOLOGY B.TECH IN BIOLOGY EDUCATION

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ABSTRACT

The aim of the study is to find out the metacognitive learning instruction on the academic achievement and retention of concept of ecology by Biology students. In order to obtain the pertinent information four research questions and four null hypotheses was set to guide the study. A Quasi-experimental research design was adopted with two group (experimental and control group) which are metacognitive style and conventional lecture method respectively. There are one hundred and thirty five (135) students involved, group, 65 students in control group and 70 experiment group. ANCOVA test was used to analysis the outcomes from the Biology Achievement Test (BAT) giving to the student. The findings of the study revealed that there was significant difference in the post-test gain scores in the achievement of students taught Biology using metacognitive style and those taught with conventional method ($p < 0.05$). Hence, metacognitive style improve the understanding of the student than the conventional method. The findings of the study also disclosed there is significant difference in the retention of students taught Biology using metacognitive style and those taught with conventional method. The findings of the study also revealed that gender does not influence academic achievement in Biology. Finally the outcome of the study also disclosed there is no significant difference in the post-test gain scores in the retention of male and female students taught Biology using metacognitive style. Based on the finding it was recommended that the education stakeholders should encourage tutors to adopt the use of metacognitive teaching strategies in teaching Biology amongst others. School Authority and teachers should also be enlighten on the importance of metacognitive style in teaching and learning.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

A major concern in science education is the lack of retention skills demonstrated by students. In spite of extensive research in the field of problem solving over the past few decades, there are still important areas that remain largely under-explored. Students' learning and coping with science and metacognitive monitoring strategies could be a better solution to the problem.

Biology is a branch of natural science that deals with the study of living organisms, their structures, functions, evolution, distribution and interrelationships. Biology occupies a unique position in the secondary school education curriculum because of its importance as science of life. In Nigeria, the secondary school Biology curriculum is designed to continue students' investigation into natural phenomena, deepen students' understanding and interest in biological sciences and to encourage students' ability to apply scientific knowledge to everyday life (Federal Ministry of Education, 2009). Biology is an important science subject and stands as the bedrock to the learning of other science courses like Medicine, Pharmacy, Nursing, Biochemistry, Genetics and Agriculture that are of great economic importance to the nation. Besides the importance of Biology as the science of life, it is one of the science subjects that are mostly preferred by many students in secondary schools. For this reason, Biology has a very high enrolment of students in the external examination (West African Examination Council, 2011).

The objectives of the Biology curriculum according to the National Policy on Education is to prepare students to acquire: adequate laboratory and field skill in Biology, meaningful and relevant knowledge of Biology, the ability to apply scientific knowledge to everyday life in

matters of personal and community health and agriculture and reasonable and functional scientific attitude. In pursuance of the above stated objectives of biology curriculum, the contents and context of the curriculum place emphasis on field studies, guided discovery, laboratory techniques and skills along with conceptual attitude (Federal Ministry of Education, 2011).

To achieve these objectives of the Biology curriculum, emphasis should be placed on the teaching and learning process in other to allow students develop their highest potentials (Pratoomtong, 2011). Caine (2002) posited that good teachers should organise classroom activities that emphasize on active role of the learners to construct their own knowledge and understanding through interacting with the environment around them. However, these activities should be interesting to learners and appropriate for their developmental level so that they can use their whole brain to participate in them, which will in turn improve their academic achievement.

Studies have shown that Biology teaching does not always employ effective instructional approaches in teaching the subject (Nwosu, 2009). This has led to situations where students cannot be able to apply the knowledge of biology into real life situations. Agame (2010) posited that in most secondary schools, teaching methods are mainly based on inappropriate instructional approach, which requires teachers to give explanation or demonstration while students usually focus on textbook reading, note taking and memorization of facts. Despite the effort of science educators such as stated by Jibrin and Abba (2011) towards finding a suitable instructional strategy for effective teaching in secondary schools. There still exist some reports of poor academic performance in public examinations results such as NECO and WAEC in Biology (Ogbenevwede, 2010; Adebayo, 2011 & WAEC, 2011).

This poor achievement of students in biology at the senior school certificate examination leaves one in doubt about the effectiveness of instructional approaches employed by the biology teachers for the teaching and learning of biology Nwagbo (2001) stated that most biology teachers use the conventional lecture methods in teaching of the subjects. Nwosu (2001) also stated that the use of lecture methods does not allow for active learner participation in the classroom. In order to enhance students' achievement and active participation in the learning process in Biology, much attention should be placed on student's learning styles and their impact on the teaching and learning process.

Learning style is an individual's unique ways of perceiving and processing information. According to Reynolds cited in Omole (2011), learning style is an individual's natural or habitual pattern of acquiring and processing information in learning situation. The notion of learning style and its implications in education is not new in the education system. Learning style is also an individual's special way of understanding and applying information gathered during the teaching and learning process. Ubah (2012) reported that knowledge of the existing learning styles among students could increase their academic success. Reynolds (2007) proposed that matching learning styles and instructional methods could lead to improved learning.

In the classroom, students come in with their different learning styles and all the dominant learning styles needs to be addressed during the learning process (Merrill, 2003). When teachers are considering the design of a learning process for active learning classroom environment, there is need for them to be aware of the impact of learning styles of students to create an enabling environment for learning to take place. Brown (2003) stated that if instructional design match students' learning style preferences, it could have a positive impact on students' achievement. In addition, Roy (2007) stated that recognizing students'

learning style could help teachers to develop course structures that will provide a better fit between instructional goals and student' 'learning style preferences. The importance of recognising students learning styles in classroom learning environment can be highlighted by stating that the teacher places emphasis on intuition, feeling, sensing, and imagination, in addition to traditional skills of analysis, reason and sequential problem solving. The teacher designs instructional methods to connect with different learning styles, using various combinations of experience, reflection, conceptualisation and experimentation. Finally, the teacher employs variety of assessment techniques, focusing on each of the different learning styles and the development of the whole brain capacity (Brown, 2003).

Metacognitive prompts are suggested as an instructional technique for enhancing students' learning (Carr, 2010) and may also be influenced by self-efficacy. Studies on metacognition have proven that there is a strong correlation between metacognition and problem solving. The students with a higher level of metacognitive skills become successful in problem solving (Howell, 2010). There exist positive and meaningful increases in the achievement of students using instruction activities towards developing metacognitive skills Efklides (2009) stated that the problem solving process requires analyzing the given information about the problem, organizing the information, preparing an action plan and assessing all the operations carried out. These operations performed during the process are skills which constitute the character of metacognition.

The metacognition is also known to largely contribute retention of student. The retention is purely an ability to student to recall or remember things learned previously or to store information for long periods. Okoro (1984) found that high academic achievement demands from the learners the following: ability, intellect, interest and discipline among others. Urebvu (1990) observed that poor learning and retention in science may be related to the

learner‟s inability to link new learning to previous knowledge. Maduabum (1996) reported that stimulating learning environment, interest, and activity oriented teaching strategies are all that the learners need to retain new learned information.

Structurally, the human brain is made up of right and left hemisphere. The human brain functions in many ways; it acts as two brains (right/left) hemisphere and it is the way individuals experience the world around them. Brain research has found out that the two hemispheres of the brain (left/right) process information differently, both hemispheres are equally important in terms of whole brain functioning and individuals rely more on one information-processing mode than the other, especially when they approach new learning (Chatuporn, 2002). The left hemisphere is dominant with regard to language and logical processing, while the right hemisphere handles spatial perception. There is evidence that each brain hemisphere has its own distinct functions, a division referred to as lateralization (Chatuporn, 2002). The left hemisphere is serial, analytic, rational, systematic and verbal. Analysis and planning are key strategies in the left hemisphere.

In this mode, problems are solved by looking at the parts and sequence is critical. The right hemisphere on the other hand is global, visual and holistic; it is able to see patterns and connections. The right mode processing seeks patterns and solves problems by looking at the whole picture. Intuition, belief and opinion are key processing strategies of the right hemisphere.

The issue of gender and students' academic achievement especially in biology has been inconclusive. Some researchers are of the view that male students perform better than females, others disagree with this view, arguing that achievement is a factor dependent on several factors such as socio – economic background, and teaching method among others. Therefore, one sees that the issue of gender has not yet been resolved particularly in relation

to students' achievement in biology, hence the need for further study on that regard, especially when trying out new teaching strategies. In this study, the researcher is interested in using the metacognitive model to design learning activities in Biology and find out its effect on achievement, retention and acquisition of multiple intelligences of students with different learning style. In addition, this study will find out the influence of gender on students' achievement in biology when exposed to metacognitive instructional learning.

1.2 Statement of the Problem

Over the years, the achievement of students in Biology in Nigeria secondary schools has been very poor. Students' achievement in Biology in internal and external examination is on the decline. The WAEC Chief Examiner Report of 2009 - 2011 indicated poor achievement of students in biology. The students' poor achievement in biology could be attributed to so many factors such as poor classroom management, use of gender biased instructional material, lack of adequate instructional materials, lack of adequate laboratory activities, poor teaching methods employed in teaching biology by the secondary school teachers and lack of competent biology teacher. Biology as a science subject is so verse and activity based; it therefore, needs a virile teaching method that can take care of learning styles of the students In other to overcome the problems of poor achievement, retention and acquisition of multiples intelligences by students in biology, some researchers have suggested the use of diverse instructional strategies, which may help to enhance students' achievement in biology. This study seeks to use an instructional model, which could be able to address students learning styles and brain hemispheric preference and provide practice and feedback in ways of thinking and solving problems. The students may not initially be comfortable with this type of instructional strategy, but they will have to use it to be fully effective in the learning process. The use of metacognitive could be a solution to the problem of poor achievement

and retention of students in biology. This is because metacognitive is an instructional model that could take care of the differences in the way students learn; instill multiple skill acquisition which and enhance students achievement in biology. metacognitive could also enhance students' ability to retain the biology concepts because it engages students actively during the learning process and gives students the opportunity to construct their own knowledge.

The target of this study therefore, is to assess the influence of metacognitive teaching instruction on the academic achievement and retention of concept of ecology by biology students in Minna metropolis.

1.3 Aim and Objectives of the Study

The main aim of this study was to investigate the effect of metacognitive learning instruction on the academic achievement and retention of concept of ecology by biology students.

Specific objectives of this study are to:

i. determine the effect of metacognitive style and conventional teaching style on academic achievement of students in Biology.
ii. find out the effect of metacognitive style and conventional teaching style on retention of students in Biology.
iii. determine the influence of gender on academic achievement of students taught Biology using metacognitive style.
iv. determine the influence of gender on retention of students taught Biology using metacognitive style.

1.4 Research Questions

The following research questions were posed to guide this study

i. What is the mean achievement scores of students taught Biology using metacognitive style and those taught using conventional teaching method?

ii. What is the mean retention scores of students s taught Biology using metacognitive style and those taught using the conventional lecture method?

iii. What is the interaction effect of metacognitive style on male and female achievement scores in Biology?

iv. What is the interaction effect of metacognitive style on male and female achievement scores in Biology?

1.5 Research Hypotheses

The following null hypotheses were formulated and were tested at alpha level of 0.05.

HO_1: There is no significant difference in the mean achievement scores of students taught Biology using metacognitive style and those taught with conventional method.

HO_2: There is no significant difference in the mean retention scores of students taught Biology using metacognitive style and those taught with conventional method.

HO_3: Gender does not significantly influence the mean achievement scores of students taught Biology using metacognitive style.

HO_4: Gender does not significantly influence the mean retention scores of students taught Biology using metacognitive style.

1.6 Significance of the Study

The study was expected to be of immense benefits to the following stakeholders; students, teachers, curriculum planners, author and researchers.

The finding will help to strengthen the application of these theories in teaching and learning in science subject, specifically in Biology.

The findings of this study could enhance student's participation in science activities that will increase their acquisition of multiple intelligences, retention and achievement in biology. It could also help students to spend their leisure wisely by engaging in activities that pertains to science, thereby improving the functionality of science. This finding of this study could guide the students on a career path and help them make important decisions that will impact their future.

For the teachers, the study will enable them to understand that even though the traditional science instructions saves time in terms of content coverage, it has also contributed to the myriad of misconception. It is hoped that the findings of this study would help the teachers to know the efficacy of metacognitive in teaching and learning, so as to be able to apply it to their daily teaching in other to improve students' achievement, retention. It will also help teachers to present their teaching in a manner that would accommodate student's diverse learning style and stimulate the functions of the left and right brain hemisphere. The findings may likewise help to modify the nature of teacher's interaction with the students, which will in turn help to create the spirit of inquiry among the students. In addition, teachers in all subjects may be willing to try out some multiple intelligence techniques in their classroom if they see positive results from the study.

Furthermore, the study would help curriculum planners to appreciate the need to accommodate learning styles and activities that stimulate the brain hemispheric functions in designing the school curriculum. The findings of this study will enable them to have some basis for encouraging their teachers to try multiple intelligences in their classrooms, and it can enable them to implement a multiple intelligence-based curriculum.

To other researchers, the findings of this study will help them to build their literature and it will serve as a guide to their study.

1.7 Scope of the Study

The scope is restricted to Senior Secondary School Minna metropolis, Niger State. The class that will be used for this study is SS 2 Biology students from the three (3) co – educational schools in Bosso Local Government Ares of Niger State. Co – educational schools will be used because the researcher wants to find out if metacognitive style would have any influence on the academic performance and retention in Biology based on their gender. The choice of SS 2 students was considered most appropriate because they would have been exposed to some basic Biology concept and skills. The topic to be treated is restricted to concept of ecology. The variable scope of this study are:- conventional teaching style and metacognitive style. While the dependent variables are achievement and retention, and the moderating variable is gender. The experimental fieldwork is proposed to last for four (4) weeks.

1.8 Basic Assumption of the Study

The basic assumptions of the study are as follows:

i. The school authorities are yet to realize the relationship between Biology failure and teaching method.

ii. The biology teachers are not aware that metacognitive style is an essential aspect that should not be ignored.

iii. The students has never been taught using metacognitive style.

1.9 Operational Definition of Terms

Observation: is an essential path to the method of science, which expresses the ability to ask the right question and make the selected reflection relevant to that question. Hence, science begins with observations of objects and events; these observations lead to the asking of questions.

Conventional method: In the concept of this study, conventional method is regard to used or known method of teaching by the teacher or lecturer in the institution or schools.

Metacognitive method: refers to methods used to help students understand the way they learn; in other words, it means processes designed for students to 'think' about their ‘thinking’ in order to improve their academic performance.

Achievement: is the performance outcome that indicates the extent to which a student has accomplished specific goals that were the focus of activities especially in an institution environment.

Retention: is student’s ability to remember and recall information, materials and experiences learned over time. It a measure degree of retaining and recalling of what was learnt or seen over short or long period.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter fully discussed the literature related to this study, and will be reviewed under the following headings**:**

- **Conceptual Framework**
- **Theoretical Framework**
- **Empirical Studies**
- **Summary of Literature Review**

2.2 Conceptual Framework

2.2.1 Concept of Biology

Biology is the science that studies life and living organisms, including their physical structure, chemical processes, molecular interactions, physiological mechanisms, development and evolution. Despite the complexity of the science, there are certain unifying concepts that consolidate it into a single, coherent field. Biology recognizes the cell as the basic unit of life, genes as the basic unit of heredity, and evolution as the engine that propels the creation and extinction of species. Living organisms are open systems that survive by transforming energy and decreasing their local entropy to maintain a stable and vital condition defined as homeostasis (Modell *et al.,* 2015).

The term biology is derived from the Greek word βίος, bios, "life" and the suffix -λογία, -logia, "study of. Biology began to quickly develop and grow with Anton van Leeuwenhoek's dramatic improvement of the microscope. It was then that scholars discovered spermatozoa, bacteria, infusoria and the diversity of microscopic life. Investigations by Jan Swammerdam

led to new interest in entomology and helped to develop the basic techniques of microscopic dissection and staining. Below are the foundations of modern biology:

Cell Theory

Cell theory states that the cell is the fundamental unit of life, that all living things are composed of one or more cells, and that all cells arise from pre-existing cells through cell division. In multicellular organisms, every cell in the organism's body derives ultimately from a single cell in a fertilized egg. The cell is also considered to be the basic unit in many pathological processes (Duve, 2002). In addition, the phenomenon of energy flow occurs in cells in processes that are part of the function known as metabolism. Finally, cells contain hereditary information (DNA), which is passed from cell to cell during cell division. Research into the origin of life, abiogenesis, amounts to an attempt to discover the origin of the first cells.

Evolution

A central organizing concept in biology is that life changes and develops through evolution, and that all life-forms known have a common origin. The theory of evolution postulates that all organisms on the Earth, both living and extinct, have descended from a common ancestor or an ancestral gene pool. This universal common ancestor of all organisms is believed to have appeared about 3.5 billion years ago (Larson, 2008). Biologists regard the ubiquity of the genetic code as definitive evidence in favor of the theory of universal common descent for all bacteria, archaea, and eukaryotes.

Genetics

Genes are the primary units of inheritance in all organisms. A gene is a unit of heredity and corresponds to a region of DNA that influences the form or function of an organism in specific ways. All organisms, from bacteria to animals, share the same basic machinery that copies and translates DNA into proteins. Cells transcribe a DNA gene into an RNA version of the gene, and a ribosome then translates the RNA into a sequence of amino acids known as a protein. The translation code from RNA codon to amino acid is the same for most

organisms. For example, a sequence of DNA that codes for insulin in humans also codes for insulin when inserted into other organisms, such as plants (MecNeil *et al.,* 2012).

Homeostasis

Homeostasis is the ability of an open system to regulate its internal environment to maintain stable conditions by means of multiple dynamic equilibrium adjustments that are controlled by interrelated regulation mechanisms. All living organisms, whether unicellular or multicellular, exhibit homeostasis (Prusiner, 2009).

Energy

The survival of a living organism depends on the continuous input of energy. Chemical reactions that are responsible for its structure and function are tuned to extract energy from substances that act as its food and transform them to help form new cells and sustain them. In this process, molecules of chemical substances that constitute food play two roles; first, they contain energy that can be transformed and reused in that organism's biological, chemical reactions; second, food can be transformed into new molecular structures (biomolecules) that are of use to that organism.

2.2.2 Concept Teaching

Teaching method refers to the principles and approaches used for instruction. The choice of teaching method or methods to be used depends largely on the information or skill that is being taught, and it may be influenced by the aptitude and enthusiasm of the students (Agbai, 2004). Agbai stated further that there is no single method for the teaching of science. The method adopted at any time depends on a number of factors. Such factors include; the nature of the topic, skills required to be acquired, the age of the learner and the learning environment among others (Agbai, 2004). There are different teaching strategies (methods) in science education. A good science teacher should be able to use variety of methods considered

suitable for any given instruction, the different methods are not mutually exclusive. The method often used for science teaching include; the traditional lecture method (chalk and talk method), the discovery, inquiry method, demonstration method, laboratory method and problem solving instructional methods (Obiekwe, 2008). Obiekwe also categorized the teaching method into two approaches; teacher- centered approaches and student centered-approaches. Guisti (2008) and Campbell (2008) stated that teacher centred approaches to instruction are often referred to as the traditional method of teaching, didactic or direct instruction, and that it includes all the methods grounded in behaviourism, such as the lecture/expository methods, demonstration and recitation.

The term teacher-centred depends on the role that the teacher assumes in traditional classroom context, which focuses more on content than on student. McDonald (2002) explained that in teacher-centred instructional approach, it is difficult to determine student's capacity, because the teacher centred approach places control for learning in the hands of the teacher. The teacher uses the expertise in content knowledge to help learner make connections. Teacher centred approaches is centred on transmission of knowledge in a manner that emphasizes training or memorization. (Guisti, 2008) described teacher- centered approaches to learning as approaches centred on one fact laden text, consisting of assign, recite, test and then discuss the test. Most of the methods under teacher centered approaches especially the lecture method is commonly used among teacher and is criticized by many researchers as poor method of instruction (Mandor, 2002). They argued that the information flow is unidirectional manner making learners to be less active in the learning process, limit the amount of student's participation, hence are not adequate for teaching hand-on skills and maintaining student's interest in the learning process (Ibe, 2004). Lecture method is a type of teacher centered teaching method.

Lecture method involves verbal presentation of ideas, concepts, generalizations and facts. In lecture classroom, the teacher does most of the activities in form of talking while the students are either passive listeners or slightly involved. According to Ibe (2004) this method leads to rote learning where by students memorize what they have learnt and regurgitate the facts (knowledge) as the teacher presented it to them. This method could be ineffective in the teaching of Science subjects (biology) because it involves mostly talk-chalk approach and appeals to only the sense of hearing.

Lecture method gives the teacher the chance to expose students to unpublished or not readily available material and allows the teacher opportunity to precisely determine the aims, content, organization, pace and direction of a presentation. In contrast, more student-centered methods, e.g., discussions or laboratories, require the instructor to deal with unanticipated student ideas, questions and comments, can be used to arouse interest in a subject, can complement and clarify text material, complement certain individual learning preferences. Some students depend upon the structure provided by highly teacher-centered methods and it facilitates large-class communication. Lecture method places students in a passive rather than an active role, which hinders learning and encourages one-way communication; therefore, the teacher must make a conscious effort to become aware of student problems and student understanding of content without verbal feedback; requires a considerable amount of unguided student time outside of the classroom to enable understanding and long-term retention of content. In contrast, interactive methods (discussion, problem-solving sessions) allow the instructor to influence students when they are actively working with the material and requires the teacher to have or to learn effective writing and speaking skills (mandore, 2002).

Traditional teaching methods have been found to be deficient in creating permanent and meaningful learning (Inanyang and Ekpeyoung, 2000). According to the researchers, students poor performance has been caused by chalk and talk method adopted by many science teachers. Madu (2004) found that conventional method as used by majority of science teachers is unlikely to develop adequate conceptual change in physics students. Okebukola (2002) tagged it stereotyping method of teaching. In general, there is no doubt that traditional teaching methods do not take into account of existing beliefs of students, and therefore is largely ineffective in changing student's naive conception in science (Yeo & Zadnik, 2001; Eryilmaz, 2002; Baser,

2006). Hence, in view of this Okebukola (2002) stated thus "there are number of reasons why we need to put on a new garb in our delivery of science education and strive towards going beyond stereotypes". This statement of Okebukola is a pointer to the need for student-centred instructional strategies.

The student-centered approach includes all the instructional methods that underscore teachers as decision makers and problem solvers (O'Bannon, 2002) it includes all instructional methods that view the teacher as a facilitator (guide) as the learners construct their own understanding (Guisti, 2008). Teaching styles that are often referred to as student centered approaches include discovery, constructivist, inquiry, problem solving, cooperative learning, case studies, graphic organizers, role play stimulation etc (Ibe, 2004, Campell, 2006). Student- centered approaches are characterized by students sharing some degree of the responsibility for making decision in the classroom (Campbell, 2006 and Guisti, 2008). The teacher in the student- centered approach is seen as a facilitator, a mentor, a coach or a consultant as the student constructs their learning (kirshner, Sweller and Clark, 2006; Guisti, 2008).

The principles of student-centered approaches are rooted in the philosophy of Rousseau's work 'Emile' that particularly stressed the instinctual (intuitive) nature of children to investigate and naturally lean from experience from the environment (Exline, 2004 and Guisti, 2008). Today, the learning theory advocating for student-certered idea is the constructivism, while its application to educational settings has obvious link to Dewey, its epistemological under mining, are closely tied to the work of Jean Piaget (Exline, 2004).

The student-centered approach however, emphasizes a variety of different types of methods that shifts the role of the instructors from givers of information to facilitating student's learning. Many researchers (Campell, 2006.; Kirshnerl, Sweller and Clark 2006) are of the view that learning in a student centered environment makes learning more meaningful and durable as student are more active participants in the learning process, Today, many educators and researchers (Ibe and Nwosu,2003) promote a shift from teacher-centered approaches of instruction to student centered approaches of instruction, especially in sciences (Exline, 2004 and Kirshner, Sweller and Clark 2006). Practices that support student centered approach includes, less structured activities such as open-ended projects that focus on problem solving and analytical skills rather than mastering of facts. Student-centered learning allows student to actively participate in discovery learning process from an autonomous viewpoint. Student consume the entire class time constructing a new understanding of the material being learned without being passive, but rather proactive and the teacher recognizes the students' learning difference and styles.

2.2.3 Concept of Learning

Learning style is an individual's natural or habitual pattern of acquiring and processing information in learning situations. According to kolb and Kolb (2005) learning style is the overall pattern that provides direction to learning and teaching. According to the authors,

learning style can also be described as a set of factors, behaviors and attitudes that facilitates learning for an individual in a given situation. Learning styles influences how an individual learn, how teachers teach, and how the teachers and learners interact in a learning situation. Each individual is born with certain tendencies towards particular styles, but these biological or inherited characteristics are influenced by culture, personal experiences, maturity level and development (Kolb and Kolb, 2005). Each learner has a distinct and consistent preferred ways of perception, organization and retention. These learning styles are consists of cognitive, affective and physiological behaviors that serve as good indicators of how learners perceive, interact with and respond to learning environment and individuals differ in how they learn.

The idea of individualized learning styles originated in the 1970s, and has greatly influenced education (Pashler, 2008). Proponents of the use of learning styles in education recommend that teachers assess the learning styles of their students and adapt classroom methods to fit each student's learning style. Persons learning style has been defined similarly by several different learning theorists. Smith and Welliver (1994) defined the concept of learning style as a person’s preferred mode of learning. James and Blank (2005) states that a learning style is the complex manner and conditions under which, learners most efficiently and most effectively perceive, process, store and recall what they are attempting to learn. They also identified learning style as that particular set of behaviours and attitudes related to the learning context. Swanson (1995) defined learning style as the cognitive, affective, and physiological factors that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment. Magner (2009) postulated that a learning style is a biological and developmental set of personal characteristics that make identical instructional environments, methods, and resources effective for some learners and

ineffective for others. Dunn and Dunn (1992) simplified a useful definition of learning style as the way in which individuals begins to concentrate on, process, internalize, and retain new and difficult academic information.

One common misconception among educators is that learning style represents only the perceptual differences in how a person learns. Researches done in the 1980's by Barbe and Milone (1981) and Dunn (1988) brought national and international attention to the value of modifying curriculum and pedagogy to the perceptual differences of students thus:

- Cognitive styles – information processing to include the way one encodes, processes, stores, retrieves, and decodes information;
- Affective styles – personality dimensions to include attention span, motivation, interests, and emotions; and
- Physiological styles – to include gender behaviour, health-related behaviour, and physical environmental conditions.

The concept of learning style describes individual differences in learning based on the learner's preference for using different modes of the learning cycle. Kolb and Kolb (2005) explain that hereditary make-up, unique life experiences and the demands of our present environment, all contribute to developing a preferred learning style. They also indicate that individuals resolve the conflict between being concrete or abstract and between being active or reflective in four patterned, characteristic ways: diverging, assimilating, converging, or accommodating. These four patterns are the defined learning styles in Kolb's Learning Style Inventory (KLSI).

Learning Style Inventory was created by Kolb and Kolb (2005) to fulfill two purposes: to serve as an educational tool to increase individuals' understanding of the process of learning

from experience and their unique approach to learning and to provide a research tool for investigating experiential learning theory and the characteristics of individual learning styles. The Kolb Learning Style Inventory identifies four learning styles that are associated with the four patterned characteristic approaches to learning: diverging, assimilating, converging, and accommodating. The preferred learning style is dependent on the learner's two dominant modes.

In the classroom environment, students come to the classroom with their preferred learning styles; therefore, all of these dominant learning styles should be addressed (Merrill, 2003). When teachers are considering the design of a learning process for an active learning classroom environment, they should be aware of the impact of learning style (Carrier & Sales, 1987). Stice and Dunn (1985) stated that if instructional design matched student learning style preference, it will have a positive impact on students' achievement. This is also supported by Stitt-Gohodes (2001: 1) who stated that "knowing this type of information can help instructors develop course structures that provide a better fit between instructional goal and students" learning style preference. The impacts of recognizing students' learning styles on the classroom- learning environment can be summarized in the following criteria (Sirinoot, 2005).

Curriculum: The teachers must place emphasis on intuition, feeling, sensing, and imagination, in addition to the traditional skills of analysis, reason, and sequential problem solving.

Instruction: The teachers should design their instruction methods to connect with all four learning styles, using various combinations of experience, reflection, conceptualization, and experimentation.

Assessment: The teachers should employ a variety of assessment techniques, focusing on the development of "whole brain" capacity and each of the different learning styles.

2.2.4 Retention as a Factor in learning

Retention according to Encarta dictionary is defined as ability to remember things. It is also viewed as keeping or holding something mentally. This is the ability to recall or remember things learned previously or to store information for long periods. Okoro (1984) found that high academic achievement demands from the learners the following: ability, intellect, interest and discipline among others. Urebvu (1990) observed that poor learning and retention in science may be related to the learner"s inability to link new learning to previous knowledge. Maduabum (1996) reported that stimulating learning environment, interest, and activity oriented teaching strategies are all that the learners need to retain new learned information.

Imagery is the recalling of mental picture or events seen or experienced (Bello 1981). It is maintained that imagery maybe visual, tactual or auditory in nature. Bello (1990) contended that power of imagery using these censors differ from one learner to another. It was stated that imagery is of great importance to retention and retrieval of learned materials. Bello (1981) advised that teachers should put across the learning material using methods that appeal to many senses.

However, it is one thing to retain learned materials and another to retrieve or access the retained information.

Soyibo (1991) specified that learner who had no thorough understanding of factors, principles and concepts learned resort to memorization and adopt cramming approach. It was

found that meaningful learning and retention are guaranteed if the teaching strategies help learners linked new information to previous one.

Igboko and Ibeneme (2006) carried out a research on effect of cognitive constructivism instructional approaches on students‟ achievement, interest and retention in the study of Introductory Technology in Nigeria and found out that both constructivist learning approach and the conventional ones are equally effective with respect to students‟ achievement and retention in Introductory Technology.

Okoye and Okeke (2006) reported that eliminating superstitious beliefs strategy on achievement and knowledge retention in genetics among secondary school students was found to be significantly more effective in teaching genetic concepts and also enhances knowledge retention among students. The animation instructional strategy have power of imagery since it involves more than one scene organs. It may help the students to link previous knowledge to the new concept. This can reduce rote learning thereby improve retention in chemical bonding.

2.2.5 Metacognitive

The development of cognitive psychology redirected the focus of reading research from reading skills to metacognition. Metacognition was first defined by Flavell in 1978 as “knowledge that takes as its object or regulates any aspect of any cognitive endeavor” (Flavell, 1976). Since then, Flavell’s definition was elaborated to include “conscious awareness of one’s own knowledge of task, topic and thinking, and conscious self-management” (Jacobs & Paris, 1987). Reading researchers generally accept

Metacognition as knowledge about cognition and self-regulation of cognition and cognitive resources (Baker & Brown, 1984; Nist & Mealey, 1991; Pressley, 2002). Brown (1980) specifically defined metacognition and its relationship to reading as "evaluation of the comprehension process while reading and ability to take action when comprehension fails." Metacognition is composed of three factors: metacognitive knowledge, metacognitive skill, and metacognitive experience (Eriksson, 2000). Metacognitive knowledge is also composed of three factors - the person, the task, and the strategies. A reader with metacognitive knowledge is aware of his/her abilities and limitations as a reader, what is required to complete a task and how to meet the requirements, and methods useful towards reaching the goal (Eriksson, 2000). Eriksson (2000) defines metacognitive skill as the reader's knowledge of what he/she is currently doing. Eriksson (2000) also defined metacognitive experience as "experience accompanying an intellectual task," such as knowing you do not understand, using previous experience to solve a problem, or feelings of success or failure. Regulation during reading happens when a reader monitors his/her comprehension to detect errors and separates important and unimportant information. Self-regulation involves planning (selecting particular actions to reach a goal), monitoring, and evaluating strategy use while reading (Nist & Mealey, 1991; Paris & Jacobs, 1984; Baker & Brown, 1984). To demonstrate metacognitive awareness, readers must have declarative knowledge (knowing the information you need is in your head), procedural knowledge (knowing how to connect what is in your head to what you read), and conditional knowledge (when and why to use the information in your head while reading) (Craig & Yore, 1992).

Reading researchers see metacognition as the "foundation upon which comprehension is built" (Nist & Mealey, 1991). Results of research in metacognition show a significant positive relationship between metacognitive awareness and comprehension ability (Spence,

1995). Simpson and Nist (2000) found that students who practice deeper levels of processing perform better on assignments and tests. Students who practice deeper levels of processing access and integrate old and new information to create understanding. In unstressful reading situations, metacognition proceeds without the reader's awareness. It is when reading becomes difficult that metacognition becomes overt and conscious (Jacobs & Paris, 1987).

Pressley (2002) defined metacognition as "knowledge of the thinking process, thinking in the here and now, and thinking in the long-term." According to Pressley, the most important thinking in the here and now is whether or not a text is being understood. This is especially true in science reading. Without metacognition, many science misconceptions go unnoticed. Long-term metacognition pertains to knowledge of reading strategies; however, without knowledge of the thinking process or thinking in the here and now, comprehension strategies are useless. If students are not aware when comprehension breaks down, the comprehension strategies will not work (Nist& Mealey, 1991).

Metacognition is a process that gradually develops (Eriksson, 2000). Several studies indicate that comprehension evaluation improves with age (Jacobs, 1982; Otero & Campanario, 1990). Jacobs and Paris (1984) found significant differences in the metacognitive abilities of eight and ten-year olds. Nist and Mealey (1991) agree that metacognitive skills increase with age, but suggest that as students become older, their reasons for not using metacognitive skills change. Among these reasons are a lack of motivation, a lack of prior knowledge, and competing demands on time (Barnett, 1997).

2.3 Theoretical Framework

2.3.1 Theory of Constructivism

Constructivism is a theory that explains how knowledge is constructed in human beings when information is exposed to existing knowledge that had been developed by experiences. Constructivism according to Millar (1989) is a perspective whereby individuals through their own mental activity, experience with the environment through social interactions, progressively build up and restructure their schemes of the world around them. This theory assumes that humans construct their own knowledge, using their existing knowledge. This construction of knowledge takes place within a context of social interaction and agreement (Hewson, 1992). Constructivism has been described as a theory which rests on the notion that there is an innate human drive to make sense of the world. Instead of absorbing or passively receiving objective knowledge that is already discovered and packaged, learners actively construct knowledge by integrating new information and experiences into what they have previously come to understand, revising and reinterpreting old knowledge in order to reconcile it with the new (Nwafor, 2007).

Constructivism, therefore, can be perceived as an educational theory, a learning theory, an educational movement or a philosophy of learning. Though described variously, its common characteristics include active involvement of the learner who is intrinsically driven, knowledge production by the learner, social learning environment and social contacts, functional and authentic sequenced complex experiences, multiple realities and use of previous experiences of the learner (Nwafor, 2007). With these propositions, the students can construct their own knowledge by interacting with the objects in their environments.

Constructivists admit that effective learning occurs when the learner is actively involved during teaching and learning encounter and therefore advocate for hands-on and minds-on pedagogy. Constructivists sees the learner as a king who is creative, innovative, originality and self-directed, not a servant who takes orders without question. The teacher is seen as the

servant, mentor, facilitator, mid-wife and a helper who stands to guide the students during teaching and learning process. According to the social constructivism approach, instructors have to adapt to the role of facilitators and not teachers.

Millar (1989) identified important features of constructivist pedagogy, they are:

i. identifying and building on knowledge schemes that learners bring to lessons;
ii. developing and restructuring those knowledge schemes through experiences with phenomena, and through exploratory talk and teacher intervention;
iii. enabling students to construct for themselves and use appropriately conventional science schemes;
iv. encouraging students to take responsibility for their own learning;
v. helping students develop an understanding of the nature and status of scientific knowledge itself, the claims it makes and the way these are validated and may change over time.

The constructivist perspective leads to an interpretation of many of the observed regularities and consistencies in students' responses as alternative conceptions that students' hold about the natural world and how it works (Hewson, 1992). These students' alternative views are not as precise, not as extensive, and not as widely useful as those that teachers want students to learn. This means that students' alternative conceptions are tenacious (Hewson, 1992). In summarizing, constructivism remains an underlining theory behind four mode application techniques metacognitive style, because accordingly, system engages students to construct their own ideas and promotes multiple intelligences, which are based on constructivist approach. There are many proponents of constructivism theory. They are John Dewey, Maria Montessori, Lee Vygotsky, Jean Piaget, George Kelly, Jerome Brunner and Ernst Von Glasersfeld. However, for the sake of this study only Jean Piaget Cognitive theory and

Vygosky's social cognitive theory will be discussed. This is because beside their commonality in views, Piaget theory is closely related to this work and therefore has a pervasive influence on Four Modes Application Techniques and likewise Vygosky's social cognitive theory.

Piaget's Cognitive Theory

Cognitive theory is based on the work of Swiss developmental psychologist Jean Piaget 1956. Piaget's theory of cognitive development proposes that humans cannot be "given" information, which they immediately understand, and use. Instead, humans must "construct" their own knowledge. They build their knowledge through experience. Experiences enable them to create schemas. One important generalization of Piagetian theory is role of the teacher. In a Piagetian classroom an important teacher role is to provide a rich environment for the spontaneous exploration of the child. A classroom filled with interesting things to explore encourages students to become active constructors of their own knowledge (their own schemas) through experiences that encourage assimilation and accommodation.

General Implications of Cognitive Theory

There are two key Piagetian principles for teaching and learning:

Learning is an active process: Direct experience, making errors, and looking for solutions are vital for the assimilation and accommodation of information. How information is presented is important. When information is introduced as an aid to problem solving, it functions as a tool rather than an isolated arbitrary fact. Learning should be whole, authentic, and "real": Piaget helps us to understand that meaning is constructed as children interact in meaningful ways with the world around them. Thus, it means less emphasis on isolated "skill" exercises that try to teach something like long division or end of sentence punctuation. Students still learn these things in Piagetian classrooms, but they are more

likely to learn them if they are engaged in meaningful activities (such as operating a class "store" or "bank" or writing and editing a class newspaper). Whole activities, as opposed to isolated skill exercises, authentic activities which are inherently interesting and meaningful to the student, and real activities that result in something other than a grade on a test or a "Great, you did well" from the computer lesson software, are emphasized in Piagetian classrooms. This will enable students to develop multiple intelligences which is an aspect of this study.

Piaget's cognitive theory describes the cognitive development of children. Cognitive development is a progressive reorganization of mental processes because of biological maturation and environmental experiences (Mcleod, 2009). It involves changes in cognitive process and abilities. In Piaget's view, early cognitive development involves processes based upon actions and later progresses into changes in mental operations (Piaget, 1936). Children construct an understanding of the world around them, then experience discrepancies between what they already know and what they discover in their environment (Piaget, 1957).

There are three components of Piaget's cognitive Development theory: Schema; Assimilation, Accommodation and Equilibration.

The schema: This is the basic building block of intelligent behaviour. It is a set of linked mental representations of the world, which we use to understand situation (Mcleod, 2009). It is one's schema that organizes knowledge and relates it to one's aspect of world inform of objects, actions and abstract. In Piaget's view, a schema includes both a category of knowledge and the

process of obtaining that knowledge. As experiences happen, this new information is used

to modify, add to, or change previously existing schemas. When a child's existing schemas are capable of explaining what it can perceive around it, it is said to be in a state of equilibrium, i.e. a state cognitive (mental) balance (Mcleod, 2009). The implication of this (schema) as pointed out by Ezeife (1996) is that "the students have their preconceived notions or preconceptions about science/biology topics or concepts which are largely drawn from their schemas, prior experiences or their experiential environment". Hence, the duty of the teacher is to probe tactfully about students' schema before introducing any lesson/topic.

Piaget, viewed intellectual growth as a process of adaptation (adjustment) to the world, which is done through:

Assimilation: The process of taking in new information into our previously existing schemas is known as assimilation. The process is somewhat subjective, because we tend to modify experience or information somewhat to fit in with our pre-existing beliefs

Accommodation: Another part of adaptation involves changing or altering our existing schemas in light of new information, a process known as accommodation. Accommodation involves altering existing schemas, or ideas, because of new information or new experiences. New schemas may also be developed during this process. It happens when the existing schema (knowledge) does not work, and needs to be changed to deal with a new object or situation.

Equilibration*:* Piaget believed that all students try to strike a balance between assimilation and accommodation, which is achieved through a mechanism Piaget called equilibration. As students progress through the stages of cognitive development, it is important to maintain a balance between applying previous knowledge (assimilation)

and changing behavior to account for new knowledge (accommodation). Equilibration is a force which drives the learning process as we do not like to be frustrated and will seek to restore balance by mastering the new challenge (accommodation) (Mcleod, 2009). Once the learner's conceptual equilibration has been achieved, categorical mistakes will ceased, and the learner's conceptual understanding will begins to flow smoothly. See the diagram below

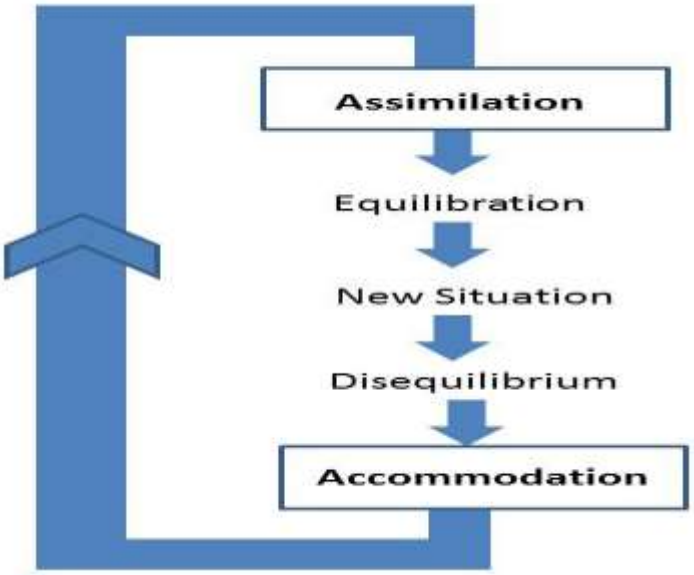

Figure 2.1: Piaget Theory of Cognitive Development (Source: Mcleod, 2009).

Vygotsky's Constructivist Social Learning Theory:

Vygotskian learning theory (1989), reasons that social interaction plays a fundamental role in the development of cognition. Individual development derives from social interactions within which cultural meanings are shared by the group and eventually internalized by the individuals. Individuals construct knowledge in transaction with the environment, and in the process, both the individual and the environment are changed. The subject of study is dialectical relationship between the individual, social and cultural milieu. Schools are the socio-cultural settings where teaching and learning take place and where

cultural tools such as reading, writing, mathematics, chemistry, and certain modes of discourse are utilized. This approach assumes that theory and practice do not develop in a vacuum. They are shaped by dominant cultural

assumptions. Formal knowledge, the subject of instruction and the manner of its presentation are influenced by historical and cultural environment that generated them. Instruction can be made more efficient when learners engage in activities and receive guidance mediated by appropriate tools.

2.4 Empirical Studies

2.4.1 Studies on Retention

Onyegegbu (1999) investigated the effects of using audio-rolliograph instructional material on students' achievement after learning the Biology concept of bilharziasis. In the study, a quasi-experimental, non-equivalent control group design involving two groups was used. A sample of 345 SSII students from eight intact classes from four secondary schools was divided into experimental (Audio rolliograph) and control (Conventional method). The result of the study showed that audio-rolliograph instructional material was significantly more effective in increasing student's achievement than the conventional lecture method. She concluded that the significant difference might be a result of the ability of the audio-rolliograph screen to provide more concrete representations of the disease as it synchronizes with the sound from the player arouses students interest, who in turn become curious and all attentions and concentration are focused on the large screen rolliograph.

Adebola (2012) studied the effect of problem-solving model as strategy for improving Secondary School students' achievement and retention in further mathematics. In the study, they adopted pre-test, post-test, control group quasi-experimental design involving

a 2x2 factorial matrix. 80 Senior Secondary School (SSII) students from two purposely-selected schools participated in the study. Three Instruments namely: Teachers' Instructional Guide, Further Mathematics Achievement Test (FMAT) (r=0.76) and student Retention Test (SRT) (r=0.75) were developed, validated and used for data collection to test six null hypotheses raised for the study. Data collected was analysed using analysis of covariance (ANCOVA) at the 0.05 level of significance. Findings showed that problem-solving strategy had significant main effect on students' achievement and retention in Further Mathematics. This study is related to the present study because retention is a variable in the study, but it differs in terms of the instructional method and level of subject used.

Chianson (2011) investigated the effect of cooperative learning method compared with the conventional learning method in order to find out the retention level of students in circle geometry. The study was carried out on SSII students in the three educational zone (zone A, B and C) in Benue state, Nigeria. The ability of students to grasp and memorize a mathematical concept or topic that was taught has become a problem in secondary schools. These problems may arise due to inappropriate teaching methods being used to explain these topics. The study adopted the cooperative learning strategy to teach 358 SSII students circle geometry. An independent T-test analysis was used to determine whether a statistical significant difference existed between the cooperative learning approach in terms of students retention of the taught concept ($t(356) = 8.474$, $p=0.001$). The findings of the study confirmed that students who were subjected to the cooperative learning strategy were able to retain the concepts of circle geometry more using the conventional learning approach.

Okereke (2006) investigated the effects of constructivists' instructional approach on students' achievement and retention in basic ecological concepts in Biology. The design of

the study is quasi experimental, specifically the non equivalent control group design. The sample was made up of 154 SS2 biology students. Five research questions and five hypotheses guided the study. The instrument for data collection in the study was 38 items multiple choice biology achievement test in ecological concepts (BATEC). The study employed quasi experiment design, specifically non-equivalent control group design. Mean and standard deviation were used to answer the research questions and ANCOVA was used to test the null hypotheses. The result of the study showed that students taught ecological concepts using constructivist instructional approach performed better than those taught using the lecture method. The study also showed that students taught ecological concepts using constructivist instructional approach had higher retention score than their counterparts taught using the conventional lecture method. This study is related to the present study because retention is a dependent variable in the study , but defer form the present study in terms of the instructional method employed in the study and in terms of the locations where the studies were carried out.

Studies on Gender and Students' Achievement.

Ukozor (2011) investigated the effect of constructivist teaching strategy on senior secondary school students' achievement and self-efficacy in physics. The study employed a quasi experimental design. The sample size of the study comprised of 184 students from four secondary schools (two boys and two girls), drawn from the population of the study. Five research questions and three null hypotheses guided the study. Mean and standard deviation was used in answering the research questions and ANCOVA used in testing the hypotheses. A significant effect of gender on students' physics academic achievement was found in favour of male students. This study is related to the present study because gender is a

moderating variable in the study, but the two studies differ in terms of the methods employed in the study.

Baser (2006) carried out a meta-analysis of gender differences in students' performance and conceptual change in physics. The total number of 23 studies was sampled out of a population of 5032. The study was designed to investigate the magnitude and direction of gender differences in physics among Nigerian students. 23 research studies conducted all over Nigeria were collated for this research synthesis. Mean and standard deviation were used to analyze the data. The results suggested that the gender difference in physics is not significant. This study is related to the present study in terms of gender, but differs in terms of method employed in the study, subject area and location.

Madu (2004) conducted a study on the effects of constructivist's instructional model (PEDDA) on student's conceptual change. The study employed a quasi-experimental design. Five research questions and four null hypotheses guided the study. The sample for the study comprised of 134 SSII students. Mean and standard deviation was used to answer the research questions, while ANCOVA was used to test the hypotheses at 0.05 level of significance. The result from conceptual change trace analysis revealed that conceptual change depends on gender, with male students in science having conceptual shift than the female students. The researcher concluded that gender influences the students' level of understanding from preconception or alternative conception to scientific conception. This study is related to the present study because gender is a moderating variable in the study, but the two studies differ in terms of the methods employed in the study.

Agommuoh and Nzewi (2003) investigated the effects of videotaped instruction on secondary school students' achievement in Biology. Three hundred and ninety eight SS1 students were selected from two co-educational schools. Purposive and stratified sampling

techniques were used. Data generated were analyzed using mean and standard deviation and Analysis of Covariance (ANOVA) was used to test the hypotheses at 0.05 significance. The results indicated that the achievement of students in physics greatly improved with the use of videotaped instruction. Student gender had no significant effect in their achievement in physics when video-taped instructions are used. This study is related to the present study, in terms of gender, but differs in terms of method employed in the study and location.

However, in all the works reviewed, some are either in favour of male, or in favour of the female students. However, none articulated the reason for such gender differences. Therefore, the present study intends to close that gap by investigating the relative effects of 4MAT on student's achievement, retention and multiple intelligences in Biology. This is aimed at finding out whether 4MAT instructions favour male or female most. In view of these inconsistent findings on gender as it relates to student's achievement, there is a gap, which the present study is geared towards filling by contributing to the body of knowledge on gender and achievement in science.

2.5 Summary of Literature Review

From the studies reviewed, there are different teaching methods employed in teaching of science subjects in secondary schools. These methods ranges from teacher-centered to students centered instructional methods and they includes lecture method, inquiry method discussion method and other problem solving methods. The study also reviewed the learning style of students. Learning styles are individual's unique way of perceiving and processing information.

The constructivist theories reviewed in this study are those of Piaget's, Vygotsky and Jerome Bruner. The Constructivists theory, rests on the notion that learner's are actively involved in the construction and generation of knowledge. When this happens, more learning that is

authentic may result. The concept of human intelligences has recently begun to be conceptualized and looked at in a more integrated way. In 1983, Gardner developed a theory called multiple intelligences that identifies and describes seven distinct ways in which people can represent what they know and how they can do it. The concept of mecognitive is very content and context oriented, focusing on human potentials, an idea related to the theme "science for all". The study also reviewed works on students' achievement and retention. Gender and students' achievement and retention in the literature of this study.

From the review, it is quite clear that limited research has been conducted to determine the effect of mecognitve strategies on student achievement and retention. Thus this will investigate in to the analysis of metacognitive learning style on the academic achievement and retention of concept of ecology in bilogy student in Minna metropolis.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

The research design used for this study is quasi-experimental design. The study adopted non-equivalent pretest - posttest control group design. The Quasi-experimental design was considered appropriate for the study because intact classes were used to avoid disruption of normal class lessons in the various schools involved in this study. The pre-test was used to find out initial differences in the two groups and to control selection bias, which is a trait to internal validity. The study design is demonstrated in the table below:

Table 3.1 Research Design Outline

Variables	Pre-test	Treatment	Post – test	Moderating Variable
Experimental	O_1	X_1	O_2	O_3
Control	O_4	X_o	O_5	O_6

O_1, O_1= pretest scores of experiment and control groups

O_2, O_5= posttest scores of experiment and control groups

O_3, O_6 = Retention scores of experiment and control groups

X_0= Conventional Style

X_1= Metacognitive Style

3.2 Population of the Study

The population of the study consists of all the SS2 Biology students from all the secondary school in Minna Metropolis of Niger, total number of student population during 2017/2018 academic session is 5,382. The targeted secondary school are co-educational because of the population characteristics (gender – male, female) considered in the study. They also have the same environment condition such as teachers, syllabus, remuneration and class size.

3.3 Sample and Sampling Techniques

The sample size of this study was 135 students captured from two intact classes in public co-educational schools in Bosso Local Government Area of Niger State. Two intact classes randomly selected were also randomly assigned by balloting and categorized into experimental and control groups. The experimental group was taught using the metacognitive teaching style and the control group was taught using conventional method. Simple random sampling techniques was used to select the schools and also randomly categorized into experimental and control respectively.

3.4 Research Instruments

The instrument used in the study was a researcher developed Biology Achievement Test (BAT). The BAT was based on the topics in Ecology Concept. This achievement test consists or two sections, A and B. Section A seeks personal information on the students with respect to name of student, name of school, gender and age while the section consists of the achievement test made up of items. Each of the test items is followed by option A – D. The respondent is expected to pick an answer by ticking the correspondent alphabet. Each correctly answered option carried 3marks, which was then counted to percentages.

3.5 Reliability of the Instrument

The achievement test question was trial – tested in Government Day Secondary School Minna, Chanchaga, which is not selected for the main study. The result computed in the test to the class was analyzed using Pearson Product Moment Correlation formula and reliability coefficient of 0.78 was obtained, showing that the items are reliable according to thumb print of (Frankel and Wallen, 2014).

3.7 Validation of Research Instrument

The instrument was validated by the supervisor of this work and two senior lecturers from Science Education Department. The questions were also validity using the following criteria: (i) subject matter coverage (ii) adequacy of language (iii) stemming of the questions. Corrections, suggestion given by experts were used to modify the content of BAT.

3.8 Method of Data Collection

A letter of request for permission was written to the school principals seeking for permission to use the school, Biology Teachers and Students for the study. The researcher also established interactions in other to enlighten them on the purpose of the visit.

The instrument containing 20; items was administered on 135 senior secondary school (SS 2) students offering Biology in Bosso Local Government Area of Niger State. At the time of giving the test, the researcher ensures that the students read the instruction before answering the questions on the Biology Achievement Test (BAT). They were also guided by a lesson plan prepared by the researcher based on the biology topics for assessment. Conventional teaching method was used for teaching the control group and metacognitive style for experimental group. Pretest was given to all the Biology students in the four schools using BAT before treatment. After the pretest, students (experimental group) in their classes of two were taught the Biology/Ecology topics using metacognitive teaching method while the control group were taught Biology/Ecology topics using conventional method

3.9 Method of Data Analysis

Data were analyzed by using descriptive statistics of mean, Standard deviation to answer research questions while inferential statistics such as ANCOVA was used to analyze the

hypotheses at 0.05 level of significance. The Statistical Package for the Social Science (SPSS) version 25.0 was used.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Introduction

The organization of data for the study was obtain from the instrument administered to the two groups. The control group is made of sixty-five (65) student in Bahago Secondary School, while the experimental group is made up of seventy (70) student from Bosso Secondary School Bosso. The result was presented in table according to the analysis of the instrument administered to the two group.

4.2 Results

4.2.1 Pretest Result

Table 4.1: Mean and Standard Deviation of Pretest Score of Control and Experimental Groups

Variable	N	$\bar{x}$	SD	Mean Difference
Control Group	65	53.51	5.43	0.71
Experimental Group	70	54.22	5.02	

Table 4.1 shows the mean pretest score of the control and experimental groups. The outcome of the result shows that the control group has maximum score of 58 and minimum score of 36 with mean score of 53.51, while the experimental group has maximum score of 57 and minimum score of 38 with mean score of 54.22, the mean of 0.71 shows a significant difference. Hence, the group are not equivalent. The ANCOVA statistics was used to take of the difference in the pre-test.

4.2.2 Analysis of Research Hypotheses

H_{O1}: There is no significant difference in the mean achievement scores of students taught Biology using metacognitive style and those taught with conventional method.

Table 4.2: ANCOVA Analysis of mean achievement scores of students taught Biology using metacognitive style and those taught with conventional method

Variable	N	Df	$\bar{x}$	SD	t-cal	p-value	Decision
Control Group	65	133	55.87	1.940	2.68	0.000	S
Experimental	70		57.01	1.962			

*S = Significant

Table 4.2 shows the significant difference in the post-test gain scores in the performance of students taught Biology using metacognitive style and those taught with conventional method. The outcome of the result shows that the means score of those student taught conventional methed is 55.87, SD = 1.940, while those taught using metacognitive style is 57.01 and the SD=1.94, df = 133, with p-value of 0.000. The null hypothesis is thereby rejected. Hence, that there is statistical significant different between the mean achievement score of students taught using metacognitive style to conventional method.

H_{O2}: There is no significant difference in the mean retention scores of students taught Biology using metacognitive style and those taught with conventional method.

Table 4.3: ANCOVA Analysis of mean retention scores of students taught Biology using metacognitive style and those taught with conventional method

Variable	N	df	$\bar{x}$	SD	t-cal	p-value	Decision
Control Group	65	133	42.01	1.841	3.014	0.02	S
Experimental Group	70		44.54	2.010			

Table 4.3 reveals the significant difference in the post-test gain scores in the retention of students taught Biology using metacognitive style and those taught with conventional method. The outcome of the result shows that the means retention score of those student taught conventional method is 42.01, SD = 1.841, while those taught using metacognitive style is 44.54 and the SD=2.01, df = 133, with p-value of 0.020. The null hypothesis is not accepted. Hence, that there is statistical significant different between the mean retention score of students taught Biology using metacognitive style to conventional method.

H_{O3}: Gender does not significantly influence the mean achievement scores of students taught Biology using metacognitive style.

Table 4.4: ANCOVA Analysis of mean achievement scores of male and female taught Biology using metacognitive style

Variable	N	df	$\bar{x}$	SD	t-cal	p-value	Decision
Male	38	68	56.99	1.969	1.36	0.89	NS
Female	32		57.03	1.954			

*NS = Not Significant

Table 4.4 shows the significant difference in the post-test gain scores in the achievement of male and female students taught Biology using metacognitive style. The outcome of the result shows the male means score is 56.99 and the SD=1.969, df = 69, with p-value of 0.89, while the female mean scores of those taught without materials is 57.03, SD = 1.954, therefore the null hypothesis of no significantly difference in mean score achievement of male and female student taught using metacognitive style was not rejected. Hence, that there is no statistical significant different between male and female students' achievement score on exposure to metacognitive style.

H_{O4}: Gender does not significantly influence the mean retention scores of students taught Biology using metacognitive style.

Table 4.5: ANCOVA Analysis of mean retention scores of male and female taught Biology using metacognitive style

Variable	N	df	$\bar{x}$	SD	t-cal	p-value	Decision
Male	38	68	44.54	1.991	2.34	0.14	NS
Female	32		44.55	2.028			

*NS = Not Significant

Table 4.4 shows the significant difference in the post-test gain scores in the retention of male and female students taught Biology using metacognitive style. The outcome of the result shows the male means score is 44.54 and the SD=1.991, df = 68, with p-value of 0.14, while the female mean scores of those taught without materials is 57.03, SD = 2.028, therefore the null hypothesis of no significantly difference in mean score retention of male and female student taught using metacognitive style was not rejected. Hence, that there is no statistical significant different between male and female students' achievement score on exposure to metacognitive style.

4.3 Discussion of Result

The analysis of research hypothesis revealed that experimental group (metacognitive style) did better than the control group (conventional method), although there is no difference in performance of male and female in the experimental group that is taught using metacognitive, the following are findings of the study in detailed.

The finding s of the study revealed the significant difference in the post-test gain scores in the performance of students taught Biology using metacognitive style and those taught with conventional method. The outcome of the result shows that there is statistical significant

different between the mean achievement score of students taught using metacognitive style to conventional method, with the p-value (0.000) < 0.000. That metacognitive style improve the understanding of the study than the conventional method.

The out the study also disclosed the significant difference in the post-test gain scores in the retention of students taught Biology using metacognitive style and those taught with conventional method. The outcome of the result shows, that there is statistical significant different between the mean retention score of students taught Biology using metacognitive style to conventional method with p-value (0.02) < 0.05. The implication of this is that there is significant effect of metacognitive teaching on the retention of student in biology.

The findings of the emanated from the study also disclosed the significant difference in the post-test gain scores in the achievement of male and female students taught Biology using metacognitive style. The result shows the that there is no statistical significant different between male and female students' achievement score on exposure to metacognitive style, that is the performance of student expose to metacognitive style is not based in gender. This in line with the finding of (Okereke, 2006), the author investigated the effects of constructivists' instructional approach on students' achievement and retention in basic ecological concepts in Biology. The findings of the study revealed that gender does not influence academic performance in biology.

Finally the outcome of the study also disclosed the significant difference in the post-test gain scores in the retention of male and female students taught Biology using metacognitive style. The result revealed that there is no statistical significant different between male and female students' achievement score on exposure to metacognitive style. This is supported by (Adebola, 2012) studied the effect of problem-solving model as strategy for improving Secondary School students' achievement and retention in further mathematics.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings of the study, on the metacognitive learning instruction on the academic achievement and retention of concept of ecology by biology students. it could be concluded that metacognitive style help the performance of student, this may be attributed to the use demonstrative, call for thinking and interactive section the metacognitive style brings to teaching. The study further highlighted the positive influence of metacognitive style on academic performance of student in Biology.

The finding s of the study revealed the significant difference in the post-test gain scores in the performance of students taught Biology using metacognitive style and those taught with conventional method. Hence, metacognitive style improve the understanding of the study than the conventional method.

The out the study also disclosed the significant difference in the post-test gain scores in the retention of students taught Biology using metacognitive style and those taught with conventional method. The implication of this is that there is significant effect of metacognitive teaching on the retention of student in biology.

The findings of the emanated from the study also disclosed the significant difference in the post-test gain scores in the achievement of male and female students taught Biology using metacognitive style. The findings of the study revealed that gender does not influence academic performance in biology.

Finally the outcome of the study also disclosed the significant difference in the post-test gain scores in the retention of male and female students taught Biology using metacognitive style. The result revealed that there is no statistical significant different between male and female students' achievement score on exposure to metacognitive style.

5.2 Recommendations

Based on the findings of the study the following recommendation were made:

1. The Ministry of Education should encourage the use of metacognitive in teaching Biology in Senior Secondary School.
2. School Authority and teachers should be enlighten on the importance of metacognitive style in teaching.
3. The student should also be enlighten on the importance of metacognitive style of learning to their careers.

5.3 Suggestion for Further Study

Based on the findings of the study following are suggested for further research:

1. Assessment of factors affecting the adoption of metacognitive style among teachers and students in senior secondary school in Minna Metropolis.
2. Influence of e metacognitive learning instruction on the academic achievement and retention of concept of ecology by biology students. In Urban and Rural areas in Niger State.

5.4 Contribution to the Knowledge

1. The study serve as an insight to towards the importance the adoption metacognitive style of learning in teaching Biology in Niger State.

2. The study also add up to the already exiting literatures in the implementation of metacognitive style of learning facilities in teaching and learning Biology.

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LESSON PLANS/LESSON NOTES

LESSON NOTES - CONTROL GROUP
(Lecture Method)

Lesson 1 - Problem-Solving Method

Date - September 2019

Subject - Ecology

Topic - Basic Ecological Concepts

Class - SS I

No. of Pupils in Class- 70

Average age - 15 years

Instructional Materials - Charts illustrating ecological concepts, Essential Biology Textbook

Previous knowledge - Students have been taught the meaning and concepts of ecology

BEHAVIOUR OBJECTIVES

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

1. Explain in their own words the following some ecological concepts:
(a) Autecology
(b) Synecology
(c) Lithosphere
(d) Hydrosphere
(e) Biotic community (f) Ecological niche (g) Environment
(h) Habitat
(i) Population
(j) Ecosystem
2. Describe in their own words the importance of these terms in the study of ecology
3. State the component of an Ecosystem
4. state types of population and explain.
5. state factors affecting population

Introduction

Class, in the previous lesson held the discussion was centered on the relevance of biology to agriculture. Have you ever heard of the word ecology? Have you also wondered how the word ecology came into the scene of our discussion? In this and other subsequent lessons, we shall be examining the different concepts of ecology. We shall discuss about

the meaning of ecology and ecological concepts.
Presentation: (Using the lecture method)

Step 1: The concept of "ecology: - a branch of biology that deals with the study of plants and animals in relation to their environment. Ecology is derived from a Greek word "Oikos" which means home or dwelling place.
Problem No. 1 to solve

Step II: Some schools of thought on the origin of ecology

(a) Defines ecology as a field of study which deals with the relationships of living organisms with one another and with the environment in which they live.
(b) Describes ecology as an environmental biology

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

Autecology – is concerned with the study of an individual organism or a single species of organism and its environment. For example, the study of a single rat and its environment.
Synecology – is concerned with the study of the interrelationships between groups of organisms or species of organisms living together in an area. For example, the study of different organisms in a river in relation to their aquatic environment.

Step III :
(a) Define the basic ecological concepts, thus Autecology
(b) Ecological concepts

(i) Environment: This includes all factors external and internal living and non-living factors which affect an organism.
(ii) Biosphere or ecosphere: This is the zone of the earth occupied by living organisms. It is a layer of life which exists on the earth's surface.
(iii) Lithosphere: is the solid portion of earth. It is the outer most layer of zone of the earth's crust. It is made up of rocks and mineral materials, and it also represents 30% of the earth's surface.

(iv) Hydrosphere: is the liquid/aquatic part of the earth or living world. It covers about 70% of the earth's crust. It holds water in various forms – solid ice, liquid (water) and as gases (water vapour).
(v) Atmosphere: The atmosphere is the gaseous portion of the earth. It is a layer of gases surrounding the earth over 99% of the atmosphere within 30km of the earth surface.
(vi) Habitat: Habitat is defined as an area occupied by a biotic community. In other words, habitat is any environment in which an organism lives naturally.
(vii) Biotic community or biome: A biotic community is any naturally occurring group of different organisms living together and interacting in the same environment. A biome is a largest community of organisms, e.g. rainforest, guinea savannah, etc.
(viii) Ecological niche: ecological niche refers to the specific portion of a habitat which is occupied by a particular species or organism. It is the functional position of an

organism within a community.

Problem 1 to Solve (5 minutes)

(a) What is ecology?

(b) What is meant by ecological concepts

Step IV: students to answer the following:

(a) What is environmental biology?

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

(i) Autecology

(ii) Synecology

(iii) Environment

(iv) Biosphere

(v) Ecosphere

(vi) Lithosphere

Step V: Problem No. 2 to solve

List five ecological concepts you know and state what each stands for.

Problem No. 3 to solve

(a) What are components of the ecosystem?

(b) List them and state what role each plays in the study of ecology

Step VI

Give a comprehensive summary of what basic ecological concepts entail e.g. Autecology; As a branch of ecology which deals with the study of an individual organism e.g the study of a single rat and its environment.

Evaluation – ask the following questions

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

(2) What is meant by a biome?

(3) Define the following:

i. Biotic community

ii. Ecological niche

iii. Population

iv. Ecosystem

v. Abiotic components

SUMMARY AND CONCLUSION

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

Lesson 2: **Problem-Solving Instructional Strategy**

Date September, 2019

Subject Ecology

Topic	Local biotic communities
Class	SS IIB Biology
Duration	40 minutes
No. of pupils in Class	30
Period	
Average age	15 years
Instructional method	Lecture method
Teaching Aids	Charts, maps of Nigeria and Africa.
Previous knowledge	Basic ecological concepts

Behavioural objectives

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

(1) Identify the different basic ecological concepts

(2) List the different branches of ecology

(3) State the relationship of living organisms with one another and with the environment in which they live.

(4) Identify the interrelationships between groups or organisms or species of organisms living together in an area.

Introduction

Step I

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

Presentation

Local biotic communities

The local biotic communities in Nigeria are grouped into two major zones. These are:

(a) Forest zone: The forest zone is made up of vegetation having mainly trees and consist of the following local biotic communities
   (i) Mangrove swamp forest (salt and fresh water swamp, (ii) tropical rainforest

(b) Savanna zone: The savanna zone is made up of mainly grasses and is further subdivided into three savanna belts and Sahel savanna mangrove swamp forest.

Location

The mangrove swamp forest is found in areas along the coast especially in states like Delta, Cross River, Rivers, Akwa-Ibom, Bayelsa, ogun and Lagos.
Characteristics of swamp forest:

(i) It has tall woody trees
(ii) Plants mainly have aerial roots
(iii) It has evergreen trees with broad leaves
(iv) It has high rainfall over 250cm throughout the year which results in water logging
(v) It is a combination of fresh and salt water.
(vi) Common plant species found are white mangrove, red mangrove, raffia palm, coconut etc.
(vii) Animals found in the biotic community include tilapia fish, oysters, crabs, snakes, birds, king fishers, chameleon an squirrel, etc.

Problem No. 4 to solve

What is meant by a community?

Explain the types of biomes you have studied

Describe in your own words what the following words stand for:

(i) Forest zone
(ii) Savanna zone

Students' activity

From your study of ecology, write an account of the different examples of a high forest.

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

3 (a) Draw a map of Nigeria showing the following

(b) Forest zone

(c) Savanna zone

(d) Mangrove swamp forest

Summary and Conclusion

Highlight the main points of the lesson with the students.

Explain how biotic communities in Nigeria have been formed (discuss with a partner)
Problem No. 3 to solve in the class (2-5 minutes). Show where you can locate mangrove and rainforest swamps in the map of your country.
Step 2: Tropical Rainforest

Location: This biotic community can be found in states like Edo, Delta, Ondo, Imo,

Abia, Lagos, Ogun, Anambra, Bayelsa and Akwa-Ibom.
Characteristics of tropical rainforest

(i) The vegetation has tall trees with buttress roots, evergreen and broad leaves

(ii) The trees exist in different heights or layers, i.e. bottom or lower, middle and upper layers.

ECOLOGY ACHIEVEMENT TEST (EAT)

Instruction:

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

1. You must use pencil for the examination.
2. Write your name in the space provided in the answer sheet.
3. Write your class and class number on the in the space provided in the answer sheet.
4. Read each question carefully before answering it.
5. Do not waste time on any question. If you find a question difficult, go on to the other questions and finish them first.
6. After you have selected what you take to be the correct answer, go to you answer sheet and circle the appropriate alphabet in the space that corresponds with your choice.
7. Circle only one letter for your answer.
8. If you change your mind on an answer, completely erase the first circling.

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

1. The word 'ecology' is a branch of Biology concerned with the study of?

a. Interrelationships between living organisms and their external environment b. The study of living organisms only
c. The study of salamaneis, snails and snakes d. The capillary movement of water in plants

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

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

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

a. Biosphere

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

4. The study of interrelationships between groups of organisms living together in an area is called……?
a. Gyneacology
b. Autecology
c. Synecology
d. Topography
5. The main kinds of habitats are……..?
a. Arboreal and ground habitat
b. Underground habitats

c. Aquatic and terrestrial habitats
c. Salt and fresh water habitats
6. One of the commonest habitats found in the terrestrial habitats is……?
a. Underground habitats
b. Fresh water habitats
c. Marine habitats
d. Brackish water habitats

7. The factors which influence living organisms in their habitats and control their survival and distribution are called……..?
a. Habitat factors

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

8. Abiotic factors refers to……..?
a. Physical factors
b. Biotic factors

c. Climatic factors

d. Edaphic factors

9. An example of topographic factors is……?

a. Temperature
b. Rainfall
c. Elevation

d. Soil texture

10. A typical example of an edaphic factor is……?
a. Soil texture

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

11. Animals that live both in water and on land are referred to as....?

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

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

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

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

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

14. Organisms which breakdown the compounds of dead organisms are called:…..?

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

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

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

16. The relationship between fungi and algae in lichens is known as:……?

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

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

a. “Producer” plants
b. Animal “consumers”

c. Decomposers

d. Parasites and commensalists

18. A sequence of species related to another predator and prey is a…….?

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

19. Which of the following pairs represents ecological equivalents_____ and _____?

a. Squirrel and rattle snake
b. House cat and lion

c. Sea gull and codfish

d. Wild horse and zebra.

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

a. It is usually populated only by plants.

b. It remains until there are several changes in the environment.
c. It represents the initial phases of evolution

d. It changes rapidly from season to season.

21. The climax organism growing above the tree line on a mountain would be the same as the climax organism found in the……..?

a. Taiga

b. Tundra

c. Tropical forest
d. Desert

22. The character of an ecosystem is determined by the environmental factor that is in shortest supply. This is……?

a. the law of minimum
b. Borty's law
c. Charles' law
d. Mendelism

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

a. Swamp

b. Tropical forest

c. Southern guinea savannah
d. Desert

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

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

25. The following measures are useful for conserving forests **EXCEPT**?

a. Preventing and controlling accidental forest fires

b. Encouraging the use of charcoal for industrial and domestic purposes
c. Combating and preventing plants diseases
d. Reforestation of depleted forest.

26. The following practices are aimed at soil conservation **EXCEPT….?**

a. Contour ridging

b. Application of manures

c. Strip cropping
d. Bush burning

27. Which of the following natural resources is most readily available to all organisms"….?
a. Water
b. Air
c. Food

d. Mineral resources

28. Which of the following is not a structural adaptation of desert plants for water conservation?
a. Tiny leaves

b. Sunken stomata leaves

c. Siems and leaves with heavy culice

d Broad leaves with numerous stomata.

29. The burning of farmlands should be discouraged because it…….?

a. Destroys some plant pests

b. Reduces the population of wild animals
c. Makes bush clearing more difficult
d. Destroys the organic part of the soil.

30. In cold climates or at high altitudes, some small mammals fall asleep in some specially prepared nests or burrows. This process is known as……..?
a. Hibernation
b. Masturbation
c. Conservation
d. Contraction

QUESTION

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

27. B

28. C

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