# EFFECTS OF ANCHORED AND COGNITIVE FLEXIBILITY INSTRUCTIONAL STRATEGIES ON SECONDARY SCHOOL STUDENTS' KNOWLEDGE, ATTITUDE AND PRACTICES IN BIOLOGY IN IBADAN,NIGERIA

**BY**

**Omolola Oluwalanu OLOYEDE**
**MATRIC NO: 56008**
**B.Sc (Archaeology) ; PGDE ; M.Ed (IBADAN)**

**A THESIS IN THE DEPARTMENT OF TEACHER EDUCATION SUBMITTED TO THE FACULTY OF EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) IN SCIENCE EDUCATION OF THE UNIVERSITY OF IBADAN**

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## ABSTRACT

It has been observed that students have poor knowledge in Biology, a trend which is evident in performances in environmental concepts and the negative practices observed in their various classes. This has been attributed to non-usage of active and participatory instructional strategies which involve computer usage of powerpoint, hypertext, motion and sound presentations such as anchored and cognitive flexibility in teaching environmental concepts in Biology. Previous studies have investigated the efficacy of anchored instruction and cognitive flexibility strategies on students' learning outcomes in Mathematics and Social studies but not in Biology. This study, therefore, determined the effects of anchored instructional strategy (AIS) and cognitive flexibility instructional strategy (CFIS) on senior secondary school (SS) students' knowledge, attitude and practices in Biology in Ibadan, Nigeria. The moderating effects of gender and cognitive style were also determined.

The pretest-posttest, control group, quasi-experimental design with 3x2x2 factorial matrix was adopted. Three senior secondary schools were purposively selected, each from Akinyele, Ibadan North and Ibadan North-West Local Government Areas. Four hundred and twenty three SS II students of intact classes participated in the study. Participants were assigned to experimental groups (AIS, CFIS), and control groups in each LGA, while the treatment lasted 12 weeks. Four validated instruments which included: Student's Knowledge of Environmental Concept Test (r=0.83), Student Environmental Attitude Scale (r = 0.88), Student Perceived Environmental Practices Scale (r=0.82) and Cognitive Style Test (r=0.89) were used for data collection. Data were analysed using ANCOVA and Scheffe post- hoc at 0.05 level of significance.

There was a significant main effect of treatment on students' knowledge ($F_{(2,421)} = 403.31$, $\eta^2 = .66$), attitude to ($F_{(2,421)} = 5.22$, $\eta^2 = .03$) and practices ($F_{(2,421)} = 8.87$, $\eta^2 = .04$) of environmental concepts in Biology. Participants in the AIS group had a higher knowledge mean score ($\bar{x} = 18.64$) than those in the CFIS ($\bar{x} = 13.85$) and control ($\bar{x} = 9.47$) groups. Participants in the CFIS group had higher attitude mean score ($\bar{x} = 63.85$) than those in the AIS ($\bar{x} = 63.13$) and control ($\bar{x} = 61.62$) groups. Also, students' in AIS group had the highest mean score in environmental practices ($\bar{x} = 50.63$), followed by CFIS ($\bar{x} = 48.15$) and control group ($\bar{x} = 48.05$). Cognitive style had a significant main effect on students' environmental knowledge ($F_{(1,422)} = 3.97$, $\eta^2 =$

.01) and attitude to environmental concepts ($F_{(1,242)} = 9.32$, $\eta^2 = .02$). The innovators had higher knowledge mean score ($\bar{x} = 14.25$) than the adaptors ($\bar{x} = 13.73$). The innovators had higher attitude mean score ($\bar{x} = 63.74$) than the adaptors ($\bar{x} = 62.00$). Gender had no significant main effect on students' environmental knowledge, attitude and practices. There were no two-way and three-way interaction effects on environmental knowledge, attitude and practices.

Anchored and cognitive flexibility instructional strategies enhanced students' environmental knowledge, attitude and practices of students in Biology in Ibadan. Biology teachers and curriculum developers should adopt both instructional strategies to improve students' learning outcomes regardless of gender in environmental concepts in Biology.

**Keywords:** Anchored and cognitive flexibility strategies, Secondary schools in Ibadan, Environmental concepts in Biology.

**Word count:** 494

## CERTIFICATION

I certify that this work was carried out by Mrs. Omolola Oluwalanu OLOYEDE Matric No. 56008 in the Department of Teacher Education, Faculty of Education, University of Ibadan under my supervision.

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**SUPERVISOR** **DATE**

**Professor Alice M. Olagunju**
Ph.D (Science Education), M.Ed (Ib) B.Sc Ed. (Ife)
Department of Teacher Education,
Faculty of Education,
University of Ibadan
Ibadan
Nigeria.

## DEDICATION

Dedicated to

THE ALMIGHTY GOD.

For it is the Lord that gives WISDOM, and from HIM cometh KNOWLEDGE and UNDERSTANDING.

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I am indebted to a number of people who gave me the encouragement to forge ahead with the attainment of this educational level and whose involvement in one way or the other has given me the impetus to get this thesis done

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June, 2015

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## LIST OF ABBREVIATIONS

AC - Abstract Conceptualization

AE - Active Experimentation

AI - Anchored Instruction

CE - Concrete Experience

CFH - Cognitive Flexibility Hypertext

CST - Cognitive Style Test

CTGV - Cognition and Technology Group at Vanderbilt

EE - Environmental Education

FEPA - Federal Environmental Protection Agency

FME - Federal Ministry of Education

IUCN - International Union for the Conservation of Nature and natural resources

KAI - Kirton Adaptation-Innovation Inventory

MBTI - Myers. Briggs Type Indicator

MDG - Millennium Development Goals

NCF - Nigerian Conservation Foundation

RO - Reflective Observation

SSSCE - Senior Secondary School Cert Education

UNESCO - United Nations Educational and Socio-Cultural Organisation

WAEC - West African Examination Council

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the study

Biology is one of the major subjects offered at both the senior secondary school level and higher institutions in Nigeria. Generally defined, Biology is the study of life. Biology as a subject is of paramount importance to any nation, including the developing ones. It is an important science subject in the Nigerian school system. According to the National Policy on Education (NPE), of the Federal Republic of Nigeria, in 2013, Biology belongs to the core subjects that must be offered by students at the Senior School Certificate Examination (SSCE). Also, a sound working knowledge of Biology is a prerequisite for entrance into such professions as Medicine, Pharmacy, Agriculture, Nursing and Biochemistry, to mention a few.

The importance of Biology, as a science subject in Nigerian schools, cannot be overemphasized. A sound theoretical and practical knowledge of Biology is very necessary for the management of our natural resources, provision of good health facilities for the masses, adequate food supply and favourable life environment (Chukwuemeka, 2011). Among the so many concepts learnt in Biology are environmental concepts, such as the natural environment, natural resources, interdependence, pollution, solid waste disposal, degradation, population, famine, health issues, energy conservation, global warming, deforestation and desertification, and ozone depletion.

From time immemorial, human beings have focused on the environment for sustenance and survival. From the agrarian period up to the industrial, and now to the revolutionary, human beings have greatly focused their attention on harnessing environmental resources for survival and sustenance/development. Thus, this has led to great strides in the area of technological development and advancement over the years. There is no doubt therefore, that technological advances in agriculture, industry, and transportation have greatly improved human life. However, these activities, while providing the raw materials for production of goods and services, have also resulted in pollution of land, atmosphere, vegetation and rivers. As in most other countries of the world, the Nigerian environment today presents a grim litany of woes.

Every state of the federation suffers from one form of environmental problem or the other in varying degrees, from wind erosion in the northern part of the country to water erosion in the southern part of the country. Urban cities and towns in Nigeria are increasingly threatened by pollution of air and water as well as an improper disposal of solid waste while the rural areas are plagued by soil erosion, deforestation, and bush burning (NEST, 1991).

The interaction of man and his environment has resulted in the imbalance within the ecosystem. This imbalance is manifested in various environmental problems like air pollution, water pollution and land pollution, oil spillage, gas flaring, desertification, flooding, soil erosion, bush burning and indiscriminate waste disposal (Ogunbiyi, 2007). The rate of environmental deterioration has gone so far as affecting the climate with resultant effects on ways of life, survival and health of man.

Poverty and illiteracy are causes as well as consequences of environmental degradation (Babalola, Babalola and Okhale, 2010). The high level of poverty and illiteracy in Africa is directly linked to the current level of environmental pollution and degradation in the continent. The poor and the illiterate are often more interested in issues related to their daily survival than environmental management. This lack of interest and awareness often lead to a more reckless environmental behaviour which in turn breeds more environmental problems and leads to a vicious cycle of poverty. This attitude is attributed to lack of education on environmental issues. In the modern science and technology age, the demand on environment can no longer be maintained by haphazard traditional conservation practices. Consequently, there is the need for a more conscious and deliberate form of conservation that will bring about more effective environmental use (Nwobi, 2010). This has called for the need for public enlightenment and versatile educational processes in the country.

Education has been recognised a very effective means that can be used to bring about change. Education in Nigeria is an instrument "par excellence" for effecting national development (FRN, 2004). It is also the greatest investment that a nation can make for the quick development of its economic, political, sociological and human resources. It was in realization of this that a National Policy on Education was formulated for the country. The policy seeks the

inculcation of national consciousness and national unity; the inculcation of the right type of values and attitudes for the survival of the individual and the Nigerian society; the training of the mind in understanding the world around; and the acquisition of appropriate skills, abilities and competence both mental and physical, as equipment for the individual to live in and contribute to the development of his society.

Environment is of utmost importance to life. It is concerned with the surroundings in which we live. As such, protection of our environment is everyone's duty (Medayese, 2009). Again, environmental awareness is a pre-condition for pro-environmental behaviour and sustainable environmental management (Babalola, Babalola and Okhale, 2010). Apparently, the need to protect the environment is pertinent. The 1992 United Nations Conference on the Human Environment "Stockholm Conference" and the 1992 United Nigeria Conference on Environment and Development (UNCED) came up with AGENDA 21 which spelt out the strategies for improving the quality of the environment. This document emphasized the need for environmental education as a weapon that could be used by all nations to arouse people's consciousness, positively change their attitudes and instil in them those values and skills that can promote effective environmental management (UNESCO, 1992). With access to environmental information, the people have full knowledge of the implications of their activities on the environment and are able to participate more effectively in decision making processes that affect the environment (UNESCO, 1992).

The goal of Environmental Education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, a world population that has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively towards solving current environmental problems and preventing of new ones. The school system provides the largest organized base for environmental education and action. It offers an effective instrument for embedding in students the desirable environmental ethics (Medayese, 2009). Absence of Environmental Education (EE) in the school curriculum may contribute greatly to the improper use of the environment, as evidenced by the general public's lack of environmental responsibility and accountability (Ajiboye and Silo, 2008). With proper

education the practice of treating the environment with disdain will gradually become unfashionable.

EE focuses on awareness and sensitivity about the environment and environmental challenges; knowledge and understanding about the environment and environmental challenges; attitude and concern for the environment; maintain environmental quality; skills to mitigate the environmental problems; participation for exercising existing knowledge and environmental related programs (Amuyou, Okon and Oko, 2013). One of the current trends within Environmental Education seeks to move from an approach of ideology and activism to one that allows students to make informed decisions and take actions based on experience as well as data. Within this process, environmental curricula have progressively been integrated into governmental education standards. Some environmental educators find this movement distressing while others find this approach more valid and accessible.

Effective delivery of environmental education contents has been a controversial issue at the secondary school level in Nigeria. Efforts at improving environmental education learning strategies, such as the use of full and quasi participatory learning (Ajitoni, 2005), use of video drama by Aremu and John (2005), outdoor educational activities in primary schools by Olatundun (2008), and outdoor educational activities in some secondary schools in Oyo State by Oloyede (2010), have also been made. Globally, the use of outdoor and indoor activities has been identified as best for imparting environmental attitude into learners. Such activities can be conveyed, using both verbal and non-verbal strategies, in problem solving approach (UNESCO-UNEP, 1990; Olagunju, 2005).

Knapp and Benton (2006) noted that education is supposed to communicate effectively to the public, including the nature and magnitude of environmental problems, and array of alternatives available for their solution and sufficient insight, towards the right attitude and sustainable use of environmental resources, must be emphasized in environmental education. Adegbile (2002) was of the opinion that teachers who wish to impact the knowledge including magnitude of these environmental problems must employ Meta cognitive (ability to monitor, use and control thinking skills) teaching strategies. Meta-cognitive skills, on the other hand, can be

described as the "general skills through which learners manage, direct, regulate, and guide their learning" (Wenden, 1998). Benson (2007) sees the ability to draw on this type of skill as one characteristic of autonomous learners. The ability manifests itself in a reflective approach to learning. Building on their acquired Meta Cognitive Skills, their self- or person knowledge in particular, autonomous learners strive to gain a better understanding of themselves as language learners and the learning process in different environments. They reflect on their experiences to draw their own conclusions about effective approaches to language acquisition in various contexts.

It has also been observed by researchers, like Olagunju (2002) and Youssef (2004) that the foundations of pre-adult behaviour are formed during childhood and this behaviour governs the entire adult life. At secondary school level, it is necessary to develop the right environmental knowledge that will improve achievement in environmental concepts, including the right attitude and practices for maintaining and promoting sustainable environment. Secondary school students are usually receptive and strongly motivated. They are also capable of assimilating an Environmental Education that is: (i) value-oriented (ii) community-oriented, and (iii) concerned with human well-being (Ahove, 2001).

Unfortunately, the performance of students has consistently been poor over the years in environmental concepts in Biology. In spite of the importance of Biology in the school system, the problem of poor achievement of students in the Senior Secondary School Certificate Examination (SSSCE) conducted by the West African Examinations Council (WAEC), and similar examination bodies in Nigeria, has persisted over the years. This is revealed in Table 1. The enormity of this problem is further revealed in the environmental practices of both students and adults and their attitude towards environmental problems and issues (Ifegbesan, 2010).

The statistics of students' performance in Biology over the years is presented in Table 1.

**Table 1: Percentage Distribution of Students' Performance May/June Senior Secondary School Certificate (SSSCE) in Biology in Nigeria from 2002 – 2013**

| YEAR | Total Entry | Total sat | Credit Passes 1-6 | Percentage credit Passes 1-6 |
|---|---|---|---|---|
| | No of Candidates | No of Candidates | No of Candidates | % of Candidates |
| 2002 | 1,240,163 | 882,119 | 278,112 | 31.52 |
| 2003 | 1,006,831 | 909,101 | 392,249 | 44.15 |
| 2004 | 1,005,553 | 1,027,938 | 253,487 | 24.69 |
| 2005 | 1,080,162 | 1,072,607 | 375,850 | 35.04 |
| 2006 | 1,170,522 | 1,152,045 | 559,854 | 48.60 |
| 2007 | 1,270,137 | 1,238,263 | 413,211 | 33.37 |
| 2008 | 1,292,910 | 1,259,964 | 427,644 | 33.94 |
| 2009 | 1,372,567 | 1,340,260 | 453,938 | 33.87 |
| 2010 | 1,331,381 | 1,300,418 | 427,644 | 33.90 |
| 2011 | 1,540,141 | 1,505,199 | 579,432 | 38.50 |
| 2012 | 1,695,878 | 1,672,224 | 649,156 | 38.82 |
| 2013 | 1,678,154 | 1,646,741 | 850,706 | 51.66 |

***Source: Statistics Section, West African Examination Council (WAEC) National Office, Onipanu, Lagos, Nigeria.(2013)***

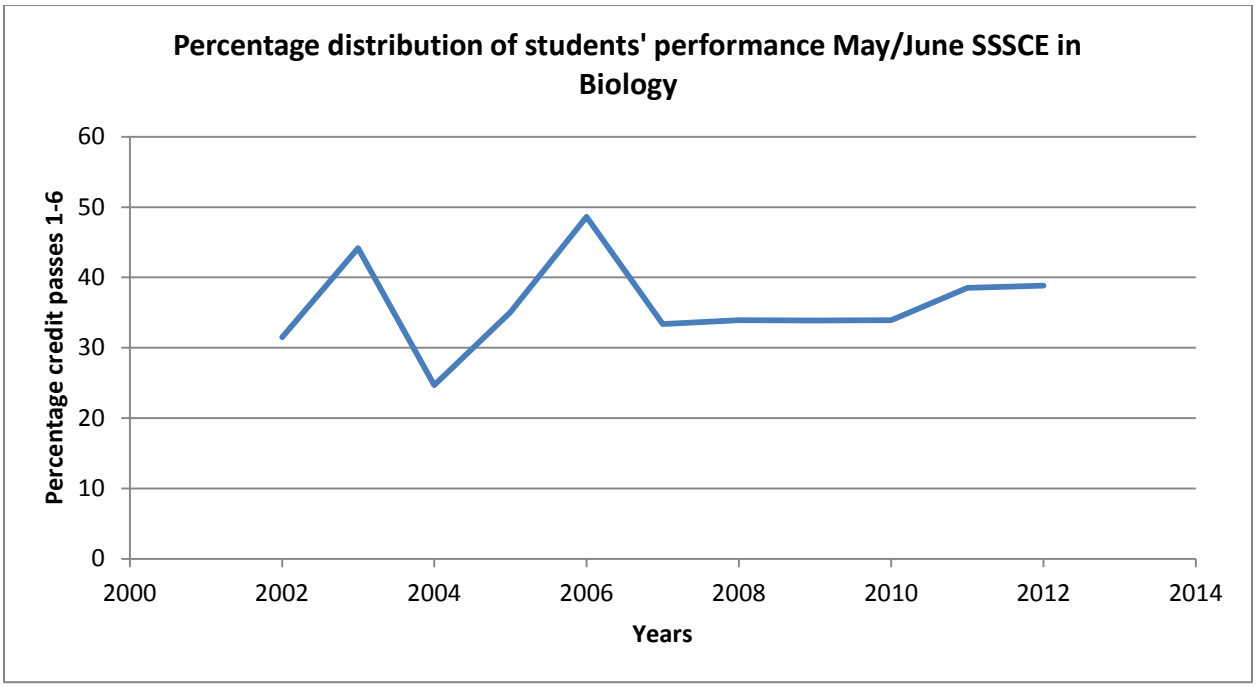


**Figure 1: Graph showing the nature of distribution of students' performance in May/ June SSSCE Biology 2000- 2013.**

A critical look at the table 1 and graph 1 during the period under review show that the trend in students' performance in Biology has not changed over the years with greater percentage of students scoring below credit grade. Reports from past results in Biology examinations have shown that students perform poorly at such examinations (Ndioho, 2007, Odubunmi, 2006). According to Odili (2006), the trends in performance in the subject (Biology) have not changed for more than two decades.

Environmental knowledge and education are closely associated with each other. An understanding of modern environmental issues requires a high level of environmental knowledge, and likelihood of high environmental knowledge is correlated to high level of education (Inglehart, 1995). WAEC chief examiner's reports maintained that students' performance in Biology is consistently poor despite the fact that several crucial efforts have continually been made, over the years, to remedy the yearly poor performance and improve students' performance in the subject.

Environmental concepts are important topics in the Biology curriculum. According to the West African Examinations Council (WAEC) (2002), Chief Examiners report stressed that candidates showed poor grasp of the concepts of ecology that a lot of the candidates did not attempt questions raised on ecology concepts and those who attempted the questions performed badly. Also, according to Chief Examiners Reports in Nigeria (2002), most candidates did well in items that require listing the correct alternative (knowledge level Bloom taxonomy), but a few made spelling errors and could not spell some environmental concepts and terminologies. Also, most candidates could not state the roles of decomposers in the ecosystem but few did well in this question.

The trend occurs in the Chief Examiners Reports in Nigeria (2003) where few candidates performed better in questions on adaptive features of climbing animals, for example, presence of prehensile tails, opposable digits, sticky/adhesive discs on fingers, etc., and generally did not score well on this sub-unit. In stating uses of water to rainforest organisms, some candidates wrote on uses of water to man and wrote 'drinking, washing and cooking' rather than maintaining body temperature, essential for plant turgidity, necessary for photosynthesis,' etc.

The trend continues in the Chief Examiners Reports in Nigeria (2004). Many candidates could not state three precautions necessary to get accurate result in the experiment to measure transpiration. A few candidates wrote that the amount of water in the soil, rather than in the atmosphere, affects the rate of transpiration.

In the Chief Examiners Reports in Nigeria (2005), it was reported that most candidates merely defined the habitat; they did not list the various types of habitat, or give examples. The same thing applied to the ecological niche; the candidates could not differentiate between defining and writing short notes. Some candidates could not state the correct uses of the ecological instrument listed, and a few made spelling errors and so lost marks, for example, 'Secchi dish' instead of 'secchi disc'. Few candidates named dogs and goats as animals found in the savanna region.

Chief Examiners Reports in Nigeria (2007) indicated that candidates performed fairly on the definition of pollution and pollutants of water. In describing the effects of the named pollutants on aquatic organisms, some candidates wrote on general effects of pollution on the environment. A few candidates who wrote on effects of the pollutants on aquatic organisms did not separate

the effects of each pollutant. They lumped the effect of all the pollutants, thus leading to loss of marks. Isa (2007), while citing from WAEC Chief Examiners reports, maintained that students' performance in Biology is poor despite the fact that several crucial efforts have continually been made over the years to remedy the yearly poor performance and also improve students' performance.

This trend occurred in the Chief Examiner's Reports in Nigeria (2008), where few candidates performed better in questions on sources of Noise Pollution but failed to perform better on items requiring answers on the effect and prevention of Noise Pollution. The same trend occurred in Chief Examiner's Report in Nigeria (2009), where few candidates were able to answer questions on the flow of Energy through the food chain.

The same trend occurred in 2010, where candidates failed to explain, convincingly, the terms: Niche, Population Density and Climatic Community. Majority of the candidates that sat for 2010 Biology examination were unable to explain the interaction between abiotic and biotic components of an ecosystem. These are environmental terminologies that candidates need to be conversant with. In 2011, a lot of candidates found it difficult to state and explain the second law of thermodynamics. In 2012, candidates were unable to state the importance of decomposers in the ecosystem and could not give correct examples. They were unable to explain the term 'endangered species'. In all these years mentioned, candidates' weaknesses were also found in the inability to identify some illustrated organisms; inability to give correct reasons for identifying labelled parts of illustrated diagrams, and errors in spelling biological terms.

Several factors have been identified as being responsible for this poor performance in Biology and other related sciences. They include large class size, poor infrastructure and facilities available in the schools (Akiri and Ugborugbo, 2009), textbook and laboratory based reasons (Ivowi, 2000), misconceptions of concepts identified by D'Avanzo (2008), in which all known misleading terms and wrong assertions are common in many Biology textbooks and among students. The traditional teacher-centred approach, that is, conventional method of teaching, is also a factor that has contributed prominently to poor performance of students in Biology. Although this method is effective in disseminating a large body of contents, it fails to stimulate students' motivation, confidence and enthusiasm. This may have led to non acquisition of skills that are important. The deficiencies of the teaching and learning situations in our schools

have called for more alternating and more effective approaches that will provide an environment for growth (Ajitoni, 2005; 2007). Bolorunduro (2005) indicated that though other methods are encouraged to be adopted in teaching science, the conventional method can still be combined with other methods to bring about learning. Contradictory remark was given by Menesses and Gresham (2009); Duru and Okereke (2010). Agoro (2012) observed that the conventional method (lecture) is the most abused of all teaching methods and the least effective in many respects.

Many studies have been carried out in order to introduce novel strategies that would bring about better use of the environmental sustainability. These studies include those of Ojo (2009), Abiona (2008), Olatundun (2008), Gbadamosi (2012), Nkire (2012), Ogundiwin (2013). These scholars have divergent views because some focused on primary school pupils while some on the community, and some others on secondary school students. Their studies also have produced conflicting results on attitude while a lot did not include environmental practices of the respondents. Interestingly, one of the millennium goals is attainment of a sustainable environment. However, all these studies have called for more intensified efforts at introducing more proven methods of effective instructional strategies that would explicitly portray the environmental situation in its real sense to the students. These strategies will ultimately increase students' knowledge and interest, thereby enhance their active participation in the process of improving and sustaining the environment as well as becoming responsible citizens of our nation.

Studies have revealed that students' environmental awareness knowledge is related to their environmental attitude. This result might be due to the fact that the knowledge gained by students, in the course of their exposure to environmental issue influenced their attitude (Akomolafe, 2011). Attitude is one of the variables that influence learning outcomes. It plays a vital role in the life of an individual. Adediwura and Bada (2007) defined attitude as a consistent tendency to react in a particular way, often positively or negatively, towards any matter. Environmental attitude can be defined as "a learned predisposition to respond consistently favourably or unfavourably with respect to the environment (Pelstring, 2009).

Despite all the efforts by the government to see to the improvement of environmental quality, it is observed that students and adults still pollute the environment and the future

sustainability of the people in it. Ifegbesan (2010), in his study, revealed that the negative attitude of the public towards the environment does not exclude educational institutions. An example, as cited by Ogunleye (2002), is the survey conducted to investigate the Nigerian students' prevailing knowledge, attitude and practices in relation to environmental issues. The study reported that students exhibited poor knowledge, negative attitude and harmful practices towards a healthy environment. This is also evident in the observation of how students littered the environment with ice cream nylons, papers, pure water nylons, sweets wraps, etc., and in the various heaps of solid wastes observed along road sides in the country nowadays. There is need for a change in attitude of students towards the method teachers use in teaching them and how they learn Biology if there must be improvement in academic achievement and attitude, especially on environmental concepts. This can be carried out by making students participate actively in the teaching and learning process. Interactive methods that enhance students' autonomy were connected to all attitude dimensions which emphasize the importance of affective and social factors in science education (Deci and Ryan, 2004; Krapp and Prezel, 2011; Osborne et al., 2003). It has, in fact, been confirmed that effective teaching strategies can create positive attitude on the students towards school subjects - Bekee (1987), Balogun and Olarewaju (1992), Akinsola (1994), Akale (1997), Olowojaiye (1999), (2000).

This has led to the need for a teaching strategy that would bring about effective learning and attitudinal change in students and utilization of learning outcomes. Adesoji in his study in 2008 have revealed a relationship between attitude and methods of instruction and also between attitude and achievement. Studies have revealed the influence of methods of instruction on students' attitudes towards science (Adesoji, 2008; Gok and Sılay, 2008). These studies generally explore how attitudes influence success. Adesoji (2008), in his study affirmed that there was positive attitude towards chemistry after exposure to problem-solving instructional strategy and that methods of instruction that are capable of changing students' attitude towards science should be used for teaching. Adesoji (2008) suggested organising workshops and seminars on the importance and appropriateness of problem solving techniques for science teaching and learning.

Some scholars, such as Olatundun (2008), Ojo (2009), Nkire (2012), Gbadamosi (2012) and Ogundiwin (2013), discussed the effects of various novel strategies on environmental attitudes. The study of Ojo (2009), on the impact of video CD and Audiocassette based instructions on secondary school students' learning outcomes in selected environmental topics in Biology, revealed a gain in students' environmental attitude scores. Abiona (2008) also revealed an improvement in the attitude of students, after exposure to guided discovery strategy, values clarification strategy and enter educate strategy. Also, there was significant change in the environmental attitude of students, as revealed in the research of Ogundiwin (2013), after exposing them to pre-theoretic intuition quiz and puzzle-based critical thinking motivation strategies. The studies of Gbadamosi (2012) and Olatundun (2008) also revealed a positive improvement in the environmental attitude of primary school pupils, after exposure to service learning and educational trips instructional strategies and outdoor educational strategies respectively. Nkire (2012) also found an improvement in the environmental attitude of non-formal adult learners after exposing them to Participatory non-formal environmental education programme. These results corroborated that of Arcury (1990); that increased knowledge about environment is assumed to change environmental attitude.

All reviewed literature indicated that education is a key variable on environmental attitudes. Attitudes without well-organized educational process, providing planned activities in which real-life situations were transformed into pedagogical situations for students to conceptualize, could not give rise to the development of skills and values systems, nor to nature-friendly behavior. Almost all research on environmental attitudes found that highly educated respondents always have more pro-environmentalist values than less educated respondents (Inglehart, 1995; Arcury, 1990). Environmental attitude research, however, has produced contradictory results. Olatundun (2008) found that male respondents were less environmentally concerned than female respondents. Nkire (2012) reported that male respondents had higher levels of environmentalism than their female counterparts. However, the findings of Gbadamosi (2012) and Ogundiwin (2013) have indicated no clear gender difference on environmental attitudes. The different contradictory findings on students' environmental attitude, therefore, call for more investigations on this important variable.

There cannot be a healthy nation without a healthy environment. A pleasant environment, which is hazard free, is a fundamental right of all Nigerians. There is an increasing national consciousness on the need for judicious management of the Nigerian environment in a sustainable manner. Scientists have warned over the years that an unhealthy population and a degraded environment will hinder progress towards development goals (Mohammed, 2011). A healthy environment that brings about sustainable development can only be attained through positive environmental attitude and the right environmental practices. The actual environmental practices of the people are a necessary factor towards the attainment of a clean and healthy environment (Ogundiwin, 2013). However, previous studies show that many students and teachers lack sufficient environmental knowledge but demonstrate positive attitudes towards the environment. This lack of knowledge is believed to contribute to the lack of pro-environmental behaviours among them (Esa, 2010).

Environmental attitudes are related to environmental practices. Environmental practices are those actions people can take to improve the environment's performance**.** There is the need to recognize that our long-term social and economic well-being depends on the well-being of a life-supporting environment. It is not news that good environmental practices make good economic sense (Gelberg, 2010). The actual environmental practices of the people are a necessary factor towards the attainment of a clean and healthy environment. Ajiboye and Ajitoni (2008), in their study, posit that Nigerians are at best indifferent to the environment. Houdre (2008) has made it clear that the prime reason for implementing environmental practices is geared towards profitability; delivering good environmental performance is integral to man's day-to-day activities. Environmental practices should be geared towards sustainable use of the natural resources for both the present and future generations. It is assumed that beliefs and misconceptions, which young people have, tend to stick with them for a long period later in life.

Noibi (1993) reported that daily experiences in Nigeria have revealed very poor environmental practices. Therefore, the most sensitive group of population, who may be initiated, involved and prepared for the understanding and tackling of the environmental problem, to the extent possible, are the secondary school students. They are usually receptive, strongly motivated and capable of assimilating an Environmental Education that is value-oriented, community-oriented and concerned with the human well-being. The poor science skill

acquisition by students is not in accordance with the aims and objectives of education in Nigeria which states that ‘education should aim at helping the child acquire appropriate skills, abilities and competences, both mental and physical as equipment for the individual to live in and contribute to the development of his society’’ (FME, 2004).

In the urban centres, there is an alarming rate of poor waste generation and disposal by families, sellers of various items in market places and corporate bodies as well as ineffective waste management system and legislation by the government (Abiona, 2008). All these may rightly be attributed to earlier submission that ignorance, or lack of environmental awareness, of the right action to take is the greatest single contributor to environmental degradation problems (Ojo, 2009). A consideration for practical solutions for the conservation of all environmental resources in a sustainable manner will be of national interest because majority of Nigerians will benefit from an improved environment (Ajiboye and Olatundun, 2010). To this end, environmental practices are necessary because environmental degradation, if not checked, can have a great impact on natural resources, human health and ecosystems, with adverse consequences for the present and future generations of Nigerians. Oladapo(2011) was of the opinion that the public needs to be informed about issues that affect their well-being, especially pollution and national resources depletion with adverse and / or disastrous health consequences including the common practices which are becoming the order of the day in all the towns and villages without environmental considerations.

There seems to be a consensus of opinions among science educators concerning the important role played by instructional strategy adopted as a classroom variable in affecting students’ achievement, attitude and practice in environmental concepts in Biology (Ige, 2001; Nwosu, 2003; Olagunju, 2002). The deficiencies of the teaching and learning situations in our schools have called for more alternating and more effective approaches that will provide an environment for growth (Ajitoni, 2007; 2005).

Anchored instruction refers to instruction in which the material to be learnt is presented in the context of an authentic event that serves to anchor or situate the material and, further allows it to be examined from multiple perspectives. The name is derived from the technique of designing instructional activities around an "anchor" which may be a theme, case-study, or

problem to be solved. The anchor is presented in an authentic-like context that people can explore to find plausible solutions. Learners in this context engage in exploration and discovery learning. Anchored instruction in education is closely related to problem-based learning in other fields (e.g., business, medicine), but it differs somewhat because all the information for solving anchored problems is available, whereas, it may not be in actual problem solving situations. Anchored instruction is designed to help students learn information so that it can be recalled and flexibly applied to solve problems. It emphasizes the need to provide students with opportunities to think about and work on problems, which is an emphasis of cognitive constructivist. This allows teachers to move from a role as "professor of knowledge" to that of coach or mentor. This model for instruction arose to solve the needs of educators, such as limited instruction time and need to cover more material faster, attempt to make information and learning more relevant, useful, and meaningful; giving students appreciation of common concepts and cross contextual applications, and the adoption of multiple perspectives when solving problems. This strategy has been found to be effective in the development of sophisticated mathematic skills and positive attitudes (Young and Barab, 1999; Bottge et al, 2002; Hsin-Yih Cindy Shyu, 2002); in social studies (Vye, 1990); and Language Arts (Reith et al, 2003). All these studies have revealed a significant improvement among the students taught with anchored instruction.

Cognitive flexibility is a learning strategy that helps a person develop the ability to switch between modes of thought and to simultaneously think about multiple concepts. It has been shown to be a vital component of learning. Moreover, it refers to simultaneously considering multiple aspects of thought at once, whether they are two aspects of a specific object, or many aspects of a complex situation (Boger-Mehall, 2007). Cognitive flexibility has been more broadly described as the ability to adjust one's thinking from old situations to new situations as well as the ability to overcome responses or thoughts that have become habitual and adapt to new situations. Cognitive flexibility has implications both inside and outside of the classroom (Boger-Mehall, 2007). However, cognitive flexibility has been shown to be a broad concept that can be studied with different age groups and situations. Studies conducted with people of various ages, and with particular deficits, have further informed how cognitive flexibility develops and changes within the cognition. Thus, with tasks ranging from simple to complex

research, it suggests that there is a developmental continuum that spans from infancy to adulthood. There are further indications of how cognitive flexibility greatly impact the nature and formation of cognitive structures, affect the ability to store and readily access information by students who were exposed to the technique. Researchers in the field advocate a teaching style that incorporates group problem-solving activities and those demanding higher-level thought. Cognitive flexibility, therefore, depends on attention processes and knowledge representation.

Cognitive flexibility theory suggests that learners grasp the complex concepts more readily when presented with multiple representations of the same information in different contexts. By seeing multiple representations of the same phenomenon, learners develop the mental scaffolding necessary for considering novel applications within the knowledge domain. Thus learners will be more flexible in their understanding of various concepts and be able to apply important concepts in their day to day activities.

The goal of cognitive flexibility is to give people the kind of knowledge they can make connections with and use as tool for solving and dealing with new problems and situations. Cognitive Flexibility involves the adaptation of cognitive processing strategies which brings about changes in complex behaviours, and not in discrete responses. Evidence abounds that cognitive flexibility instructional strategy has been developed in teaching and learning of science education (Yuh-Tyng, 2012; Martin and Anderson, 2009; Jacobson and Spiro, 1995) and has been found to be effective in promoting knowledge transfer and helping students to use knowledge in new ways and in new situations.

Gender is a factor whose influence on students' learning outcomes has been vigorously examined by researchers. The influence of gender on students' achievement has continuously been a thing of concern to researchers. This may be as a result of divergent results obtained from such gender-related studies which abound in fields of research on gender issues. Okeke (2001), Solomon (2004) and Usak et al. (2005), in their review of studies concluded that gender differences exist in students' achievement in science.

Studies have shown significant difference in favour of boys (Bilesanmi-Awoderu, 2002; Aremu and John, 2005; Abiona, 2008; Ojo, 2009); sometimes in favour of girls (Ogunleye 2002, Olatundun 2008) and sometimes the studies have shown no significant difference between boys

and girls in relation to their achievement and attitude in different science subjects (Raimi and Adeoye, 2002; Owoyemi, 2007; Oduwaiye, 2009; Okoye, 2010). Ogunkola and Fayombo, (2009), in their study, found out that there was no statistical difference in secondary school students' achievement based on their gender. Ogunkola (2000), in his study, found that there was no significant main effect of gender on students' attitude to and achievement in Biology.

The studies by Ajitoni (2005) and Bolorunduro (2005) revealed that there were significant differences between female and male students in terms of attitude in favour of females. Ebere (2006) reported in his study that students (boys and girls) who were exposed to science process based learning activity oriented, utilizing students' manipulation of materials, yielded a more effective learning outcome irrespective of gender than other students. It has been observed that one of the ways of improving the performance of girls is the use of instructional resources (Olagunju, 2002). Aremu and John (2005), in their study, have stated that the search for strategies to bridge the gap in the achievement of males and females is an ongoing one.

Gender as a moderating variable, therefore, attracted further investigation in this study because of the conflicting nature of results from previous research that focused on gender and science and science related subjects. The need arises for new studies to consider this variable in an attempt to build a body of more consistent evidence on the influence of this important factor of gender on achievement, attitude to the environment and environmental practices.

Cognitive style refers to the preferred way individuals process information. It describes a person's typical mode of thinking, remembering, or problem solving. Students' cognitive style has been observed to mediate learning (Ige, 2001). Cognitive style represents the ways in which individuals receive, analyse, store, retrieve, and transmit information, much like the way a computer's processing unit performs the same functions for a computer. It is how a person processes experiences and knowledge, and how they organise and retain information. It is usually described as a personality dimension which influences attitudes, values, and social interaction. Cognitive learning styles and learning strategies differ from person to person.

A number of cognitive style models and measures which have been in use over the years, has been identified.

Most of the differences encountered in students' learning and utilization of knowledge acquired could be described in terms of different manners in which students perceive and analyse a given problem and how to solve it. An understanding of the cognitive styles of students would greatly enhance an understanding of the diversity in their inert environmental problem solving abilities and the utilization of these abilities.

Therefore, for learners to gain significantly from classroom interaction there is a need to consider the cognitive styles of individual learners, and the instructional strategies that are most responsive to particular cognitive styles (Awofala, 2002). In view of this, Ogundipe (2002) maintained that understanding individual learning styles may lead to reduction of teacher and student frustration, thereby enhancing accommodation of a variety of learners in the classroom and improving communication with administrators, parents, councillors and other staff. This agrees with the findings of Ige (2001) in her study of concept mapping and problem-solving teaching strategies as determinants of achievement of student in secondary school ecology (on environmental concept in Biology). The result reveals an interaction of teaching strategy and cognitive style. From the above, therefore, teaching strategy can be deduced to have a relationship with cognitive style. For meaningful learning to take place, consideration should be given to the cognitive style of individual learners (Olagunju and Ogundiwin, 2008). Cognitive style significantly affect students attitude, this in turn will affect individual knowledge and practices towards the environment (Olagunju, 2002). Kirton's cognitive style was chosen for this study because it involves a measurement scale that has to do with problem solving abilities and it is more related to the strategies to be used in this investigation.

From the foregoing discussion, it is observed that the teaching of Biology as a subject in school has been characterised by the use of conventional teaching method where the teacher alone does the talking while the learners remain passive. This has failed to deal effectively with the problem of individual differences, and also lead to poor achievement in, and attitude towards, the subject. Bassey (2005) opined that several problems are associated with the conventional method of teaching. This indirectly results to poor performance of students. The use of conventional method of teaching in Biology class has equally failed to provide for the students' appreciation and understanding of learning as a continuing aspect of modern learning which stresses students' active involvement in the teaching/learning process. The current traditional pedagogical

practices, which are confined to transmitting information, involve telling, reading and memorising, and characterised by the dominance of cognitive goals and teacher adopting the fountain of knowledge approach, have failed to cope with problems of development and national integration (Ajiboye and Ajitoni, 2007). There is, therefore, a need to search for more effective instructional strategies that are likely to improve learning outcomes.

## 1.2 **Statement of problem**

Despite the awareness that is being propagated towards sustaining the environment, man has persistently exhibited harmful practices and negative attitude towards the environment. This attitude is attributed to lack of awareness through environmental education that is needed to create good orientation to environmental issues. The persistent poor achievement of students in environmental concepts in Biology is an evidence to support this.

Students, although exposed to instructions about the environment, still exhibit poor performance, negative attitude and harmful practices towards the environment. They are unable to tackle simple problems in their environment. Several factors have been identified as being responsible for this situation in Biology and other related sciences. These include the use of lecture method, laboratory-based reasons, misconceptions of concepts and gender stereotype. Researchers have suggested various teaching strategies, such as the use of Video Compact Disc, audiocassette, guided discovery, values clarification, outdoor activities, enter-educate, amongst others which have not yielded sufficient positive results, as evidenced in the performance of students in environmental concepts in Biology in external examinations. Researchers have suggested the use of meta-cognitive teaching strategies, such as anchored instruction and cognitive flexibility. It appears, however, that no study has devised an intervention education programme to explore the possibility of using cognitive flexibility and anchored instructional strategies for teaching Biology in Nigeria, although the strategies have been used in the teaching of subjects like Social Studies and Mathematics in other countries with significant effects observed. Students were observed to have improved in their knowledge of concepts and mathematical problem solving skills. Therefore, this study seeks to determine the effects of anchored and cognitive flexibility instructional strategies on secondary school students' knowledge, attitude and practices in

Biology in Ibadan. The study further seeks to examine the influence of gender and cognitive style on students' learning outcomes in Biology.

## 1.3 Hypotheses

The following null hypotheses would be tested at $p \leq 0.05$ level of significance.

Ho 1**:** There is no significant main effect of treatment on students'

(a) knowledge of environmental concepts,

(b) attitude to environmental concepts and

(c) environmental practices

Ho 2: There is no significant main effect of gender on students'

(a) knowledge of environmental concepts

(b) attitude to environmental concepts and

(c) environmental practices

Ho 3: There is no significant main effect of cognitive style on students'

(a) knowledge of environmental concepts,

(b) attitude to environmental concepts and

(c) environmental practices

Ho 4: There is no significant interaction effect of treatment and gender on students'

(a) knowledge of environmental concepts,

(b) attitude to environmental concepts and

(c) environmental practices

Ho 5: There is no significant interaction effect of treatment and cognitive style on students'

(a) knowledge of environmental concepts,

(b) attitude to environmental concepts and

(c) environmental practices

Ho 6: There is no significant interaction effect of gender and cognitive style on students'

(a) knowledge of environmental concepts,

(b) attitude to environmental concepts and

(c) environmental practices

Ho 7: There is no significant interaction effect of treatment, gender and cognitive style on students'

(a) knowledge of environmental concepts,

(b) attitude to environmental concepts and

(c) environmental practices

**1.4 Significance of the study**

This study is considered significant because it might bring about increase in students' knowledge of environmental concepts and also bring about building a positive attitude and desired practices towards the environment.

The findings of this study would help in establishing teachers' professional competences in enhancing their classroom instructional practices with respect to using strategies that promote learning.

The study would form empirical basis for subsequent research on students' environmental achievement and attitude towards environmental concepts in Biology.

It would also help to create the need for holistic environmental consciousness and awareness in students as a key to future participation in community action, decision making and/or problem solving in issues of environment. This would help in proposing concrete and attainable practical steps through which one of the Millennium Development Goals of ensuring environmental sustainability would be achieved.

The outcomes of this study would contribute significantly towards providing information to science educators on learners' characteristics, such as cognitive style and gender towards their performance in Biology.

It is also envisaged that the effectiveness of this strategy, as would be revealed in this study, would enhance the utility of knowledge and skills acquired through the formal education system, for better living and sustenance of the environment in the process of harnessing it for survival. This would help to remove purely cognitive achievement and eventually lead to a systemic change in the society.

## 1.5 Scope of the study

This study was geared towards determining the effects of anchored and cognitive flexibility instructional strategies on secondary school students' knowledge, attitude and practice on environmental concepts in Biology.

The study was carried out among selected senior secondary school students' (SS II), from three local government areas in Ibadan. Intact classes of SS II students were used. Moreover, the study was delimited to finding out the influence of students' gender and cognitive styles on their learning outcomes.

The environmental concepts studied are natural environment, pollution (water, air and land), desertification, erosion and conservation of natural resources.

## 1.6 Operational definition of terms

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

**Adaptors:** Adaptors are people who tend to prefer to use what is given to solve problems. They are those that use the conventional methods to solve problems.

**Anchored Instructional Strategy**: This is a teaching strategy that situates, or anchors, problems in authentic-like contexts that people can explore to find plausible solutions.

**Attitude to environmental concepts in Biology**: - An individual's behaviour / predisposition towards environmental concepts in Biology.

**Cognitive Flexibility Strategy:** This is a learning strategy that enables people develop the ability to adaptively re-assemble diverse elements of knowledge to fit the particular needs of a given understanding or problem-solving situation.

**Cognitive Styles**: refers to a psychological disposition which shows how an individual is inclined to think, learn and process information. It is classified as Adaptors and innovators.

**Environment**: - The natural world in which people, animals and plants live.

**Environmental Concepts**: - These are concepts that have to do with nature and things in the environment.

**Environmental Knowledge**: - Ideas and facts of environmental concepts and effects of human actions on the environment known to an individual, to be used for solving environmental problems.

**Environmental Problems**: - Difficult issues related to the conditions of the environment that affect behaviour and development of people and things.

**Environmental Practices**: The behaviours of the secondary school students towards environmental problems and conservation techniques. This will be determined by using Perceived Environmental Education Practices questionnaire.

**Innovators:** Innovators are people who look beyond conventional methods to novel ideas /innovative technologies to solve problems.

**Modified Conventional Strategy:** This is a teaching strategy in which the teacher uses lecture method to teach but have been restricted to the limit of use of some instructional materials.

# CHAPTER TWO

# REVIEW OF RELATED LITERATURE

Literature would be reviewed under the following themes: theoretical framework, conceptual review and empirical review.

## 2.1 Theoretical Framework

### 2.1.1 Constructivist Learning Theory

## 2.2 Conceptual Review

### 2.2.1 Man and his Environment

### 2.2.2 Environmental Degradation

### 2.2.3 Environmental Sustainability

### 2.2.4 Environmental Education (EE)

### 2.2.5 Metacognitive Strategies and Learning

### 2.2.6 Anchored Instructional Strategy

### 2.2.7 Cognitive Flexibility Strategy

### 2.2.8 Modified Conventional (Lecture) Strategy

### 2.2.9 Students' Knowledge of Environmental Concepts and Problems

### 2.2.10 Students' Environmental Attitude

### 2.2.11 Students' Environmental Practices

### 2.2.12 Gender

### 2.2.13 Cognitive Style

## 2.3 Empirical Review

## 2.1 **Theoretical Framework**

The theoretical foundation upon which this study is built is Constructivist theory. This theory has a profound impact on instruction in that instruction is now shifting focus from "teacher-centred" to "learner-centred".

### 2.1.1 Constructivist Learning Theory

The Anchored instructional and Cognitive Flexibility strategies are based on constructivist learning theory. Constructivist as a learning theory, the roots of which can be found in various research studies, can be traced back to decades, while the actual application of the theory is relatively new (Richardson, 2003).

Constructivism is a very broad conceptual framework in philosophy and science. It is a theory of knowledge (epistemology) which argues that humans generate knowledge and meaning from their experiences. Constructivism states that learning is an active, contextualized process of constructing knowledge rather than acquiring it. It says that all knowledge is constructed from a base of prior knowledge and it is constructed based on personal experiences and hypotheses of the environment. The learner is not a blank slate (tabula rasa), but brings past experiences and cultural factors to a situation. Each person has a different interpretation and construction of knowledge process and, thus, actively constructs or creates their own subjective representations of objective reality.

The originators and important contributors include Lev Vygotsky, Jean Piaget, John Dewey, Giambattista Vico, Rorty and J. Brunner. Formalization of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanisms by which knowledge is internalized by learners. He suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individual's experiences are aligned with their internal representation of the world, but may also occur as a failure to change a faulty understanding.

According to the theory, accommodation is the process of reframing one's mental representation of the external world to fit new experiences. Bruner's constructivist theory is a general framework for instruction based upon the study of cognition. He states that a theory of instruction should address four major aspects: predisposition towards learning, the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, the most effective sequences in which to present material and the nature and spacing of rewards and punishments.

**Principles**

The principles of constructivism are:

- Instruction must be concerned with the experiences and contexts that make the students willing and able to learn.
- Instruction must be structured so that it can be easily grasped by the students (spiral organization)
- Instruction should be designed to facilitate extrapolation and / or fill in the gaps (going beyond the information given).

In the constructivist classroom, students work primarily in groups while learning and knowledge are interactive and dynamic. There is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. Some activities encouraged in constructivist classrooms are experimentation, research projects, field trips, films (visual context presentation) and class discussions. The teacher is expected to be a facilitator of knowledge (Brunner, 1996). He provides guidelines and creates the environment for the learner to arrive at his or her own conclusion.

**The assumptions of constructivism**

According to Merrill (1991) in Mergel (1998), the assumptions of Constructivism include:

- Knowledge is constructed from experience.

- Learning is a personal interpretation of the world
- Learning is an active process in which meaning is developed on the basis of experience
- Conceptual growth comes from the negotiation of meaning.
- The sharing of multiple perspectives and the changing of our internal representations through collaborative learning.
- Learning should be situated in realistic settings; testing should be integrated with the task and not as a separate activity.

From constructivists' viewpoint, it is important to take into account the background and culture of learners throughout the learning process, as this background helps to shape the knowledge and truth that the learners create, discover and attain in the learning process. The critical goal is to support the learners in becoming effective thinkers.

### 2.1.2 Application to the Present Study

This theory forms the bedrock of this study, in that the principles of this theory would be applied in this study.

Students would be allowed to obtain a holistic knowledge through experience, especially based on direct confrontation with practical environmental and social problems, so as to bring about meaningful and significant learning. This in effect is expected to bring about personal growth and development in the individual and the expected attitude towards the environment.

Knowledge would be structured in a way that learners would be able to grasp the needed information, especially in a realistic setting and be able to internalize the knowledge.

Based on their personal experiences, using hypertext and anchored instruction, students would be able to construct knowledge of the processes and things involved in the environment and be able, through constructive thinking, develop problem-solving skills to tackle the issues and problems within the environment.

## 2.2 CONCEPTUAL REVIEW

### 2.2.1 **Man and his Environment**

According to *Oxford Advanced Learners' Dictionary*, environment is the natural world in which people, animals and plants live. The term environment is simply defined as the physical space and the surroundings in which man lives or resides (Aluko, 2006). In the pure biological sense and usage of the concept, the "environment" consists of those things outside an organism. In the sense, therefore, the environment is anything outside of man himself (Aluko, 2006). Thus, the particular or specific place, setting or location, in which man lives constitutes what is known as the environment. The environment consists of two major components: the natural and the cultural environment. The natural environment consists of four major components – the atmosphere, hydrosphere, lithosphere and biosphere. The biosphere is man's immediate environment in which all the substances and conditions, which allow and foster the continuance of all the physical and chemical processes constituting living organisms, are found. It is biosphere of which man is a part, that has the resources out of which he derives his sustenance and survival (Muoghalu , 2004).

The environment serves three basic functions for man: providing life sustenance resources, serving as a waste repository and housing man and all other living species (Aluko, 2006). The interaction and interdependence between man and his environment is a reciprocal one. As man influences his environment, he is in turn influenced by his environment. However, mankind is yet to have the knowledge of the total environment. There is either little or no awareness of the danger inherent in the misuse of the environment (Jekayinfa and Yusuf, 2008). If people are not aware of environmental risks, they will be less willing to pay to reduce them. Thus, providing people with information about environmental hazards may increase their welfare by raising environmental quality to a more appropriate level. There have been series of environmental protection measures introduced in Nigeria. Some of these include the abatement measure, environmental awareness campaign, environmental legislations, environmental policies, afforestation and land reclamation. Environmental sanitation exercises are put in place, conferences are organized, and environmental organizations, such as Federal Environmental Protection Agency (FEPA) and Nigerian Conservation Foundation (NCF), are established.

### 2.2.2 **Environmental Degradation**

Environmental degradation can be interpreted to mean the process by which the environment of a place changes to a worse condition (Fatubarin, 2009). Environmental degradation is the deterioration of the environment through depletion of resources, such as air, water and soil, the destruction of ecosystems and the extinction of wildlife. (Wikipedia)

Environmental degradation is said to occur when the environment becomes less valuable or damaged: when habitats are destroyed, biodiversity is lost, or natural resources are depleted. The environment is then said to be hurt.

Environmental degradation can occur naturally, or through human processes. Human activities and the environment are inter-related. This is because any activity of man is done in the environment and the resultant effect on him is either positive or negative (Harte 2007).

Human activities are diverse. A lot of human activities have combined to deplete the earth's resources, degrade the environment and cause loss of biodiversity. From all indications, human activities impinge on the environment, which as noted earlier, may have either positive or negative effects on man. However, the positive effects would be well taken by man, but what is of concern to man are the negative effects, especially as they concern degradation (Harte, 2007).

There are countless forms of environmental degradation which include, among others: deforestation, water pollution, improper waste disposal, air pollution, and global warming.

When something very harmful, poisonous or fatal to animals, human beings, and other living things is added to the environment, it is called 'pollution'. In simple term, pollution is a contamination by a chemical or other pollutant that renders part of the environment unfit for intended or desired use. It is triggered by industrial and commercial waste, agricultural practices, day to day human activities and, most notably, modes of transportation as well as many other sources. Pollution is occurring all over the world and poisoning the planet's oceans. Even in remote areas, the effects of marine degradation are obvious (Partha, 2008).

In some areas, the natural environment has been exposed to hazardous waste. In other places, major disasters, such as oil spills, have ruined the local environment. For instance, agriculture

requires pesticides that pollute the atmosphere or enter drainage system via run off and sewers. Other activities which lead to pollution include thermal power stations, burning of fossil fuels, exhaust fumes. All these emit harmful pollutants like sulphur dioxide, carbon monoxide, etc., that cause acid rain, global warming and the malfunctioning of human haemoglobin, etc.

Other human activities capable of causing environmental nuisance and degradation include;

- Destructive logging of forests

- Overgrazing and over-cropping of arable lands

- Strip mining etc. This may be extended to include oil exploitation, industrialization, improper disposal of domestic solid waste and human excretal including liquid waste, over-utilization of non-degradable materials for packaging among others. (Harte, 2007)

Poverty still remains a problem at the root of several environmental problems and degradation (Ray and Ray, 2011). All kinds of man's needs are met by the environment. It supplies the basic necessities for life and supports large number of life forms. Man is dependent on the environment for food, shelter, water, air, soil, energy, medicines, fibres, raw materials, and many other things. The environment maintains atmospheric composition and protects all kinds of life on earth from harmful effects of solar radiation. In spite of all these benefits, the quality of the environment is deteriorating and it is being degraded continuously. It is not only that the resources of the environment are being irrationally utilized; human beings are contributing dangerously to its degradation. There is an urgent need to take all possible steps to check environmental degradation. Considering the fact that the environment is the key to man's welfare, survival and life support system, it is very important that environmental degradation should be controlled. As citizens of one world, we should, therefore, treat the environment as an important factor for our sustenance and survival.

Not only will man suffer selfish decisions, with regard to the environment, but so will many generations to come. The kind of damage that man is causing is much more complex than what we are aware of. Education is an important tool in establishing respect for our environment and establishing responsibility for our actions. There is the need for consideration for future

generations that should not be forced to pay the price for our selfish short-sightedness ( Aguillon *et al*., 2014).

### 2.2.3 Environmental Sustainability

Environment can be viewed as all physical, non physical, external, living and non living situations surrounding an organism or groups of organisms that determine the existence, development and survival of organism(s) at a particular time. It encompasses constantly interacting sets of physical (natural and man-made) elements and non-physical, living and non-living (e.g. social, cultural, religious, political, economic) systems which determine the characteristic features, growth and sustainability of the component elements of the environment and the environment itself (Johnson, 1992; Muoghalu, 2004).

Man is totally dependent on the environment for his daily needs, such as food, shelter and clothing. It is in the bid to acquire these basic needs that he has dealt adversely with the environment. In Nigeria Mba *et al* (eds) (2004) identified several types of environmental problems classified as ecological, poaching and habitat loss, increasing desertification and soil erosion. These are further subdivided into pollution, deforestation, global warming and slum development, etc.

Generally, environmental problems are mostly due to developmental processes and are of local, regional and global effects which have far reaching implications on sustainable development. These effects are viewed as consequences of human activities, and are most often harmful on human beings, livelihoods, animals and plants presently, or transferred to posterity.

Some of the issues that pose major environmental sustainability problems include:

• destruction of the living environments (habitats) of native species

• discharge of polluting chemicals and other materials into the environment

• emission of greenhouses gases into the atmosphere than can cause climate change

• depletion of low cost oil and other fossil fuels

This increasing hostile and unhealthy environment is causing the dislocation, depletion and extinction of species of plants and animals. To maintain the environment at a life sustaining level, with attendant economic development, and also have a reserve for the future, calls for the concept of sustainable development (Ezeabasili, 2009).

Nigerian cities are witnessing high rate of environmental deterioration and are rated among urban areas with the lowest liveability index in the world. It is estimated that between 20 percent and 30 percent of the urban population enjoy decent urban life in the country. At international level, effort is being made by the European Union at protecting the environment.

To define environmental sustainability, sustainability must first be defined. Sustainability is the ability to continue a defined behaviour indefinitely. Sustainability issues arise wherever there is a risk of difficult or irreversible loss of the things or qualities of the environment that people value. And whenever there are such risks there is a degree of urgency to take action. Environmental sustainability programmes include actions to reduce the use of physical resources, the adoption of a 'recycle everything/buy recycled' approach, the use of renewable rather than depletable resources, the redesign of production processes and products to eliminate the production of toxic materials, and the protection and restoration of natural habitats and environments valued for their liveability or beauty (Ezeabasili, 2009).

**The Three Pillars of Sustainability**

The principle of the Three Pillars of Sustainability says that, for the complete sustainability problem to be solved, all three pillars of sustainability must be sustainable. The three pillars are social sustainability, environmental sustainability, and economic sustainability.

Of the three pillars, the most important is environmental sustainability. If this is not solved, then no matter how hard we try; the other pillars cannot be made strong because they are dependent on the greater system they live within- the environment.

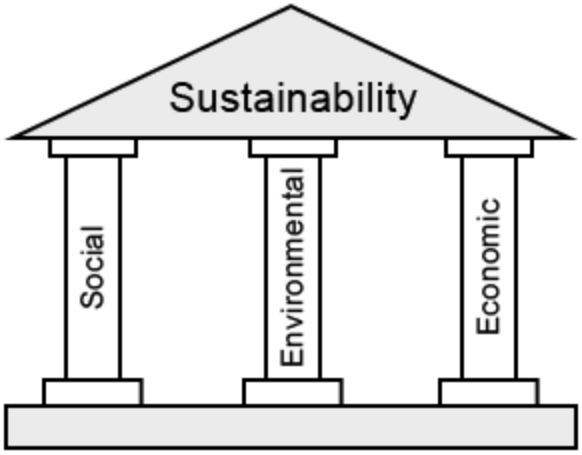


Figure 2: Diagammatic representation of the three pillars of sustainability

Sustainability is important to making sure that we have, and will continue to have, the water, materials, and resources to protect human health and environment. Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on the natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony that permits fulfilling the social, economic and other requirements for present and future generations (TomoPlan, 2011).

Environmental sustainability is the ability to maintain the qualities that are valued in the physical environment. Environmental Sustainability can also be defined as the ability of the environment to continue to function properly and indefinitely. This involves meeting the present needs of humans without endangering the welfare of future generations. The goal of environmental sustainability is to halt environmental degradation. Sustainability, in this context, relates to the ability of the environment to meet the basic requirements for the sustenance of the living and non- living components of the ecological, economic and socio-cultural systems, in a manner that does not limit the possibility of meeting the present and future needs of the various components and aspects of the environment (Daramola and Ibem, 2010).

Environmental sustainability involves making decisions and taking actions that are in the interests of protecting the natural world, with particular emphasis on preserving the capability of the environment to support human life. Currently, environmental sustainability is a topical issue

that receives plenty of attention from the media and from different governmental departments. This is a result of the amount of research going into assessing the impact that human activity can have on the environment. Although the long term implications of this serious issue are not yet fully understood, it is generally agreed that the risk is high enough to merit an immediate response.

The existence of man will continue to register its effects and impact on the environment. This development will continue to trigger off questions which must be answered. It is the responsibility of all of us to pay particular attention to protect the environment by ensuring that we avoid anything that might destroy it, and at the same time obey rules and regulation that will help sustain the environment. It is necessary to eliminate irrational use of natural resources that causes environmental depletion. Sustainability requires managing the needs of development in a way that ensures that the economy and society continue to exist without destroying the natural environment on which we depend.

**Environmental Sustainability and Sustainable Development**

Environmental sustainability is integral to, and a key pillar of, sustainable development. While the term 'environmental sustainability,' which is at the heart of the seventh goal (MDG 7), is not explicitly defined in the Millennium Declaration, countries concur that 'we must spare no effort to free all of humanity and, above all, our children and grandchildren, from the threat of living on a planet irredeemably spoilt by human activities, and whose resources would no longer be sufficient for their needs' (UNDG, 2010). World leaders identify 'respect for nature' as a fundamental value required in the twenty- first century and call for a 'new ethic of conservation and stewardship.'

In the case of MDG 7, the targets and indicators are illustrative of key global environmental issues and commitments. Because they are global in nature, they require responses from both developed and developing countries, with common but differentiated responsibilities. The framework assumes that improvements at the national level would impact regional and global trends through meeting the targets by 2015. The global MDG 7 targets and indicators are a starting point for monitoring country-level progress towards ensuring environmental sustainability.

To translate the vision of the MDGs into national reality, countries need to make the goals relevant to their specific national contexts, by identifying targets to work into policies and programmes for implementation, as well as complementary indicators to measure progress towards those targets and the overall goal.

**Values Underlying the Millennium Declaration**

The Millennium Declaration—which outlines 60 goals for peace, development, the environment, human rights, the vulnerable, hungry and poor, Africa, and the United Nations—is founded on a core set of values described as follows:

• Freedom. Men and women have the right to live their lives and raise their children in dignity, free from hunger and from the fear of violence, oppression or injustice. Democratic and participatory governance, based on the will of the people, best assures these rights.

• Equality. No individual and no nation must be denied the opportunity to benefit from development. The equal rights and opportunities of women and men must be assured.

• Solidarity. Global challenges must be managed in a way that distributes the costs and burdens fairly in accordance with basic principles of equity and social justice. Those who suffer or who benefit least deserve help from those who benefit most.

• Tolerance. Human beings must respect one another, in all their diversity of belief, culture and language. Differences within and between societies should be neither feared nor repressed, but cherished as a precious asset of humanity. A culture of peace and dialogue among all civilizations should be actively promoted.

• Respect for nature. Prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development. Only in this way can the immeasurable riches provided to us by nature be preserved and passed on to our descendants. The current unsustainable patterns of production and consumption must be changed in the interest of our future welfare and that of our descendants.

• Shared responsibility. Responsibility for managing worldwide economic and social development, as well as threats to international peace and security, must be shared among the

nations of the world and should be exercised multi-laterally. As the most universal and most representative organization in the world, the United Nations must play the central role.

Finally—and in many ways, most importantly—sustainable development is defined in practice. The practice includes the many efforts at defining the concept, establishing goals, creating indicators, and asserting values. But additionally, it includes developing social movements, organizing institutions, crafting sustainability science and technology, and negotiating the grand compromise among those who are principally concerned with nature and environment, those who value economic development, and those who are dedicated to improving the human condition. (Kates *et al*., 2005)

If it can be agreed that a sustainable environment is a necessary prerequisite to a sustainable socioeconomic system, then it also should make sense that the actions we take to remove threats to, and foster environmental sustainability should contribute to such a system (Morelli, 2011). The protection of the environment is sequel to the awareness of man to control it.

The concept of sustainable development is not novel. However, the concept has become so widely embraced beyond the initial application within the limited environmental jurisprudence. In the process, two schools of thought have evolved and are fiercely battling for dominance. They are the positivists/optimists on the one hand and the negativists/pessimists on the other hand (Ogbodo, 2010). While the positivists/optimists insist on promoting development for the mutual benefit of both the present and future generations, the negativists/pessimists insist on restricting development in the same name of sustainable development. Nigeria has wisely embraced a holistic approach to the concept of sustainable development by meshing both their development aspirations with environmental consciousness. In the same vein, both the needs of the present generation and future generation are safeguarded (Ogbodo, 2010).

### 2.2.4 **Environmental Education (EE)**

Education involves the imparting of knowledge and development of skills for self-realization. It is concerned with the development of an individual's ability to think, reason and create (Ogueri, 2004). Education is the way personal growth can help make the world a better

place. Its role in the ever- increasing environmental crisis for awareness and advocacy cannot be relegated to the background.

The Federal Government of Nigeria sees education as the greatest force that can be used to bring about change, and the greatest investment that a nation can make for quick development of her economic, political, sociological and human resources. It was in realization of this that the National Policy on Education seeks the inculcation of the right type of values and attitudes for the survival of the individual and the Nigerian society; the inculcation of national consciousness and national unity: the training of the mind in the understanding of the world around; and the acquisition of appropriate skills, abilities and competence both mental and physical as equipment for the individual to live in and contribute to the development of his/her society. The policy also states that there is need for functional education for the promotion of a progressive, united Nigeria. To this end, school programmes need to be relevant, practical and comprehensive while interest and ability should determine the individual's direction in education (FRN, 2004).

Amidst the on-going environmental crisis, which is of great concern worldwide, and the realization for sustainability, especially since the environment is the major source of survival, the need for environmental education was necessitated. Thus, the breadth and depth of the environmental crisis have encouraged the inclusion of Environmental Education in the school curriculum.

Environmental Education (EE) is a field of education incorporated into the educational system in order to enhance the awareness of the people on environmental issues at all levels of education. It is an approach to education which is hoped to bring some solutions to the deteriorating relationship between man and the environment.

Through environmental education, it is believed that man would be able to find a mechanism where clean environment will be adequately enhanced through consistent day-to-day increase in the knowledge of emerging environmental problems. The children will be adequately equipped intelligently, emotionally and with the necessary manipulative skills that will help them to meet the challenges posed to them by both the present and the future environment. ( Jekayinfa and Yusuf, 2008).

Okebukola (1993), as cited by Olatundun (2008), defined Environmental Education (EE) as the process of acquiring or transmitting knowledge, attitudes and skills for the sustainable use of natural and man-made resources. The International Union for the Conservation of Nature and Natural Resources (IUCN) defined EE as the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelation of man, his culture and his biophysical surroundings. The world inter-governmental conference on Environmental Education and its declaration in 1975, as quoted by Adara (1993), defined Environmental Education (EE) as a process aimed at developing a world population that is aware of, and concerned about, the total environment and its associated problems, and which has the knowledge, attitude, motivations, commitments and skills to work individually and collectively towards solutions of current problems and the prevention of new ones (Olagunju, 2002)

Environmental education is generally concerned with the development of skills, knowledge and motivation necessary to make informed decisions about environmental issues (Rim-Rukeh 2007). It is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations and commitments to make informed decisions and take responsible action (UNESCO's Tbilisi Declaration, 1978).

It involves much: it considers the environment in its totality; it is interdisciplinary in nature; it emphasizes active participation in solving "environmental problems"; it focuses on future and current "environmental situations"; it examines all development and growth from an environmental perspective; it promotes the value and necessity of local, national and international co-operation among others (Blackmoore, 1994 as cited by Ogueri, 2004). EE focuses on awareness and sensitivity about the environment and environmental challenges, knowledge and understanding about the environment and environmental challenges, attitude concern for the environment and help to maintain environmental quality; skills to mitigate the environmental problems; and participation for exercising existing knowledge and environment related problems.

The cornerstone of EE is to identify the individual with the environment as inseparable and interdependent parts of a single entity (Ogueri, 2004). Environmental Education is essential for developing a healthy, sustainable society. For us to be a successful nation, we need an environmentally literate citizenry. We must develop a citizenry that has the skills, knowledge and motivation necessary to make well-informed decisions about environmental issues (Rim-Rukeh, 2007). It has a big role to play in bringing change to people's values and attitudes. EE cuts across all other disciplines and subjects. It deals with real problems arising outside the four walls of formal education. It helps in revealing to pupils and students the need to secure the foundations of life. Nobody and/or country can overemphasize the need for, and importance of, EE at any level of education, especially in the developing world.

The importance of EE, in relation to sustainable growth, cannot be overemphasized. Education for environment touches all facets of human life. EE helps to develop an individual to the totality of environment and its associated problems and at the same time creates awareness on how to participate individually and collectively in decision making towards solutions to and/or resolution of current environmental issues/problems and/or prevention of new ones.

Environmental awareness is conceived as a way of understanding the environment, looking after it, and feeling towards it in an effective way, it involves viewing the environment with wonder, with awe and with humility, as something to feel part of, to love and to cherish, rather than to exploit, impoverish and destroy (Goldsmith, 1988 in Inyang-Abia & Umoren, 1995). To achieve this worthwhile or desired behavioural change or awareness, the formal school or education system constitutes the fundamental and universal criterion (Inyang-Abia & Umoren, 1995).

EE requires a 'student-initiative education' in the sense that it is fundamentally problem oriented. The inadequate environmental ethics, ignorance and inadequate environmental awareness, knowledge and skills in pupils and students in particular, can only be removed through such education (Ogueri, 2004).There is, therefore, the need for a methodology that will make the students functional in Environmental Education. The need of the hour is to have environmentally conscious citizens who are concerned about saving the environment from disasters. It might happen only when people are knowledgeable about their environment and

associated problems, when they are aware of the solutions to these problems, and are thus motivated to work for these (solutions). This naturally means change in attitude and behaviour of the public (Ahove, 2001). The more we learn, the better we realize the worth of our environment.

### 2.2.5 Metacognition and Metacognitive Strategies

The importance of metacognition, in the process of learning, is an old idea that can be traced from Socrates' questioning methods to Dewey's twentieth-century stance which opines that we learn more from reflecting on our experiences than from the actual experiences themselves (Dewey, 1933). What is more recent is the coining of the term "metacognition" and the emergence of a metacognition research field in the last four decades. Credited to the developmental psychologist John Flavell, in a publication from the 1970s, metacognition is used in different disciplines in different ways.

Metacognition is often referred to as "thinking about thinking." It is a regulatory system that helps a person to understand and control his or her own cognitive performance. Metacognition allows people to take charge of their own learning. It involves awareness of how they learn, an evaluation of their learning needs, generating strategies to meet these needs and then implementing the strategies (Hacker, 2009). Metacognition is one's ability to use prior knowledge to plan a strategy for approaching a learning task; take necessary steps to solving the problem; reflect on and evaluate results, and modify one's approach as needed. It helps learners to choose the right cognitive tool for the task, and plays a critical role in successful learning. It refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Activities, such as planning how to approach a given learning task, monitoring co.mprehension, and evaluating progress toward the completion of a task, are metacognitive in nature. (Livingston, 1997)

Improved metacognition can facilitate both formal and informal learning. It can improve the performance of new tasks on the job and help teams problem solve more effectively. Learners often show an increase in self-confidence when they build metacognitive skills. For all age groups, metacognitive knowledge is crucial for efficient independent learning because it

fosters forethought and self-reflection. Metacognitive strategies can often (but not always) be stated by the individual who is using them (Malamed, 2014).

**The Processes of Metacognition**

Many theorists (Flavel, 1981; Kluwe, 1982; Brown, 1987) have organized the skills of metacognition into two components. This makes it easier to understand and remember.

According to the theory of cognition, metacognition consists of two complementary processes: 1) the knowledge of cognition and 2) the regulation of cognition.

1. **Knowledge of cognition** has three components: knowledge of the factors that influence one's own performance; knowing different types of strategies to use for learning; knowing what strategy to use for a specific learning situation.
2. **Regulation of cognition** involves: setting goals and planning; monitoring and controlling learning; and evaluating one's own regulation (assessing results and strategies used).

**Metacognition and Expertise**

1. Many experts cannot explain the skills they use to elicit expert performance. (Perhaps this is due to the automatic functioning of the expert.)
2. Metacognitive strategies often separate an expert from a novice. For example, experts are able to plan effectively on a global level at the start of a task—a novice won't see the big picture.
3. Some adults with expertise in one domain can transfer their metacognitive skills to learn more rapidly in another domain.
4. On the other hand, some adults do not spontaneously transfer metacognitive skills to new settings and, thus, will need help doing so. (Malamed, 2014)

**Examples of Metacognition Skills You May Use**

Successful learners typically use metacognitive strategies whenever they learn. They may however fail to use the best strategy for each type of learning situation. Here are some metacognitive strategies that will sound familiar:

1. Knowing the limits of your own memory for a particular task and creating a means of external support.
2. Self-monitoring your learning strategy, such as concept mapping, and then adapting the strategy if it is not effective.
3. Noticing whether you comprehend something you just read and then modifying your approach if you did not comprehend it.
4. Choosing to skim subheadings of unimportant information to get to the information you need.
5. Repeatedly rehearsing a skill in order to gain proficiency.
6. Periodically doing self-tests to see how well you learned something.

In summary, metacognition is a set of skills that enable learners to become aware of how they learn and to evaluate and adapt these skills to become increasingly effective at learning. In a world that demands lifelong learning, providing people with new and improved metacognitive strategies is a gift that can last forever.

**Metacognitive Strategies**

Metacognitive strategies refer 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'. They are techniques that help people become more successful learners.

Metacognitive strategies are sequential processes that one uses to control cognitive activities, and to ensure that a cognitive goal (e.g., understanding a text) has been met. These processes help to regulate and oversee learning, and consist of planning and monitoring cognitive activities, as well as checking the outcomes of those activities. ( Livingston, 1997)

Because cognitive and metacognitive strategies are closely intertwined and dependent upon each other, any attempt to examine one without acknowledging the other would not provide an adequate picture. Metacognitive and cognitive strategies may overlap in that the same strategy, such as questioning, could be regarded as either a cognitive or a metacognitive strategy, depending on what the purpose for using that strategy may be (Livingston, 1997).

Simply possessing knowledge about one's cognitive strengths or weaknesses, and the nature of the task without actively utilizing this information to oversee learning, is not metacognitive. Teachers who use metacognitive strategies can positively impact students who have learning disabilities by helping them to develop an appropriate plan for learning information, which can be memorized and eventually be routine. As students become aware of how they learn, they will use these processes to efficiently acquire new information, and consequently, become more of an independent thinker (Malamed, 2014).

**What are they?**

- First, a metacognitive strategy is a memorable "plan of action" that provides students an easy to follow procedure for solving a particular math problem.
- Second, metacognitive strategies are taught using explicit teaching methods.
- Metacognitive strategies include the student's thinking as well as their physical actions.
- Some of the most common metacognitive strategies come in the form of mnemonics which are meaningful words where the letters in the word each stand for a step in a problem-solving process or for important pieces of information about a particular topic of interest.
- Metacognitive strategies are memorable and it must accurately represent the learning task. **(**Mylene Dizon,2014**)**

**How does this instructional strategy positively impact students who have learning problems?**

- Provides students an efficient way to acquire, store, and express math-related information and skills.

- Provides students who have memory problems an efficient way to retrieve from memory information they have learned.
- Facilitates independence by those learners who are typically dependent on high levels of teacher support.

- Helps students move from concrete and representational understanding to abstract understanding. **(**Mylene Dizon,2014**)**

The foundation of Metacognitive strategy has three parts:

– Understanding that the ability to learn is not fixed, and is affected by many factors

– Planning, setting goals and applying specific strategies to those factors

– Evaluating the effectiveness of your plans. (Anderson, 2014)

Metacognitive strategies range from simply recognizing the mental benefits of exercise, sleep and diet, to elaborate techniques, such as the method of loci, information acronyms and cognitive reframing. (Anderson 2014). Metacognitive strategies are becoming popular among teachers who want to improve their students' learning and teach them the habits that promote high-achievement. (Anderson 2014)

Metacognitive strategies facilitate learning how to learn. It can be incorporated as appropriate, into eLearning courses, social learning experiences, pre- and post-training activities and other formal or informal learning experiences.

1. **Ask Questions.** During formal courses and in post-training activities, ask questions that allow learners to reflect on their own learning processes and strategies. In collaborative learning, ask them to reflect on the role they play when problem solving in teams.
2. **Foster Self-reflection.** Emphasize the importance of personal reflection during and after learning experiences. Encourage learners to critically analyze their own assumptions and how this may have influenced their learning.

3. **Encourage Self-questioning.** Foster independent learning by asking learners to generate their own questions and answer them to enhance comprehension. The questions can be related to meeting their personal goals
4. **Teach Strategies Directly.** Teach appropriate metacognitive strategies as a part of a training course.
5. **Promote Autonomous Learning.** When learners have some domain knowledge, encourage participation in challenging learning experiences. They will then be forced to construct their own metacognitive strategies.
6. **Provide Access to Mentors.** Many people learn best by interacting with peers who are slightly more advanced. Promote experiences where novices can observe the proficient use of a skill and then gain access to the metacognitive strategies of their mentors.
7. **Solve Problems with a Team:** Cooperative problem solving can enhance metacognitive strategies by discussing possible approaches with team members and learning from each other.
8. **Think Aloud.** Teach learners how to think aloud and report their thoughts while performing a difficult task. A knowledgeable partner can then point out errors in thinking or the individual can use this approach for increased self-awareness during learning.
9. **Self-explanation**. Self-explanation in writing or speaking can help learners improve their comprehension of a difficult subject.
10. **Provide Opportunities for Making Errors.** When learners are given the opportunity to make errors while in training, such as during simulations, it stimulates reflection on the causes of their errors **(**Mylene Dizon,2014**)**

### 2.2.6 Anchored Instructional Strategy

Anchored instruction refers to instruction in which the material to be learned is presented in the context of an authentic event that serves to anchor or situate the material and, further, allows it to be examined from multiple perspectives(Barab, 2000). It allows people to explore situations to find plausible solutions to problems. Anchored instruction is closely related to the situated learning framework and also to the Cognitive Flexibility theory in its emphasis on the use of technology-based learning. The anchored instruction paradigm is based upon a general

model of problem-solving. It is designed to help students learn information so that it can be recalled and flexibly applied to solve problems. It emphasizes the need to provide students with opportunities to think about and work on problems, which is an emphasis of cognitive constructivists.

**Anchored Instruction Design**

Cognition and Technology Group at Vanderbilt (CTGV) has been developing a series of macro contexts with corresponding classroom material for the purpose of supporting anchored instruction learning activities (CTGV, 1997). These macro contexts incorporate seven important cognitive learning and instructional design principles that were developed for mathematics problem solving in the Adventures of Jasper Woodbury series. Modifications of these principles for science and literacy are discussed in CTGV (1992a; 1997).

**Design Principles**

The principles that govern the design of anchored learning are outlined below (CTGV, 1997). It involves the following:

1. Generative Learning Format. The macro context storyline creates a meaningful context for problem solving. The end of the story, however, is generated by the student through the resolution of the challenge. Having students generate the story's ending provides motivation: students like to determine for themselves the story's outcome.

An additional advantage of the generative format is that students must become active learners when generating and solving the sub-problems required by the challenge. Research findings suggest that there are important benefits to having students generate information (e.g., Soraci, et al., 1994).

2. Video-Based Presentation Format. The video medium allows students to comprehend complex and interconnected problems much better than if the information were presented in a text form. This is especially true for students who have difficulty with reading. The video format allows characters, actions, and settings to be depicted in a rich, vivid, and realistic manner that is hard to achieve in text-only presentations. A second advantage of the video-based format is that it provides the ability to weave in related background information which might motivate the study of other problems in mathematics and other domains.

3. Narrative Format. The video narrative is designed to contain setting information, a slate of characters, an initiating event, and consequent events. The challenge at the end of the video follows naturally, creating for students the impression that they are solving a realistic problem rather than responding to a lecture on video. Furthermore, the more vivid and graphic depiction of events creates for students a more authentic use of mathematical concepts (e.g., Brown, Collins & Duguid, 1989).

4. Problem Complexity. The challenge presented to students is a complex problem with many interrelated steps. The complexity is intentional and based on a very simple Anchored Interactive Learning Environments 3 premise: students cannot be expected to learn to deal with complexity in the real world unless they are trained to do so. Unfortunately, traditional classroom activities do not routinely provide students with the opportunity to engage in the kind of sustained mathematical thinking necessary to solve complex problems. The video presentation of the challenge does not hide the complexity of the task, but at the same time makes it look interesting and solvable.

5. Embedded Data Design. An important design feature of the mathematics macro contexts is the embedded data format. All the data necessary to solve the challenge are seamlessly embedded in the video story along with a great deal of extraneous information. Unlike typical word problems, the video does not explicitly identify the mathematical problems that need to be solved to complete the challenge. The result is that students must first identify and understand the problem, determine what information is relevant, remember where this information was presented, and then extract that information from the story. In other content areas, the macro context introduces students to additional resources they can use to gather necessary data (Goldman, *et al.* 1991; Sherwood, *et al.*, 1995).

6. Opportunities for Transfer. Cognitive science literature on learning and transfer suggests that concepts acquired in only one context tend to be welded to that context; hence, they are not likely to be spontaneously accessed and used in new settings (Bransford *et al.*, 1989). The adventures in the Jasper series are designed so that there are, at least, three episodes for each problem type: trip planning, statistics and business planning, algebra and geometry. This provides students with the opportunity to use and reuse mathematical concepts in a variety of contexts; thus, considerably increasing the likelihood of skill transfer to new situations and

reducing the likelihood of inert learning. There are also a set of analog problems associated with each adventure, which help reinforce and extend mathematical concepts that students use in the original adventure.

7. Links across the Curriculum. Each video story contains all the data necessary to solve the challenge. In addition, the story also provides many opportunities to introduce topics from other subject matters. For example, in the trip planning episodes, maps are used to help figure out the solutions. These provide a natural link to geography, navigation, and famous events in which trip planning was an important component, such as Charles Lindbergh's solo flight across the Atlantic.

These seven design principles mutually influence one another and operate as a gestalt rather than as a set of independent features. For example, the use of video brings the world into the classroom in a manner that motivates students. It makes complex mathematical problem solving accessible to students who have difficulties comprehending complex situations from text material (Bransford *et al*., 2000). The narrative format, the generative design of the stories, the complexity of the challenge, and the fact that the adventures include embedded data present learning opportunities on sub goal generation helps in finding relevant information and engaging in logical decision making tasks while keeping the complexity of the task manageable. The narrative format also makes it easier to embed information and allude to related problems that provide opportunities for links across the curriculum.

Principles of anchored instruction:

- Learning and teaching activities should be designed around an "anchor" which is often a story, adventure, or situation that includes a problem or issue to be dealt with, which is of interest to the students.
- Instructional materials should include rich resources students can explore as they try to decide how to solve a problem (e.g., interactive videodisc programs).

Anchored instruction in education is closely related to problem-based and case-based learning in other fields (e.g., business, medicine), but it differs somewhat because all the information for solving anchored problems is available whereas it may not be in actual problem

solving situations. The initial focus of the work was on the development of interactive videodisc tools that encouraged students and teachers to pose and solve complex, realistic problems. The video materials serve as "anchors" (macro-contexts) for all subsequent learning and instruction

Humans can process information coming from auditory stimulus and visual stimulus at the same time (Moreno and Mayer, 2000). The multimedia learning is learning from verbal and visual information (Mayer and Massa, 2003). The verbal information included the written form of printed words and the oral form of spoken language, and any represented by pictorial forms such as illustration, diagram, photo, animation, and film are categorized in the visual information. According to the dual coding theory, brain encodes visual and verbal information simultaneously but differently, in separate areas (Lane and Wright, 2009). The brain clearly handles visual content differently than it does in textual information. Using PowerPoint to present multimedia materials in class can benefit students (Apperson *et al*., 2008). PowerPoint slides are the great visual presentation tools which comprise various multimedia formats such as text, chart, graph, sound and video. Teaching with PowerPoint can provide students with a brief description for teaching sequence and organization of the learning contents. This teaching manner benefits the students' further constructing learning concepts and conducting information-processing analysis (Susskind, 2008). It is known that the traditional way of teaching discourages active learning, and the slide show presentation simply enlarges the passive nature of the instruction. (Yuh, 2011)

An anchored instruction activity supports learning opportunities that relate to and extend thinking to other content areas. Learning and teaching activities are designed around an "anchor" which is often a story, an adventure, or situation that includes a problem or issue to be resolved and that is of interest to the students. The "anchoring" refers to the bonding of the content within a realistic and authentic context: Anchored modules typically embed all of the information need— embedded data or hints are used as scaffolding— to solve the problem, making it easier to manage in environments with limited time or limited resources. Anchored modules can take the form of full-blown multimedia with branching or simple Web pages with photos, text, and video streaming.

Anchors are typically shown in a short video (8-to-12 minutes) or slides, which students search to find information they need for solving the embedded problems. In a typical classroom using anchored instruction, students work together to formulate strategies for solving the sub-problems embedded in the anchor. The steps to follow in using this method are as follow:

Step 1 – The class is divided into small groups with 5-6 students in each group.

Step 2 – The 'Anchor' (the subject matter) is presented in a realistic situation using power point slides.

Step 3 – Research assistant encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to "play back" or "re-explore" story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to the class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

Here analogous problems using new data help students to engage in "what if" thinking about the original scenario making students more likely to become independent thinkers and apply knowledge. However, when the learning process occurs in the working memory, a cognitive load which is essential for learning will be imposed (Baddeley, 2002; Chandler and Sweller, 1991; Plass *et al.*, 2003). The cognitive load is related to the human information processing capacity. Based on the properties of the task being displayed, there are three categories of the cognitive load: intrinsic, germane and extraneous (Sweller, 1999). The intrinsic cognitive load refers to the burden imposed on the learner to construct a semantic context required for a particular learning task. The germane cognitive load refers to the learning activities that are related to schema acquisition and automation such as asking students to

compare solution procedures in structurally similar but contextually different situations (Kalyuga, 2007; Lai *et al.,* 2011). However, the extraneous cognitive load represents the ineffective structure or semantic contents that take over the working memory, thereby reducing the capacity of working memory available for learning activities. The result of poor instructional design will lead to increased extraneous cognitive load. The role of the facilitator is to provide context of a problem. Formulating a problem statement is a key role (e.g., represents the major issues or major problems that seem to be causing the problem) followed by an extraction and organization of data related to the problem by the students.

A series of quasi-experimental studies comparing Anchored Instruction (AI) to traditional modes of instruction with students at several achievement levels (i.e., low, average, high) have confirmed and expanded the earlier findings with AI. These studies have yielded medium-to-large effect sizes ($Z^2$) on curriculum-aligned problem solving tests (.31 to .79) and transfer tasks among students without disabilities (.14 to .38) (Bottge, 1999; Bottge, Heinrichs, Mehta, & Hung, 2002). Similar results have been found in studies involving students with learning disabilities (Bottge *et al*., 2007) and emotional/behavioral disabilities (Bottge *et al*., 2006). An important finding generated from these studies suggests that teachers need substantial amounts of training to use AI effectively. This training should include both pedagogical methods for teaching AI and deep understanding of the principles embedded in the AI problems.

### 2.2.7 Cognitive Flexibility Strategy

Cognitive Flexibility is based on the hypothesis which claims that the acquisition of ill-structured and complex knowledge is more effective when there is an exposure of students multiple times within the same learning situations. In fact, students face complexity of learning situation more easily and with necessary mental developments but according to different perspectives with application of hypertext systems to educational situations. Covering domain of knowledge with different viewpoints, multiple representations of knowledge, and connecting abstract concepts with case studies allow an effective learning (Jacobson *et al*., 1995).

Cognitive Flexibility proposes a number of instructional principles that are intended to simplify complex and ill-structured knowledge domains and to make educational material cognitively

tractable. There are five instructional principles guiding the application of Cognitive Flexibility in a learning environment. These are:

(1) Multiple knowledge representations: In general, the use of uni-dimensional depiction of complex and ill-structured knowledge does not simplify the acquisition of knowledge by students and misrepresents important conceptual facets of the domain (Barhoumi and Rossi, 2013). Cognitive Flexibility recommends the use of multiple ways to represent knowledge in the learning process (e.g. multiple themes, multiple analogies, multiple intellectual points of view) to reflect more accurately the multifaceted nature of complex knowledge. The cognitive flexibility hypertext theory as suggested by Jacobson and Spiro (1995) generally provides multiple representations of the same knowledge to be acquired by learners and allows for them necessary mental developments for treatment of information.

(2) Linking and tailoring abstract concepts to different case examples in the learning process with application of hypertext systems: In ill-structured knowledge domains, there is a considerable variability in terms of how abstract concepts apply to actual case situations. In the aim of showing knowledge as "knowledge-in-use, Cognitive Flexibility recommends designing abstract concepts with using multiple case examples to demonstrate to the learner the nuances of abstract conceptual variability associated with ill-structured domains (Spiro and Jehng, 1990).

(3) Early introduction to the complexity of knowledge domain: A common instructional approach applied to the learning process is to break a complex topic of knowledge into small conceptual units. Then comes learning these units in isolation, and then combine the units. Unfortunately, this approach tends to oversimplify and decontextualize complex material. Cognitive Flexibility recommends introducing early to the complexity of knowledge domain in a cognitively manageable manner that still reflects some of the multifaceted interactions of various conceptual elements (Spiro and Jehng, 1990). The advanced learner is thus prepared for a deeper explication of the knowledge with further study that is not qualitatively different from the earlier instruction

(4) Stressing the interrelated and web-like nature of knowledge: Cognitive Flexibility recommends a demonstration of interrelationships in multiple contexts to provide for students a flexible understanding of a complex content area. In contrast, teaching an isolated abstracted

knowledge element in isolation may produce more rigid knowledge representations that limit the ability of the learners to apply the knowledge in new knowledge application situations.

(5) Recommending assembly of knowledge. In educational material based ill-structured and complex domain of knowledge, sometimes there is a germane knowledge from a variety of previously learned sources of concepts and cases that are relevant to a novel knowledge application situation. Cognitive Flexibility recommends that learners assemble relevant abstract conceptual and case-specific knowledge components for a given knowledge application or problem-solving task. Learners assemble it without any retrieving knowledge previously treated in the human memory to adapt knowledge treatment to the new learning situation.

The steps to follow in using this method are as follows:

Step 1 – The class is divided into small groups with 5-6 students in each group.

Step 2 – The multiple hypertext representations of content is presented using power point slides.

Step 3 – The groups are encouraged to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to study the slides with emphasis on knowledge construction and not transmission of information.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to the class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

Here the teachers received a disc of the course content, a hypertext document that allowed the learners to access content in a self-directed manner. Hypertext refers to “computer-based texts that are read in a linear or non-linear fashion and that are organized on multiple dimensions.

Participants can view the same material (text, pictures, video, and audio) in different ways, essentially creating their own paths. The use of hypertext is a practical way to review the ideas of other people and record your own ideas about ill-structured and complex content/problems. Nonlinear instruction used in simple knowledge domains may place an unnecessary additional cognitive load on learners. Hypertext is best suited for advanced learning, where participants can apply, evaluate and synthesize their learning in a changing environment. This Cognitive Flexibility Hypertexts (CFH) provide a "three-dimensional" and "open-ended" representation of material for learners, enabling them to incorporate new information and form connections with pre-existing knowledge. While further research is needed to determine the efficacy of CFH as an instructional tool, classrooms where cognitive flexibility theory is applied in this manner are hypothesized to result in students more capable of transferring knowledge across domains. Cognitive flexibility hypertext theory was conceived by Spiro and his co-workers (1987) but it was repeated by Godshalk *et al*. (2004).

### 2.2.8 Modified Conventional (Lecture) Strategy

The word *lecture* comes from the Latin word *lectus,* from the 14th century, which translates roughly into "to read." The term *lecture*, then, in Latin, means "that which is read." It wasn't until the 16th century that the word was used to describe oral instruction given by a teacher in front of an audience of learners. The lecture method is just one of several teaching methods, though in schools it's usually considered the primary one (Paris, 2014).

Despite the lecture method being so unpopular among professional educational advisers, reformers and intellectuals generally - and almost annual declarations that information technology will render lectures obsolete - many scientists continue to give lectures and students continue voluntarily to attend them.

The steps involved in the use of conventional strategy include;

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions on the content discussed.

Step 5: Teacher gives homework/ assignment on the topic discussed.

**Advantages of the Lecture Method**

The lecture method has a few advantages that has kept it as the standard approach to teaching for so long. These include:

Teacher control: Because the lecture is delivered by one authoritative figure – a teacher, professor, or instructor of some other kind – that person has full reign of the direction of the lesson and the tone of the classroom. They alone are able to shape the course, and so lectures remain highly consistent when it comes to what kind of information is delivered, and how it's delivered.

New material: Lectures are literally just long-winded explanations of information, deemed important by the lecturer. As such, students can absorb large quantities of new material.

Effortless: The lecture method makes the learning process mostly effortless on the part of the students, who need only pay attention during the lecture and take notes where they see fit. Because so little input is required from students, it's the clearest, straightforward, and uncomplicated way to expose students to large quantities of information and in a way that is controlled and time sensitive. Students just need to know how to take good notes.

**Disadvantages of the Lecture Method**

One-way: People who are against the lecture method see it as 'a one-way street'. Professors dictate information to students, who have little to no opportunity to provide their own personal input, or protest the information being delivered.

Passive: Not only do people see the lecture method as a biased, one-way road, but they also see it as a wholly passive experience for students. Not being actively engaged in a discussion over certain material can make the material itself seem worthless to a student. After all, the point of an education isn't to be programmed to think a certain way, according to your instructor's an

education isn't to be programmed to think a certain way, according to instructor's lectures, but to critically analyze the information being provided and learn how to apply it in different contexts. If a student has no course material in line with the person delivering the lecture, they will receive only a shallow understanding of the subject being discussed. Simply put, they might even be bored by the material because they will have no opportunity to learn how the subject applies to them on a personal level.

Strong speaker expectations**:** The lecture method can be disadvantageous to the professor, as well. Not all academics can be expected to have the same level of public speaking skill. What if a teacher is a genius in his or her field, knows the material from every angle, and is enthusiastic about the subject but has trouble speaking in front of large groups? The quality of a professor's course should not suffer because they are unable to prepare a decent lecture. Just as being lectured to might not be the learning method of choice for many students, being the one that is expected to do the lecturing might not be the best way for every instructor to present their course material. But because the range of academic teaching methods are so limited, they are usually expected to do exactly that, potentially losing the elements of their lesson plan that makes it so strong (Paris, 2014).

### 2.2.9 Students' Knowledge of Environmental Concepts and Problems

Human population exists in an environment. Man lives, resides, organizes, reacts, adapts to and exploits the environment in order to sustain and enhance the quality of life. It has long been known that the basis for many environmental problems and issues is irresponsible environmental behavior. The relationship between population and ecology has shown that the environment in which man lives is such that it is not only man that affects the environment; human beings are also influenced by the environment.

In order to continue to exist in that environment, man must cope with the problems posed by the environment, which is indifferent to its survival, but offering resources potentially useful for the maintenance of life. A human population modifies its environment to a greater or lesser degree by merely occupying the environment as well as by the exploitation of its resources, thus introducing environmental changes additional to those produced by other organisms, geological

processes and the like. Not only does the environment act upon the population, but also the human population reacts upon its environment either directly or through co-action with other species. It can therefore be said that the adjustment of a population to its environment is not a state of being static, but a continuing and dynamic process (Ogunjuyigbe, 2006).

As a matter of fact man's interaction with the environment is a multi-dimensional phenomenon and touches virtually every area of life (Aluko, 2006).This interaction has caused a lot of environmental problems now affecting the entire world. These problems include air pollution, global warming, hazardous wastes, ozone depletion, water pollution, overpopulation and rain forest destruction. Because man possesses a potential dominance over the environment, his misuse and over-exploitation of environmental resources have resulted in these detrimental effects which have not only affected the environment itself, but also man. Man damages the environment either intentionally by design or unintentionally by accident. Whatever the sources of damage, man is usually at the receiving end, and he is the one bearing the brunt. The day-to-day damage and the deterioration of the environment ultimately pose a devastating threat to man and other living species (Aluko, 2006).

The severity of the outcome of these issues vary in intensity and spatial occurrence and include severe pressure on our resource base, exposure of the soil to erosion (especially gully erosion), depletion of the ozone layer, desertification; air, water and soil pollution, depletion of marine life, severe damage to water shed, loss of valuable land, mounting heaps of solid wastes in cities, production of acid rain, etc (Muoghalu, 2004).

Students have been observed to exhibit poor environmental knowledge and attitude. This is observed in their poor performance in the environmental concept questions posed to them in external examinations such as WAEC and NECO. Ogunleye (2002) cited a survey study conducted to investigate the Nigerian students' prevailing knowledge, attitude and practices in relation to environmental issues which reported that students exhibited poor knowledge, negative attitude and harmful practices towards a healthy environment. According to Babalola *et al* (2010) Environmental awareness is a pre-condition for pro-environmental behaviour and sustainable environmental management. If people are knowledgeable about their environment, the associated

problems and subsequent solutions and motivated or inspired for actions, the situation would eventually change for the benefit of both present and future generations (Olagunju, 2002).

### 2.2.10 Students' Environmental Attitude

Attitude is a way of life or human behavioral pattern which can always serve a direction to human endeavour (Afuwape, 2003). An attitude is a hypothetical construct about a mental state which is inferred from verbal reports and behavioral observation. As a concept, attitude takes its reality from a person's introspection. Man believes in attitudes and finds them useful for understanding the behavior of others. Attitudes are based on values, have horizontal and vertical structure and tend from general to specific. Without doubt, one of the most important influences on behavior is attitude. The basis for many environmental problems and issues is irresponsible environmental behavior.

Environmental attitudes are fundamentally important, widely discussed, frequently measured, and poorly understood. Environmental attitudes are conceptualized in terms of attitude theory as being composed of beliefs and affect toward an object. Environmental concern appears to be a specific belief which is largely embedded in cognitive structure and should be considered an opinion rather than an attitude. Environmental attitudes have been defined as "the collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues" (Schultz *et al*., 2004). Environmental attitude can also be defined as 'a learned predisposition to respond consistently, favourably or unfavourably with respect to the environment (Pelstring, 2009). Environmental attitudes are related to environmental problems

Young people's environmental attitudes are particularly important because young people ultimately will be affected by and will need to provide solutions to environmental problems arising from present-day actions. As future scientists, policymakers, consumers, and voters, today's youths will be responsible for "fixing" the environment, and they will be the ones who must be persuaded to adopt and pay the costs of future environmental policies. Therefore, it appears that effective environmental education for school age students is crucial. In general, young people's attitudes towards the environment begin to develop at a very early age. By the time they reach adolescence, many have acquired some level of environmental understanding of

issues such as ecology, technology, and economics and can formulate their own views on how each influence environmental concerns and policy.

An individual should have new experience and information to change their attitude toward an object. Individuals are not born with attitudes, they learn them afterwards. Some attitudes are based on one's own experiences, knowledge and skills, and some are gained from other sources (Kagıtcıbası, 2004). Attitude can be learned or acquired by following examples or opinions of parents, teachers or friends. It may be positive or negative towards certain objects and are usually traceable to culture and tradition. According to Egu (2001), one way of influencing our attitude and behavior to our environment will be through education from infancy to adulthood and must transcend both formal and informal sectors. Environmental Education is of critical importance for promoting Responsible Environmental Behavior (REB) and sustainable development (Rim-Rukeh, 2007). The study of Akomolafe (2011) revealed that students' environmental awareness knowledge is related to their environmental attitude. This result might be due to the fact that the knowledge gained by students in the course of their exposure to environmental issue, constitutes great influence on their attitude. Teachers thus play a very significant role in developing desirable attitude towards awareness about the environment among students. Personal development of students is impossible without installing in them environmental values (Kostova, 2000).

Attitudes without well-organized educational process, providing planned activities in which real-life situations were transformed into pedagogical situations for students to conceptualize, could not give rise to the development of skills and values systems, nor to nature-friendly behavior. Attitudes toward the environment are used interchangeably with environmental concerns which represent human predispositions that influence behaviour in a certain manner (Milfont and Duckitt, 2004). The object of most environmental attitude research has been the environment. The specific topics have been related to attitudes and behavior consistency, the construction of environmental attitude, and the relationship with other variables including demographic variables. Age is another factor that affects environmental attitudes. Younger persons are more environmentally concerned than older persons (Arcury, 1990; Inglehart, 1995). Also experience, beliefs about control, efficacy, responsibility, and personal values all affect environmental attitude (Park, 2009). Literature also indicated that gender, residence, income, and political

tendency are also predictors of environmental attitudes (Arcury, 1990; Buttel and Flinn, 1974; Tarrant and Cordell, 1997; Cottrell and Graefe, 1997; Buttel and Johnson, 1977; Dunlap and Van Liere, 1978; Albrecht, 1982; Ramsey and Rickson *et al.*, 1976; Mohai and Twight, 1987; Freudenburg, 1991; Inglehart, 1995; Bowman, 1977; Dunlap, 1975; Stern *et al.*, 1993).

According to Proops (2001), the study of environmental attitudes is important for the following reasons: (1) enquiring into the public's perceptions and attitudes to environmental issues may reveal local and 'informal' knowledge, and help in identifying environmental problems which have not been noticed by formal scientific study; (2) for local environmental problems (e.g. water quality, local air pollution), deciding on which should be tackled first will be as much about the public's perception of these problems as about their 'scientific' and 'economic' consequences; and lastly, (3) for wider or less immediately obvious environmental problems (e.g. ozone layer depletion, global warming), government policy is much more likely to be effective if it works together with public perceptions and opinion, rather than against it. Where public attitudes are not conducive to necessary environmental policy, this can indicate where public education and/or the use of economic incentives are needed.

Literature suggests that age and education are two of the best explanatory variables related to environmental attitudes. Dunlap and Van Liere (1978) argued that environmental issues were related to more than just attitudes and concerns about the environment, describing that "implicit within environmentalism was a challenge to our fundamental views about nature and humans' relationship to it" (Dunlap *et al.*, 2000).

### 2.2.11 Students' Environmental Practices

Environmental practices are those actions people can take to improve the environment's performance**.** Every single thing man does impacts the environment. However, mankind is yet to have the knowledge of the total environment. Observations have shown that, the keeping of environment clean and neat is deteriorating (Akomolafe, 2011). There is either little or no awareness of the danger inherent in the misuse of the environment (Jekayinfa and Yusuf, 2008).
Most organizations around the world, as well as their stakeholders, are becoming increasingly aware of the need for environmental management, socially responsible behaviour, and

sustainable growth and development. Generally, Nigerians are at best indifferent to the environment (Ajiboye and Ajitoni, 2008).

The actual environmental practices of the people are a necessary factor towards the attainment of a clean and healthy environment. There have been series of environmental protection measures introduced in Nigeria. Some of these include the abatement measure, environmental awareness campaign, environmental legislations, environmental policies, afforestation and land reclamation. Environmental sanitation exercises are put in place, conferences are organized, and environmental organizations such as Federal Environmental Protection Agency (FEPA) and Nigerian Conservation Foundation (NCF) are established.

According to Anthony (2006), a great deal of effort has been invested by the Nigerian Educational Research Development Council (NERDC) to also incorporate the environmental concept into many subjects in the junior and senior secondary school curricula. Through environmental education, it is believed that man would be able to find a mechanism where clean environment will be adequately enhanced through consistent day-to-day increase in the knowledge of emerging environmental problems.

Education enriches people's mind, skills, understanding and quality of life and also makes them contribute meaningfully to the socio-economic and political development of the country.

Houdre (2008) has made it clear that the prime reason for implementing environmental practices is geared towards profitability; delivering good environmental performance is integral to man's day-to-day activities. Environmental practices should be geared towards sustainable use of the natural resources for both the present and future generations.

To this end, good environmental practices are necessary because environmental degradation, if not checked, can have a great impact on natural resources, human health and ecosystems, with adverse consequences for the present and future generations of Nigerians.

### 2.2.12 Gender

Gender according to the *Oxford Advanced Learners Dictionary* refers to the fact of being male or female. The World Health Organization (WHO) defines gender roles as "socially constructed roles, behaviours, activities, and attributes that a given society considers appropriate for men and women." From birth, children learn gender stereotypes and roles from their parents and environment.

Gender equality is a human right. Gender inequalities persist in education in terms of subject preferences and performance, and in cultural aspects of the education and training experience. Mathematics, Science and Technology (MST) courses are predominantly male in profile and courses with a care bias are disproportionately female. Both cultural and organisational factors contribute to these gendered choices.

Many researches have been carried out in the past on factors that affects the performance of students in science and science related subjects. Amongst other factors that have received attention are learner characteristics such as gender. Although the issue of gender and achievement in science is an important area that has involved a lot of researches, available results have not yielded a conclusive trend in performance (Bilesanmi- Awoderu, 2002).

Okeke (2001), Solomon (2004) and Usak et al (2005), in their review of studies concluded that gender differences exist in students' achievement in science.

Studies have shown significant difference in favour of boys (Bilesanmi-Awoderu, 2002; Aremu and John, 2005; Abiona, 2008; Ojo, 2009); sometimes in favour of girls (Ogunleye 2002, Olatundun 2008) and sometimes the studies have shown no significant difference between boys and girls in relation to their achievement and attitude in different science subjects (Raimi and Adeoye, 2002; Owoyemi, 2007; Oduwaiye, 2009; Okoye, 2010). Ogunkola and Fayombo, (2009), in their study, found out that there was no statistical difference in secondary school students' achievement based on their gender. Ogunkola (2000), in his study, found that there was no significant main effect of gender on students' attitude to and achievement in Biology.

According to Owoyemi (2007), students' achievement in physical chemistry courses has nothing to do with attitude or whether the student is male or female. Ogunleye (2002) and Olatundun (2008) in their different research works revealed in their findings that female possessed more verbal commitment to the environment. Raimi and Adeoye's (2002) research results show that no significant effect(s) of gender and ability existed on science students' attitude.

A Transfer of Knowledge programme for disseminating knowledge of effective methodologies for enhancing women's participation and success in MST programmes should be developed.

Education has the potential to play a key role in converging issues of disparity with respect to gender. Good teaching does not discriminate. High quality public education is important for students who come from social backgrounds or gender groups that are not traditionally high achievers in a given field. Raising standards of education and levels of expectation, combined with supports and care for students, will produce higher attainments and expectations among girls and boys in non-traditional fields of study.

### 2.2.13 Cognitive Styles

The construct of cognitive styles was originally proposed by Allport (1937), referring to an individual's habitual or typical way of perceiving, remembering, thinking, and problem solving. The cognitive styles describe how the individual acquires knowledge (cognition) and how an individual processes information (conceptualization). The cognitive styles are related to mental behaviors, habitually applied by an individual to problem solving, and generally to the way that information is obtained, sorted and utilized. Cognitive style is usually described as a personality dimension which influences attitudes, values and social interaction. Cognitive learning styles are the information processing habits of an individual. Unlike individual differences in abilities, cognition describes a person's typical mode of thinking, perceiving, remembering, or problem solving.

The concept of cognitive styles is one that crosses many disciplines. Initially part of the realm of Jungian/Piagetan psychology, cognitive style research is now an important part of fields such as, education, computer programming, and information science. All of these fields have goals in common for studying cognitive style, that is, how users (students, computer users, or information seekers) process information and how systems (teaching styles, computer interfaces, or information systems) can be better built to accommodate the diversity of the user population. Furthermore, all three fields also have to contend with the issues that arise from the permeation of computers into the daily tasks of users, a fact that can cause difficulty for those with certain cognitive styles (Lucas-Stannard, 2003).

In most situations, cognitive styles and learning styles are used interchangeably. Generally, cognitive styles are more related to theoretical or academic research, while learning styles are more related to practical applications. A major difference between these two terms is the number

of style elements involved. Specifically, cognitive styles are more related to a bipolar dimension while learning styles are not necessarily either/or extremes. Cognitive/learning styles measures conventionally lie somewhere between aptitude measures and personality measures.

In addition, Ausburn and Ausburn (1978) argued that cognitive styles were characterized by three important properties. The first important property is the generality and stability across tasks and over time. Therefore, they are resistant to training and change. The second important property is the relative independence of cognitive styles from traditional measures of general ability. The third important property is cognitive styles' relationships with some specific abilities, characteristics, and learning tasks. Cognitive styles have either positive or negative relationships with motivation and academic achievement depending on the nature of the learning task. In summary, there are at least three major motivations for studying cognitive styles: providing a link between cognition and personality; understanding, predicting, and improving educational achievement; and improving vocational selection, guidance, and, possibly, placement.

Various fields have developed diverse approaches to understanding the way people process information. Educators have tried to boost learning by focusing on differences in learning styles. Cognitive styles seem to have important implications for educational theory and practice (Papanikoloaou et al., 2006).

There are different cognitive learning styles for each person. Each person has his/her own styles of learning and thinking. Each person also have ways of learning and thinking and processing information that we share with others. This shared cognitive style differentiates us from those raised in different linguistic and cultural environments. Knowledge of these similarities and differences is crucial in education. While accepting that students will interact with, and deal with, curricular learning experiences in their own individual manner, curriculum development is often based upon the understanding of the shared elements of the learning process. Numerous strategies exist to assist improving the learning environment and interaction in the classroom for diverse students. One important strategy is to address the instructional implications of cognitive learning styles

How a person processes experiences and knowledge, and how they organize and retain information, is a cognitive learning style. Some people need to visualize the task before starting. Some people approach learning and teaching sequentially or randomly. Some work quickly or deliberately. These are all examples of cognitive learning styles and their characteristics.

Cognitive style theorists presume that in many cases students who are experiencing learning problems have intact learning abilities, but their styles of learning are inappropriate for the classroom demands. This leads to underachievement and cumulative information deficits (Smith 2010).

A number of cognitive style models and measures have been identified and have been in use over the years. Amongst these are:

(1) The Myers-Briggs Type Indicator (MBTI) developed in 1962 and is an instrument developed that can be used to assess cognitive style. It assesses cognitive style in four dimensions:

1. Extraversion (E) versus Introversion (I)
2. Sensing (S) versus Intuition (N)
3. Thinking (T) versus Feeling (F)
4. Judging (J) versus Perceiving (P)

There are a couple of points that must be kept in mind when attempting to use the MBTI and interpret MBTI scores.

1. The MBTI is licensed by CCP and requires certification for administration of the instrument
2. The MBTI is an instrument that attempts to measure cognitive style.
3. While it has strong validity and reliability measures, its accuracy is dependent on the honesty of the individual completing the instrument. Also the frame of reference (work, social, family) one takes when completing the instrument, affects one's score.
4. Cognitive style, as a variable, measures the strength of preference for the manner in which information is processed. It is different from cognitive skill.

**Extraversion (E) -- Introversion (I)**

As a dimension of cognitive style and information processing, extraverts differ from introverts in their preferred from of information gathering and transmission.

**Extraverts** (E) tend to and have a preference for:

- Processing information through social interaction
- Developing and building on their ideas through interaction with others
- Verbalizing ideas in order to reinforce them
- Responding to questions quickly, as if thinking out loud
- Schedule more face to face meetings rather than sending memos and written communication

**Group Decision Making Issue**

- Prefers to make decisions and work on assignments in the study group setting
- Feeds on reaction to his/her comments by other group members
- Brainstorms case ideas verbally

**Introverts** (I) tend to and have a preference for:

- Processing information internally
- Develops ideas and makes decisions in isolation
- Does not always verbalize ideas and opinions
- Responds only after reflection
- Prefers written forms of communication to presentations and meetings.

**Group Decision Making Issues**

- Is likely to have worked through a case or assignment before coming to a meeting

- After a discussion in which changes in approach or in solution have been suggested, the Introvert will generally prefer to look over a completed written document describing the plan before finally deciding

**Sensing (S) -- Intuition (N)**

This dimension of cognitive style attempts to describe the ways in which individual process and analyze information as part of a decision making or problem solving process. How do people know what they know? Put another way, how people analyze the information to which they have access and come up with conclusions. Whenever an attempt is made to diagnose problems to attribute causes to certain behaviours or outcomes, a deductive or inductive process is use. Those using an inductive approach rely on facts and evidence on which to base conclusions. Thus the empirical approach is the preference for sensors. Diagnosis often takes the form of trial and error or reference to know situations, companies in the same situation or past problem episodes. On the other hand, intuitives make ample use of theories and mental models from which to drawn their conclusions and "facts" of a situations. Attribution of causes is most often accomplished by deductive reasoning using a conceptual model.

**Sensors** (S) tend to and have a preference for:

- Collecting data through five senses
- Uses primarily inductive reasoning
- Focuses on details
- Learns experientially
- Sees the differences between two concepts or situations
- Is able to focus on and isolate component parts of a system
- Disassociates process with goals
- "Knows" something (cognition) because she/he has seen or experienced it.

**Group Decision Making Issues**

- Tends to focus on operational issues

- Looks for explicit evidence, looks to past experience to guide analysis
- When data conflicts with theory; goes with data.

**Intuitives** (N) tend to and have a preference for:

- Develops knowledge through deduction.
- Prefers to view things globally
- Sees the similarities between two concepts
- Sees the connections and integration between parts of a system
- Learns theoretically
- Connects processes with goals, often goal rather than process focused
- "Knows" something (cognition) because it is a logical deduction or extension of a theory/concept

**Group Decision Making Issues**

- Tends to focus on strategy issues
- Looks for model or theory to guide analysis
- when data conflicts with theory; goes with theory
- Once overall strategy is developed, often closes shop without developing operational plan

**Thinking (T) -- Felling (F)**

The third dimension of cognitive depicts the actual choice phase of a decision making process. When faced with a set of alternatives, how do people rank order them or make a choice of one option for implementation, Those with thinking styles rely more heavily on logic, cause and effect perceptions (cognitions, mental models, often constructing decision matrices scoring options against a chosen decision criteria set. Alternatively, those with a preference for feeling most often rank order options on the basis of the affect attached to each alternative. This is often referred to as "gut" feeling.

**Thinking Types** (T) tend to and have a preference for:

- Decides analytically by examining facts
- Logical, objective
- Examines cause and effect beliefs to make decisions
- Relies on cognitive component of attitude over the affective component

**Feeling Types** (F) tend to and have a preference for:

- Decides on the basis of feeling
- Uses logic to support feelings
- Relies on the affective component of attitude over cognitive component

**Judging (J) -- Perceiving (P)**

We can divide the decision making process into two stages: analysis (collecting and process information) and choice (selecting final option). Remember, preferences in the analysis stage are described by the S vs. N dimension, while choice preferences are found in the T vs. F dimension. Simply put, judging types have a preference for choice and closure, while perceiving types take comfort in analysis and information processing.

**Judging Types** (J) tend to and have a preference for:

- Primary emphasis is on making decisions and coming to closure.
- Uses cognitive schema as a basis of perceiving in order to shorten information gathering process.
- Prefers order and structure.
- Creates environments that are ordered, regulated and controlled.
- Knows "right way" and "wrong way", that is, committed to one best way.
- Difficulty with multi-tasking. Like to finish one task before starting another.
- Plans activities entirely before commencing.
- Prefers vertical thinking, that is, when confronted with an obstacles concentrates on removing that obstacle so that the original plan can be implemented successfully.

**Group Decision Making Issues**

- Pushes for closure and completion
- Will look for the format or formula to use in developing a problem or case solution

**Perceiving Types** (P) tend to and have a preference for::

- Primary emphasis is on perceiving, or gathering of information.
- Has difficulty coming to closure.
- Constantly looking for new information before making decision.
- Moves from one project to another.
- Prefers to remain flexible and avoid fixed plans, to keep options open.
- Prefers lateral thinking, that is, when confronted with an obstacle tends to go around it by developing solutions targeted at meeting the initial goal rather than implement the proposed plan.

**Group Decision Making Issues**

- Will attempt to keep group analysis and diagnosis alive, attempting to re-open analysis if new information surfaces.
- Push to find new ways to solve problems

(2) Reflection – Impulsivity which was also called conceptual tempo, studies in reflectivity – impulsivity were first introduced by Kagan in 1965 and are the easiest of the theories to measure. Kagan administered the Matching Familiar Figures Test to children and measured the time it took them to make decisions. One group of children made decisions after briefly looking at the figures, thus they were cognitively impulsive, while the other group carefully deliberated the choices before coming to a decision, and thus they were cognitively reflective. Kagan tested repeatedly to find that conceptual tempo is stable that is test subjects will repeatedly test as either impulsive or reflective. There is some hesitation as to whether this applies in high-uncertainty situations only (Sternberger & Grigorenko, 1997). It is also important to note that impulsivity,

as a cognitive style is not the same as having an impulsive personality (Sternberger and Grigorenko, 1997, in Froehlich, 2003).

(3) Field Dependence – Independence: This is one of the most researched cognitive styles to date with educational Implications and was initially proposed by Witkin **(**1962; 1979). According to Witkin, field dependence-independence is value-neutral and is characterized as the ability to distinguish key elements from a distracting or confusing background. Field dependence-independence has important implications for an individual's cognitive behavior and for his/her interpersonal behavior. Specifically, field independent people tend to be more autonomous in relation to the development of cognitive restructuring skills and less autonomous in relation to the development of interpersonal skills. Conversely, field dependent people tend to be more autonomous in relation to the development of high interpersonal skills and less autonomous in relation to the development of cognitive restructuring skills. In addition, according to Witkin, Moore, Goodenough, and Cox (1977), field independent persons tend to be intrinsically motivated and enjoy individualized learning, while field dependent ones tend to be extrinsically motivated and enjoy cooperative learning.

The field independence dimension is also related to some other individual characteristics, such as solving analogical problems. According to Antonietti and Gioletta (1995), cognitive styles, rather than general abilities, are related to analogical problem solving. Antonietti and Gioletta found that field independent participants were more likely to be analogical solvers than field dependent ones. Males tended to use analogical solutions more frequently than females. In addition, according to Braune and Wickens (1986), there are three important dimensions of individual differences in time-sharing–serial processing, parallel processing, and the internal model. Field independent persons perform better in the parallel processing conditions, while field dependent ones perform better in the serial processing conditions.

The field independence dimension is also related to some task characteristics. According to Bennink (1982), high and low field articulation (FA) students show differences in the following two major respects under cognitively demanding conditions: (a) integrating a set of semantically related sentences to answer inference questions and (b) remembering the actual propositions

themselves. This field dependence, field independence cognitive style has been commonly used by researchers such as Ford,N and Chen,S.Y (2000).

(4) Holist-Analytic

According to Riding and Cheema (1991), learning styles have two basic types of independent dimensions. One is the holist-analytic dimension. The holists tend to view a situation as a whole, while the analytics tend to view a situation as a collection of parts and often stress only one or two aspects at a time. Intermediates will have the advantage of both styles. The other is the verbal-imagery dimension, which has two basic effects: (a) how information is represented, such as verbally, imagery, or both, as well as (b) internal/external focus of attention. Generally, the imagers tend to be internal and passive, while the verbalizers tend to be external and stimulating. The latter type is related to sensory preference described later in this section. The above findings were also supported by Sadler-Smith (1997).

The holist-analytical style develops even in young children. Peters (1977) conducted a study about first language learning among very young children. According to him, children employed two basically different strategies to learn their first language. One is the analytic style, which proceeds from the parts to the whole. The other is the Gestalt style, which proceeds from the whole to the parts. In addition, Peters speculated that these two different language learning strategies may have neurological bases.

Holist-analytical styles have relationships to the type of instructional material and learning performance. According to Riding and Sadler-Smith (1992), among secondary schools or college students, types of instructional material treatment, such as abstract or pictorial presentation and cognitive styles, have very important influences on learning performance. Specifically, students on the analytic-imager dimension improve most in learning due to the inclusion of more pictorial presentations about certain types of contents. In addition, the findings in the above study were also reported in other studies (e. g., Holliday, 1976; Winn, 1982).

(5 ) Kolb’s Learning Style Model

Kolb's Learning Style Inventory is one of the dominant approaches to categorizing cognitive styles (Tennant, 1988). Kolb's model has been found to be effective in some language teaching activities (Kolb, 1984). According to Kolb, the four basic learning modes are defined as active experimentation (AE), reflective observation (RO), concrete experience (CE), and abstract conceptualization (AC). In addition, the learning process is not only active and passive, but also concrete and abstract. This model can also be considered as a four-stage model: (a) concrete experience, (b) observation and reflection, (c) the formation of abstract concepts and generalizations, and (d) hypothesis tested by active experimentation leading to new concrete experience.

Based on the four basic learning modes, according to Kolb (1984), there are four basic learning styles: converger, diverger, assimilator, and accommodator. Their characteristics are described below respectively:

(a) Converger: The convergent learning style depends mainly on the dominant learning capacities of active experimentation and abstract conceptualization. This style has great advantages in decision making, problem solving, traditional intelligent tests, and practical applications of theories. Knowledge is organized in a way of hypothetical-deductive reasoning. Therefore, persons with this style are superior in technical tasks and problems and inferior in social and interpersonal matters. They tend to choose to specialize in physical sciences.

(b) Diverger: The divergent learning style has the opposite learning advantages over converger. This style depends mainly on concrete experience and reflective observation; it has great advantages in imaginative abilities and awareness of meaning and values. Therefore, persons with this style tend to organize concrete situations from different perspectives and to structure their relationships into a meaningful whole; they focus on adaptation by observation instead of by action; they are superior in generating alternative hypothesis and ideas, and tend to be imaginative, people- or feeling-oriented; they tend to choose to specialize in liberal arts and humanities.

(c) Assimilator. The assimilative learning style depends mainly on abstract conceptualization and reflective observation. This style has great advantages in inductive reasoning, creating theoretical

models, and assimilating different observations into an integrative entity. Similar to converger, persons with this style tend to be more concerned about abstract concepts and ideas, and less concerned about people. However, persons with this style tend to focus more on the logical soundness and preciseness of the ideas, rather than their practical values; they tend to choose to work in research and planning units.

(d) Accommodator. The accommodative learning style has the opposite learning advantages over assimilation. This style depends mainly on active experimentation and concrete experience; it has great advantages in doing things, implementing plans, and engaging in new tasks. Therefore, persons with this style focus on risk taking, opportunity seeking, and action; they tend to be superior in adapting themselves to changing immediate situations in which the plan or theory does not fit the facts; they also tend to intuitively solve problems in a trial-and-error manner, depending mainly on other people for information rather than on their own thinking. Therefore, persons with this style tend to deal with people easily; they tend to specialize in action-oriented jobs, such as marketing and sales.

According to Kolb (1984), the above patterns connected with these four basic learning styles are exhibited consistently at various levels of behavior, from personality type to some specific task-oriented skills and performance, such as professional career and current job role. Kolb's model was also empirically supported by other studies. According to Trevino, Lengel, Bodensteiner, Gerloff, and Muir (1990), Kolb's above concrete experience (CE) and abstract conceptualization (AC) are similar to the perceptive vs. judging dimension measured by Myers Briggs Type Indicator (MBTI). The perceptive persons are expected to prefer rich media, such as the integrative use of pictures, tables, and diagrams, while the judging persons are expected to prefer lean media, such as without the integrative use of pictures, tables, and diagrams. This may have wide implications in distance education.

In addition, this model has proved to be of practical use. Just as Tennant (1988) remarked, "As a rule of thumb the model provides an excellent framework for planning teaching and learning activities and it can be usefully employed as a guide for understanding learning difficulties, vocational counseling, academic advising and so on". Although Newstead's (1992) study

indicated that the reliability of Kolb's Learning Styles Inventory was low and the underlying factor structure was not in agreement with what was predicted, a correlation was found between scores on the active/passive (AE-RO) dimension and the students' academic performance. Therefore, it can be inferred that Kolb's model may be of some diagnostic use in higher education. Furthermore, according to McCarthy (1980), the Kolb model, as well as the model of brain hemispheric dominance, is a very important foundation of the 4MAT curriculum design system applicable for syllabus development in some institutions.

(6) Deep-level / Surface-level Processing. This cognitive style research is similar to the holist – serialists distinction and it was developed by Marton and Säljö in 1976. Deep-level of processing involves how a student approaches material for learning while surface-level students focused their learning on what is to be learnt. Level of processing involves how a student (Marton and Säljö used undergraduates) approaches material for learning. Surface-level students focused their learning on what Marton and Säljö call *the sign*, or the literal rote learning of given material. Other students, the deep-level processors, focused on what is *signified* rather than the sign itself, these students attempted to learn the intended meaning of the material. According to their study, surface-level processors tended to say things like, "I just concentrated on trying to remember as much as possible," while the deep-level processors said that they tried to determine "what was the point of the article.

The processing level approach is very similar to Pask's theories. Deep-level processors, like holists, tended to quickly grasp the overall concepts and were normally intrinsically motivated but could sometimes miss the details. Likewise, surface-level processors, like serialists, concentrated on the details, required extrinsic motivation, and could sometimes miss the global view of a problem. However, both deep and surface-level processing are required to develop a complete understanding of a topic (Ford, 2000), the distinction lies in the way material is initially approached (Froehlich, 2003).

(7) Hudson Carey (1991) identified two cognitive styles: convergent thinkers, good at accumulating material from a variety of sources relevant to a problem's solution, and divergent thinkers who proceed more creatively and subjectively in their approach to problem-solving.

(8) Adaption-Innovation theory: One of the most popular models of cognitive style was devised by Michael Kirton (1976, 2003). His model, called Adaption-Innovation theory, claims that an individual's preferred approach to problem solving can be placed on a continuum ranging from high adaptation to high innovation. He suggests that some human beings, called adaptors, tend to prefer the adaptive approach to problem-solving, while others (innovators), of course, prefer the reverse. Adaptors use what is given to solve problems by time-honoured techniques. Alternatively, innovators look beyond what is given to solve problems with the aid of innovative technologies.

## 2.3 EMPIRICAL REVIEW

### 2.3.1a Anchored Instructional Strategy and Students' Knowledge

Research in educational settings suggests expertise is developed through problem solving activities that involve active construction of knowledge results (Bransford, Brown, & Cocking, 2000). Thus, anchored learning environments are generative because they motivate students to actively search for relevant information, use the information to plan strategies for solving the problem, and test their solutions. The studies of Hsin-Yih Cindy Shyu (2002) revealed a significant improvement among Taiwanese elementary students' problem-solving skills in mathematics with anchored instruction. This strategy has also been found to be effective in development of sophisticated mathematics knowledge, skills and positive attitudes (Young and Barab, 1999; Bottge et al., 2002); in social studies (Vve Nancy J et al., 1990); in Language Arts (Reith et al., 2003). The studies of Shyu (2000) among Taiwanese students using video-based anchored instruction was found to have enhanced students' learning and improved their problem-solving skills significantly. It is known that the traditional way of teaching discourages active learning, and the slide show presentation simply enlarges the passive nature of the instruction (Yuh, 2011). All these studies have revealed a significant improvement among the students' taught with anchored instruction.

### 2.3.1b Anchored Instructional Strategy and Students' Attitude

Anchored instruction is designed to help students learn information so that it can be recalled and flexibly applied to solve problems. Relevant researches suggested that pedagogical

approaches such as anchored instruction could enhance students' complex problem solving skills and positive attitudes towards learning (Li et al., 2010; Kumar, 2010; Kellogg, 2010; Baker, 2009; Pellegrino and Brophy, 2008).

This strategy has been found to be effective in development of sophisticated mathematics skills and positive attitudes compared to students in comparative group (Bottge, 2001). Hsin-Yih Cindy Shyu (2002) also in her study on the use of video-based anchored instruction to enhance learning: Taiwan's experience reports that results from a t-test indicate a significant main effect on student attitudes towards mathematics.

### 2.3.1c Anchored Instructional Strategy and Students' Practices

A primary goal of anchored instruction is to engage students in problem-solving activities that can help reduce the "inert knowledge" problem that Alfred North White-head identified decades ago. Knowledge presented as isolated disconnected facts remains inert and thus fails to transfer. In contrast, when knowledge and skills are contextualized as they are in anchored instruction, students are more apt to recognize when to appropriately apply them and use their prior knowledge to solve similar problems they encounter in the future. The findings of Hsin-Yih Cindy Shy (2002) suggest that video-based anchored instruction provides a more motivating environment that enhanced students' problem-solving skills. The study shows that students' problem-solving skills improve significantly with anchored instruction. Results also indicate that all the students benefited from the effects of anchored instruction on their problem-solving performance regardless of their mathematics and science abilities. Anchored instruction has been found to enhance students' complex problem solving skills and positive attitudes towards learning (Li et al., 2010; Kumar, 2010; Kellogg, 2010; Baker, 2009; Pellegrino and Brophy, 2008).

### 2.3.2a Cognitive Flexibility Strategy and Students' Knowledge

Cognitive flexibility is the ability to consider more than one dimension of the same object or event (Jacques and Zelazo, 2005;Gal Podjarny 2013). According to Spiro and Jehng (1990) Cognitive flexibility is the ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situational demands. This is a function of both the

way knowledge is represented (e.g., along multiple rather than single conceptual dimensions) and the processes that operate on those mental representations (e.g., processes of schema assembly rather than intact schema retrieval). It is the ability to simultaneously consider two aspects of an object, idea, or situation at one point in time. The Cognitive Flexibility Theory is called "cognitive flexibility" because it refers to the "flexible" way learners assemble and retrieve knowledge from their brains.

The theory is largely concerned with transfer of knowledge and skills beyond their initial learning situation. For this reason, emphasis is placed upon the presentation of information from multiple perspectives and use of many case studies that present diverse examples. The theory also asserts that effective learning is context-dependent, so instruction needs to be very specific. In addition, the theory stresses the importance of constructed knowledge; learners must be given an opportunity to develop their own representations of information in order to properly learn.

Cognitive flexibility and other skills are crucial to success both in classroom settings and life. A person's ability to switch between modes of thought and to simultaneously think about multiple concepts has been shown to be a vital component of learning (Barhoumi and Rossi, 2013). Further indicative of the role cognitive flexibility plays in education is the argument that how students are taught greatly impacts the nature and formation of their cognitive structures, which in turn affects students' ability to store and readily access information.

Cognitive flexibility also has implications both inside and outside the classroom. Classroom application of cognitive flexibility must not rely solely on computer-based instruction. Researchers in the field advocate a teaching style that incorporates group problem-solving activities and demands higher-level thought. According to this process, a teacher initially poses a single question in a number of ways. Next, students discuss the problem with the teacher and amongst themselves, asking questions. In forming these questions, students are actively brainstorming and recalling prior knowledge. At this point, the teacher provides specific conditions of the issue discussed, and students must adapt their prior knowledge, along with that of their peers, to generate a solution. Its primary applications have been in literary comprehension, history, biology and medicine.

In cognitive flexibility learning environments, the content and learning activities are represented in a variety of ways. The content is presented using different perspectives and the learning activities are structured to emphasize knowledge construction (Rossi, 2006). The instructional materials support context-dependent knowledge. The learning activities are often based on real-life situations. These types of learning activities motivate the student and the knowledge becomes easily transferable to the learner's knowledge structure. A hypertext program like “Story” could be used to explore and acquire knowledge. They could also include pictures, video and audio to their Story. The computer is ideally suited, by virtue of the flexibility it can provide, for fostering cognitive flexibility. In particular, multidimensional and nonlinear hypertext systems, if appropriately designed to take into account all the considerations have the power to convey ill-structured aspects of knowledge domains and to promote features of cognitive flexibility in ways that traditional learning environments (textbooks, lectures) could not. Cognitive flexibility hypertexts are exploratory environments that will enhance constructivist thinking, i.e. it provides building blocks for knowledge for construction. A learner is much more apt to understand concepts if they construct knowledge and use it rather than if they are required to memorize information and repeat it. Cognitive flexibility is very similar to the Constuctivist Learning Theory. Like the Constructivist Theory, it claims that learners construct knowledge by building upon existing knowledge and experiences. It differs in that it builds upon the Constructivist Theory. "Within constructivist fold, Cognitive Flexibility Theory offers an extension to the idea of the way we process new information, suggesting that we do not simply retrieve packets of old knowledge but we assemble them to form new realities which best relate to the learning material." (Kearsley, 1999)

According to Yuh-Tyng, 2011 the traditional way of teaching discourages active learning, and the slide show presentation in Cognitive flexibility strategy simply enlarges the passive nature of the instruction. Jacobson and Spiro (1995) also found Hypertext treatment (a method employed in the use of cognitive flexibility) to have promoted superior knowledge transfer and it helped students to use knowledge in new ways and in new situations. Mendes (2003) in her study on the application of the Cognitive Flexibility Theory (CFT) as an instructional theory to teach Web Engineering principles suggests that the CFT seems valuable for teaching Web engineering. Heath et al (2008) in their research support the assertion that

Cognitive Flexibility Theory-based environments promote greater knowledge acquisition and transfer than linear treatments of the same subject content.this is line with the submissions of Martin and Anderson (2009). This learning module served as an effective instructional intervention.

### 2.3.2b Cognitive Flexibility Strategy and Students' Attitude

Cognitive flexibility has been more broadly described as the ability to adjust one's thinking from old situations to new situations as well as the ability to overcome responses or thinking that have become habitual and adapt to new situations.

Regardless of the specificity of the definition, researchers have generally agreed that cognitive flexibility is a component of executive functioning, higher-order cognition involving the ability to control one's thinking. Executive functioning includes other aspects of cognition, including inhibition, memory, emotional stability, planning, and organization. Cognitive flexibility is highly related to a number of these abilities, including inhibition, planning and working memory. Thus, when an individual is better able to suppress aspects of a stimulus to focus on more important aspects, they are also more cognitively flexible. In this sense, they are better at planning, organizing, and at employing particular memory strategies.

Researchers have argued that cognitive flexibility is also a component of multiple classifications, as originally described by psychologist Jean Piaget. In multiple classification tasks, participants (those who have already developed or are in the process of developing this skill) must classify objects in several different ways at once - thereby thinking flexibly about them. Similarly, in order to be cognitively flexible one must overcome centration, which is the tendency to solely focus on one aspect of an object or situation.

Barhoumi et al (2013) reported that their study on The Effectiveness of Instruction-Oriented Hypertext Systems Compared to Direct Instruction in e-learning Environments revealed that there are significant differences between the experimental group and the control group, regarding the attitudes of students towards using flexible online course design based on cognitive flexibility hypertext theory and direct online course design.

### 2.3.2c Cognitive Flexibility and Students' Practices

A crucial aim of education is to help students learn as well as appropriately apply and adapt what they have learned to novel situations. Cognitive flexibility theory focuses on the nature of learning in complex and ill-structured domains. According to Siegler and Svetina (2002), as cited by Podjarny (2013), Cognitive flexibility is important for several social and cognitive skills, such as problem solving, creativity and perspective taking. However, cognitive flexibility has been shown to be a broad concept that can be studied with all different ages and situations. Thus, with tasks ranging from simple to more complex, research suggests that there is a developmental continuum that spans from infancy to adulthood. Martin and Anderson (2009) also found a positive relationship between cognitive flexibility and confidence in performing communication behaviour. Findings by Podjarny (2013) indicated that young children (some 4- and 5-year-olds) demonstrate concurrent cognitive flexibility skills in new matrix completion task in mathematics.

### 2.3.3 Conventional Strategy and Students Learning Outcomes

This is the oldest method of teaching used in most Nigerian schools. It is a traditional 'talk-chalk strategy. The teacher "gives out" the facts to the students and the students in turn listen and grasp the knowledge (Osokoya, 2002). The Conventional strategy /classroom lecture is a special form of communication in which voice, gesture, movement, facial expression, and eye contact can either complement or detract from the content (Davis, 2009). In addition, "lecture" courses certainly may include question-and-answer, if not discussion. It is often said that lecturing is a poor teaching method, a kind of last resort for instruction. Many lecturers, in fact, do not know how to impart information or stimulate interest effectively; consequently, their lectures are often poorly presented, badly organized, dull, and uninspiring. Lectures are a straightforward way to impart knowledge to students quickly. Instructors also have a greater control over what is being taught in the classroom because they are the sole source of information. Students are expected to take notes while listening to the lecture. Usually, very little exchange occurs between the instructor and the students during a lecture. Lecture is a teaching method where an instructor is the central focus of information transfer. The teacher delivers pre-planned lessons to the students

with little or no instructional aid or exposure to laboratory activities (Okoli, 2006). This method is teacher-centred where the instructor dominates the class, leaving learners uninvolved and passive. This method of teaching is not interactive and may render the set objectives unachievable (Adegbile, 2010; Aremu, 2010).

The predominant use of expository /lecture method in teaching Biology merely encourages students to memorize scientific concepts and principles which they regurgitate during examinations. Such memorized knowledge has little transfer value to novel situation outside the school context and does not promote creativity or sciences process skills acquisition in the learner (Okoli, 2006). The expository method of teaching is very popular and is widely used by Biology teachers to convey large volumes of scientific information to senior secondary school students in a bid to prepare them for the rigorous Senior School Certificate Examination (Okoli, 2006). Teachers refuse to change their conventional teaching style because of the limited time allotted to teaching, lack of infrastructural facilities, overloaded curriculum and lack of training programmes/workshops. Olagunju (2002) in her studies discovered that this may also be attributed to lack of skill in handling difficult concepts.

The current traditional pedagogical practices which are confined to transmitting information and involve telling, reading and memorizing, and characterized by the dominance of cognitive goals and teacher adopting the fountain of knowledge approach, have failed to cope with problems of development and national integration (Ajiboye and Ajitoni, 2007). These deficiencies of the teaching and learning situations in our schools have called for more alternating and more effective approaches that will provide an environment for growth (Ajitoni, 2005; 2007). The approaches should help students learn and participate actively in the learning process.

### 2.3.4 Gender and Students Learning Outcomes

Gender according to the Oxford Advanced Learners Dictionary refers to the fact of being male or female. Many researches have been carried out in the past on factors that affect the performance of students in science and science related subjects. Amongst other factors that have received attention are learner characteristics such as gender. Although the issue of gender and achievement in science is an important area that has involved a lot of researches, available results

have not yielded a conclusive trend in performance (Bilesanmi- Awoderu, 2002). For instance, Solomon (2004) has found significant gender – group difference (in favour of boys). Ebere (2006) reported in his study of Breaking Gender barrier on Achievement in STME, using hands-on-Mind-on-science, that students (boys and girls) who were exposed to science process based on learning activity oriented learning, utilizing students' manipulation of materials, yielded a more effective learning irrespective of gender than other students.

Also, some studies do not establish such differences or at most found gender group differences to some levels of education and some science topics only (Raimi and Adeoye, 2002). According to Owoyemi (2007), students' achievement in physical chemistry courses has nothing to do with attitude or whether the student is male or female. Ogunleye (2002) and Olatundun (2008) in their different research works revealed that female possessed more verbal commitment to the environment. Raimi and Adeoye (2002) research results showed that no significant effect(s) of gender and ability existed on science students' attitude. Ojo (2009) found a significant main effect of gender in favour of boys in their environmental attitude. Abiona (2008) also found that male students possessed higher environmental attitude score and practices than their female counterparts. There is, therefore, conflicting results from researches that focus on gender and science and science related subjects.

### 2.3.5 Cognitive Style and Student's Learning Outcomes

Cognitive styles refer to the preferred way individual process information. Styles describe a person's typical mode of thinking, remembering or problem solving. A number of cognitive styles have been identified and studied over the years. The cognitive style to be adapted in this study will be in line with that of Kirton's model of cognitive style Test (1976, 2003).This is one of the most popular models of cognitive style that was devised by Michael Kirton (1976, 2003). His model, called Adaption-Innovation (KAI) theory, claims that an individual's preferred approach to problem solving can be placed on a continuum ranging from high adaptation to high innovation. KAI theory is founded on the idea that each person is creative and solves problems (Kirton, 2003). It was developed in order to explain cognitive tendencies and problem-solving styles.KAI is chiefly concerned with cognitive style and determining how people solve problems. ). Kirton emphasized that the inventory is not designed to judge the level of creativity, or deem

one trait (adaptor or innovator) above the other. The goal is to describe the differences in order to foster unity and understanding among work groups/teams (Buffington et al., 2002). The manner in which each person solves problems varies. Adaption-innovation is a bipolar construct that helps define each person's preferred approach to problem solving (Hutchinson & Skinner, 2007).

He suggests that some human beings, called **adaptors** tend to prefer the adaptive approach to problem-solving, while others (**innovators**) prefer the reverse. Adaptors use what is given to solve problems by time-honoured techniques. Alternatively, innovators look beyond what is given to solve problems with the aid of innovative technologies. Kirton suggests that while adaptors prefer to do well within a given paradigm, innovators would rather do differently, thereby striving to transcend existing paradigms.

Kirton also invented an instrument to measure cognitive style (at least in accordance with this model) known as the Kirton Adaption-innovation Inventory (KAI). This requires the respondent to rate themselves against thirty-two personality traits. In the case of this study, the problem would be presented to the students and their response would be used to classify them to be either adaptors or innovators based on the characteristics of each group as presented by Kirton. Kirton described innovators as (a) seemingly undisciplined, approaching tasks from unsuspected angles, (b) treating accepted means with little regard in pursuit of goals, (c) capable of detailed tasks only in short bursts, (d) providing the dynamics to bring about periodic revolutionary change, and (e) having low self-doubt when generating ideas. Innovators are those who would prefer to do things differently. Kwang et al. (2005) postulated that innovators have a tendency to overhaul the entire work process. They are less concerned with acting in accordance with existing structures (Jabalokow & Booth, 2006)

Kirton originally defined adaptors with the follow descriptors: (a) concerned with solving problems rather than finding them, (b) seeking solutions to problems in tried and understood ways, (c) maintaining high accuracy in long spells of detailed work, (d) rarely challenging rules, (e) sensitive to maintaining group cohesion, and (e) providing a safe base for the innovator's riskier operations. Buffington (2002) noted that adaptors prefer more structure when problem solving. Kirton (1976) described adaptors as individuals who prefer to "do things better" and innovators as people who prefer to "do things differently." He postulated that understanding the

cognitive styles of adaptors and innovators would greatly enhance organizational cultures of change and diversity.

The manner in which students receive and process information has been found to be affected by their cognitive styles (Ige, 2001, Awolola, 2009). The result of the study conducted by Ige (2001) and Ogundiwin (2006) revealed that there was significant main effect of cognitive style on students' attitude towards environmental concepts. The habitual pattern identified by Wareing (1981) (as cited by Olagunju and Abiona, 2004) in his research Cognitive styles and Developing Scientific Attitude confirmed that Cognitive style significantly affect students' attitude, this in turn will affect individual knowledge and practices towards environment

## 2.4 Appraisal of Reviewed Literature

Literature reviewed shows that Anchored instruction and cognitive flexibility strategies engage students in higher order thinking skills which significantly affected critical thinking performance.

Literature reviewed indicated that Anchored instruction and cognitive flexibility strategies are educational tools that contribute to the creation of a powerful learning environment and allow the use of inert knowledge already developed by students. This will make them active participants and responsible citizens of the society, especially as it relates to the environment.

Literature reviewed showed that the manner in which students receive and process information has been found to be affected by their cognitive styles. Cognitive style refers to the individuals' orientation towards processing data, which is not immutable but modifiable through educative experiences.

Literature reviewed revealed that Research on thinking skills indicates that students' behavioral dispositions do not change in the short term, but cognitive skills can be developed over a relatively short period of time. Specifically, significant changes in student tendency to seek truth and confidence in thinking occurred during the junior and senior years.

Literature reviewed indicated that no study has been carried out on the effects of Anchored instruction and cognitive flexibility strategies on students' achievement and attitude towards Environmental Education concepts in Biology.

Furthermore, the review stated the need to use these novel metacognitive teaching strategies - Anchored instruction and Cognitive flexibility - to enhance students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices which are essential aspects of environmental education. The review also examined students' cognitive styles and gender with their learning outcomes. Therefore, the present study will include gender and cognitive styles as moderating variables to be investigated.

# CHAPTER THREE

# METHODOLOGY

This chapter presents the methods and procedure adopted in this study. It describes the research design, variables of the study, selection of participants, research instrument, procedure for the validation of the instrument, procedure for data collection and methods of data analysis.

## 3.1 Research Design

This study is an experimental research and so adopted a pretest, posttest control group, quasi experimental design to investigate the effect of anchored and cognitive flexibility instructional strategies on secondary school students' knowledge, attitude and practices in Biology in Ibadan, Nigeria. The study further determined the influence of gender and cognitive style on subjects' knowledge, attitude and practices to environmental issues and concepts in Biology.

The design is schematically represented as follows:

$0_1$ $X_1$ $0_2$ $(E_1)$

$0_3$ $X_2$ $0_4$ $(E_2)$

$0_5$ $X_3$ $0_6$ $(C)$

Where

$0_1$, $0_3$ and $0_5$ represent pre- test observations across the groups

$0_2$, $0_4$ and $0_6$ represent post-test observations across the groups

$X_1$ represents treatment on experimental group 1 (Anchored Instruction Strategy) $(E_1)$

$X_2$ represents treatment on experimental group 2 (Cognitive Flexibility Strategy) $(E_2)$

$X_3$ represents treatment on the control group (Modified Conventional Strategy) (C)

This shows that there are two experimental groups and one control group. The experimental groups were exposed to the learning strategies (anchored instruction strategy and cognitive flexibility strategy) while the control group were taught through the modified conventional method.

A 3 X 2 X 2 factorial matrix was also adopted with instructional strategy as treatment at three levels (cognitive flexibility, anchored instruction and modified conventional method), gender at two levels (male and female) and cognitive style at two levels (adaptors and innovators).

The factorial matrix (the analytical design) of the study is represented in the table below.

Table 3.1: Schematic Representation of the Matrix

| Treatment/strategies | Cognitive style | Gender | |
|---|---|---|---|
| | | Male | Female |
| Cognitive flexibility strategy | Adaptors | | |
| | Innovators | | |
| Anchored instruction | Adaptors | | |
| | Innovators | | |
| Modified Conventional Method | Adaptors | | |
| | Innovators | | |

## 3.2 Variables of the Study

The variables in this study are the following.

(a) Independent variable: This is the instructional strategy (treatment) at three levels.

- Anchored instruction Strategy
- Cognitive flexibility Strategy
- Modified Conventional Strategy

(b) Moderator Variables

- Gender (Male and Female)
- Cognitive style (Adaptors and Innovators)

(c) Dependent Variables: These are students' learning outcomes, which are

- Knowledge of environmental concepts
- Attitude to environmental problems
- Environmental practices

These variables are represented in the figure 3.1

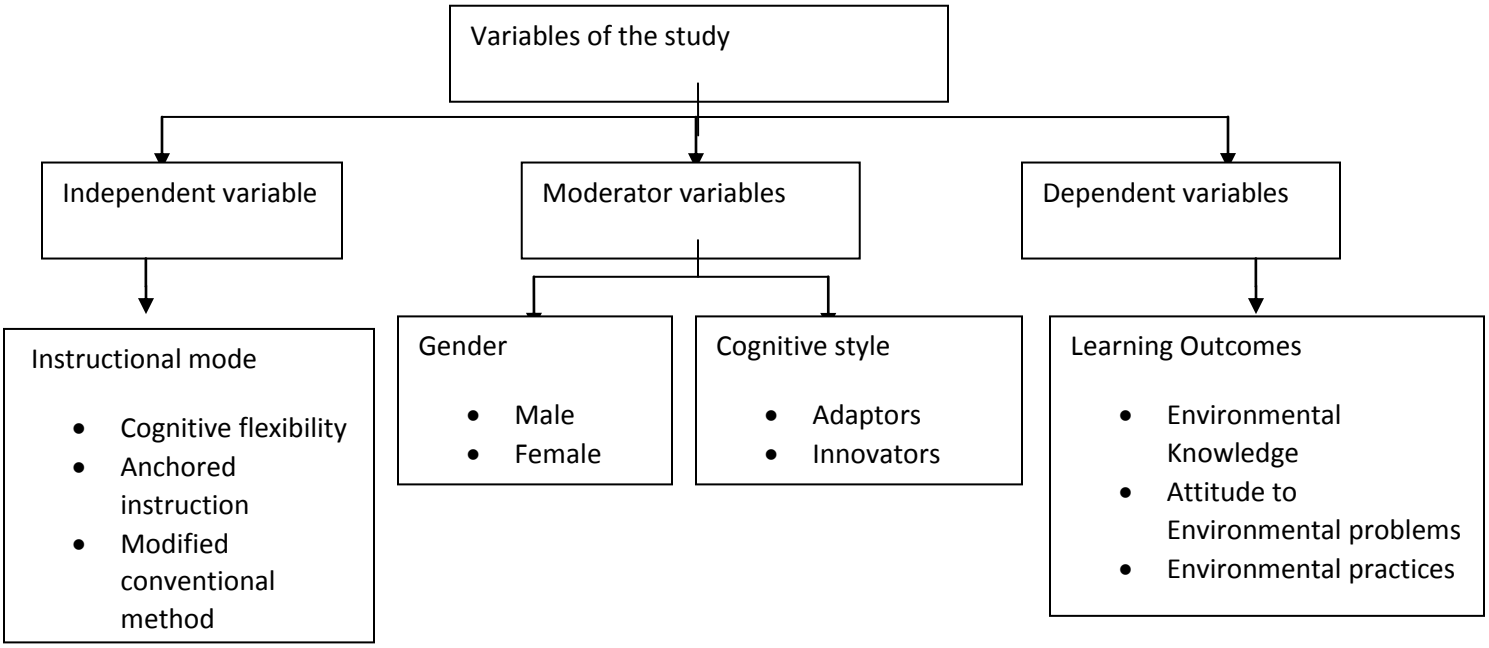


Figure 3.1: Diagrammatic illustration of the variables

## 3.3 Selection of Participants

Three local government areas were randomly selected from the eleven local government areas in Ibadan metropolis, from which nine secondary schools were purposively selected for the study.

The selection of schools was based on the following criteria:

- Must be co-education schools
- Must have evidence of presenting students for SSCE Biology examination for at least five (5) years
- Availability of experienced Biology teachers with at least three years teaching experience and ability to operate and use the computer.
- Evidence of SS II students of the schools having been exposed to basic pre-requisite environmental concepts necessary for the understanding of the concepts of the study
- Easy accessibility of the schools.
- Evidence of modern learning facilities such as computers.

The purposive sampling technique was used to assign the schools to experimental and control groups for the study. This was to ensure that the schools to be used satisfy the criteria for selection of the schools especially the experimental groups. Three schools fell into each of the experimental groups (I&II) and three schools were used as the control groups. The Biology teachers from each of the schools were trained as research assistants for the purpose of this research.

## 3.4 Selection of Concepts for the Study

The concept for this research was taken from SS II Senior Secondary Certificate Education Biology syllabus. The selection of these concepts was based on current environmental problems and issues prevalent in Nigeria. These included

1. Environmental problems: Deforestation, soil erosion, flooding, pollution, population issues and problems, waste generation and management.
2. Sustainable development and conservation
3. The human environment; resources; biodiversity, ecosystem.
4. Pressures on the environment: what human does to the environment?

5. Conservation and management of Natural resources in Nigeria.

### 3.5 Research Instruments

Ten instruments were designed and used by the researcher in this study. These are:

(a) Students' Knowledge of Environmental concept Test (SKECT)

(b) Students' Environmental Attitude Scale (SEAS)

(c) Students Perceived Environmental Practices Scale (SPEPS)

(d) Cognitive Style Test (CST)

(e) Instructional Guide for Teaching with Anchored Instructional Strategy (IGTAIS)

(f) Instructional Guide for Teaching with Cognitive Flexibility Strategy (IGTCFS)

(g) Instructional Guide for Teaching with Conventional Strategy (IGTCMS)

(h) Evaluation Sheet for Assessing Teachers (ESAT) for Cognitive Flexibility Strategy (IGTCFS)

(i) Evaluation Sheet for Assessing Teachers (ESAT) for Anchored Instructional Strategy (IGTAIS)

(j) Evaluation Sheet for Assessing Teachers (ESAT) for Modified Conventional Strategy (IGTCMS)

#### 3.5.1 Students' Knowledge of Environmental Concept Test (SKECT):

The instrument consists of two sections. The first section obtained background information from the respondents. The second section is made up of twenty multiple-choice objective test items. Each item has four options (A-D) and was designed based on the school syllabus and curriculum to test the level of acquisition of knowledge in Environmental concepts and students' application of knowledge attained to their everyday life. It was also designed to know how well students can express their understanding of the Environmental concepts in relation to their personal and societal needs. The instrument covered topics such as environment, natural resources, conservation, pollution, solid wastes, erosion, desertification and deforestation.

Table 3.2: Table of Specification for SKECT

| Topics | Knowledge | Comprehension | Thinking | Total |
|---|---|---|---|---|
| Environment | 3 (1, 3, 20) | 1 (2) | 1(11) | 5 |
| Conservation Of Natural resources | 1 ( 15) | 2(4, 13) | 2 (9,12) | 5 |
| Pollution | | 3 (6, 18, 19) | 2 (5, 10) | 5 |
| Erosion | - | 1 (14) | - | 1 |
| Desertification | - | 2 (7, 8) | 2(16, 17) | 4 |
| Total | 4 | 9 | 7 | 20 |

Nowadays, a considerable amount of attention is given to students' abilities to think critically about what they do. Table 3.2 therefore was developed in accordance with Okpala and Onocha (1995) format in which the six levels of Bloom's taxonomy have been reduced to three levels. This was done in order to show the level of thinking skills that is expected by the students for learning, retaining and applying information obtained in the process of learning.

**Validation of SKECT**

To validate the instrument, past WAEC questions related to environmental issues were selected as items used in the questionnaire. Two Biology teachers who are actively involved in teaching secondary school students in two schools other than those used for the study were asked to do both face and content validation of the questions to ensure that the items were suitable for SS II students. An experienced University lecturer in Biology further subjected the items to review. The areas considered included the scope, content relevance, ambiguity, vagueness of the items. The draft items were then presented to two lecturers from the University of Ibadan who are experts in Environmental Education. They determined the suitability of the instrument for the

target population in terms of clarity; breath and language, avoiding ambiguity of language, how wordy and easy to comprehend the instrument was by the target audience. This initial test of 30 items was then trial tested on students other than those to be involved in the main study. The data obtained were subjected to test to ensure its reliability using Kuder Richardson formula (Kr20) and a reliability coefficient of 0.83 was obtained. This shows that the instrument was reliable. The difficulty index was calculated and items with average difficulty index (0.40-0.75) and items that were easy (difficulty index of >0.75) were retained in the instrument while the very difficult ones were removed. This indicated that the items of the instrument were neither too difficult nor too simple. (See Appendix IA, page 178)

### 3.5.2 Students' Environmental Attitude Scale (SEAS):

The instrument consisted of two sections. The first section of the instrument obtained background information from the respondents. The second section of the instrument consisted of twenty items on students environmental attitudes. The items contained equal numbers of positive and negative items reflecting certain attitudinal disposition. The attitude scale used consists of a set of statements on four point Likert type ordinal scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (D) 2, to Strongly Disagree (SD) 1. Each item was designed to test the students' sense of responsibility towards the environment and how they as students could, through their attitude, show how much of environmental education ethics has been inculcated in them in order to conserve natural resources and solve environmental problems around them. Each of the respondents was required to tick the appropriate option as stated above for positively worded items and negatively worded items. (See Appendix II, page 182)

### Validation of SEAS

Two Biology teachers and two lecturers who are actively involved in teaching were asked to do both face and content validation and relevance of the questions to the purpose of research. The initial draft containing 35 items was reduced to 20 in the final draft by the experts. Cronbach Alpha reliability co-efficient of 0.88 was obtained when the SEAS instrument was trial tested on a group of Biology students who were not part of the target population to ensure that the instrument measured what it was set out to measure.

### 3.5.3 Students' Perceived Environmental Practices Scale (SPEPS)

This instrument structured by the researcher was used to obtain information on students' environmental practices. It consists of two sections. Section A of the instrument obtained background information from the respondents such as name of school of the participants, the class and gender. Section B of the instrument consisted of fifteen items on students perceived environmental practices. It assessed the participants' practices on environmental concepts such as environment, pollution, erosion, deforestation and conservation. The scale used consisted of a set of statement based on four point Likert scale of: Very often (VO) , Often (O), Seldom (S) , and Never (N) . The scoring of SEPS is as follows**:** Very Often (VO) - 4 marks, Often (O)- 3 marks, Seldom (S) – 2 marks, Never (N) – 1 mark for positively worded statement while the reverse was used for negatively worded statements i.e. Very Often (VO) - 1 mark, Often (O)- 2 marks, Seldom (S) –3 marks, Never (N) – 4 marks. (See Appendix III, page 185)

**Validation of SPEPS**

Two Biology teachers and an expert in Environmental Education were asked to do both face and content validation of the questions to ensure that the items were suitable for the students. The instrument was then trial tested to ensure its reliability using Cronbach co-efficient alpha, which gave 0.82. This shows that all the items in this instrument were reliable.

### 3.5.4 Cognitive Style Test (CST)

The cognitive style adapted in this study was the Kirton's model of cognitive style Test (1976, 2003). It is one of the foremost and popular models of cognitive style to measure problem solving, team work and creativity. His model, called Adaption-Innovation theory, claims that an individual's preferred approach to problem solving, can be placed on a continuum ranging from high adaptation to high innovation. Kirton Adaption-Innovation Inventory (KAI) theory is founded on the idea that each person is creative and solves problems (Kirton, 2003). It was developed in order to explain cognitive tendencies and problem-solving styles.KAI is chiefly concerned with cognitive style and determining how people solve problems. Kirton emphasized that the inventory is not designed to judge the level of creativity, or deem one trait (adaptor or

innovator) above the other. The goal is to describe the differences in order to foster unity and understanding among work groups/teams (Buffington, 2002). The manner in which each person solves problems varies. Adaption-innovation is a bipolar construct that helps define each person's preferred approach to problem solving (Hutchinson and Skinner, 2007).

Kirton suggests that some human beings, called adaptors, tend to prefer the adaptive approach to problem-solving while others (innovators), of course, prefer the reverse. Adaptors use what is given to solve problems by time-honoured techniques. Alternatively, innovators look beyond what is given to solve problems with the aid of innovative technologies. Kirton suggests that while adaptors prefer to do well within a given paradigm, innovators would rather do differently, thereby striving to transcend existing paradigms.

Kirton also invented an instrument to measure cognitive style (at least in accordance with this model) known as the Kirton Adaption-innovation Inventory (KAI). This requires the respondent to rate themselves against thirty-two personality traits. In the case of this study, the problem was presented to the students as pictures and their responses were used to classify them to be either adaptors or innovators, based on the characteristics of each group as presented by Kirton.

Students were expected to give some of the following suggestions as their answers

1a. The name of the problem observed in each picture (1 x 3marks)

1b Suggest possible solutions to the problem [novel ideas (3points @ 2marks each) = 6marks; conventional ideas (3 points @1 mark each) =3marks)

1c Suggest the materials needed such as the use of waste pickup truck, the use of chemicals, Supply of dustbins, making laws and stating specific punishment for defaulters, giving out the materials to companies for recycling, burning in pits or incinerators, dumping wastes in the waste disposal bins in the public places for proper, disposal by the collecting agents and inviting scientists / engineers with new ideas on the use of chemicals for proper waste disposal. (Any 3 suggestions @ 2 marks each = 6marks). (See Appendix IVA, page 187)

**Validation of CST**

The CST was used to classify the students into 'adaptors' and 'innovators' based on their answers as regarding the way they perceive the pictures presented to them and the solutions proffered by them for the problems posed. The total score for the test based on the set criteria was 15 marks. Students with marks ≤ 7 were categorised as adaptors while those with marks >7 were categorised as innovators. CST was validated using the split half reliability method and a reliability of 0.89 was obtained.

### 3.5.5 Instructional Guide for Teaching with Anchored Instructional Strategy (IGTAIS)

This is an instructional guide for teachers participating in the experimental group 1. It contains the statement of topic, objectives and the procedure expected to be followed by the teachers in teaching of EE concepts during Anchored Instruction. This was prepared and used in the training of teachers to allow for uniformity in the teaching method. This instrument was validated using Scott Pi's inter-rater reliability index and the value 0.81 was obtained which shows substantial agreement between the raters, making the instrument reliable for use. (See Appendix VA, page 190)

### 3.5.6 Instructional Guide for Teaching with Cognitive Flexibility Strategy (IGTCFS):

This is an instructional guide for teachers participating in the experimental group 2. It contains the statement of topic, objectives, instructional materials and the procedure expected to be followed by the teachers in teaching of EE concepts in the classroom using the cognitive flexibility method **(IGTCFM)**. This was prepared and used in the training of teachers to allow for uniformity in the teaching method. This instrument was validated using Scott Pi's inter-rater reliability index and the value 0.75 was obtained which shows substantial agreement between the raters, making the instrument reliable for use. (See Appendix VIA, page 206)

### 3.5.7 Instructional Guide for Teaching with Modified Conventional Strategy (IGTMCS):

This is an instructional guide for teachers participating in the classroom using the conventional method/lecture method of teaching. It contains the statement of topic, objectives, instructional materials and the procedure expected to be followed by the teachers in teaching of

EE concepts in the classroom. This was prepared and used in the training of teachers to allow for uniformity in the teaching method. This instrument was validated using Scott Pi's inter-rater reliability index and the value 0.70 was obtained which shows substantial agreement between the raters, making the instrument reliable for use. (See Appendix VIIA, page 222)

### 3.5.8 Evaluation Sheet for Assessing Teachers (ESAT):

Three evaluation sheets/ instruments were designed to be used in evaluating the teachers in the various groups (cognitive flexibility, anchored instruction and modified conventional method) to assess the effective use of the instructional guides during the teaching process. It shows their presentation of concepts, mastery of the topics, use of materials and activities as directed and how effective their presentation was for the mastery of concepts by the students. (See Appendix VIII, page 238)

### 3.5.9 Rubrics for the Anchored and Cognitive Flexibility Instructional Strategy Compact Disc (CD)

A rubric is a scoring tool that explicitly represents the performance expectations for an assignment or piece of work. A rubric divides the assigned work into component parts and provides clear descriptions of the characteristics of the work associated with each component, at varying levels of mastery.

Rubrics make work assessment quick and efficient, and they help teachers justify the development and use of some sophisticated instructional tools to develop sophisticated critical thinking skills in students. When used correctly, they serve the purposes of learning as well as of evaluation and accountability. Although the format of an instructional rubric can vary, all rubrics have two features in common: (1) a list of criteria, or "what counts" in a project or assignment; and (2) gradations of quality, with descriptions of strong, middling, and problematic student work.

In addition, the gradations of quality help to see clearly what the weakness of the material is, the adjustment that needed to be made in order to get it to an acceptable standard for the expected result.

For the purpose of this study, the rubrics were used for the qualitative validation of the powerpoint presentations in the two experimental groups (Anchored instruction and cognitive flexibility strategies). The power point CDs were first assessed by some students outside of those for the main study to know if any meaningful learning can take place if used. With the informative feedback about the weakness, strengths and areas in need , the draft was revised and then also assessed by teachers and some education technology students and lecturer who graded it using the rubrics. In an ideal situation, a total score of 30 was expected which shows a 100% approved quality, but in real life situation, a 70- 85% still shows an acceptable standard. The assessment gave 80% standard quality which was acceptable as being valid before it was finally used for the study.

## Table 3.3: RUBRICS FOR THE POWER POINT

| CATEGORY | 4 | 3 | 2 | 1 | POINTS |
|---|---|---|---|---|---|
| **Effectiveness** | Project includes all material needed to gain a comfortable understanding of the topic. | Project includes most material needed to gain a comfortable understanding of the material but is lacking one or two key elements. | Project is missing more than two key elements. | Project is lacking several key elements and has inaccuracies. | |
| **Sequencing of Information** | Information is organized in a clear, logical way. It is easy to anticipate the type of material that might be on the next slide. | Most information is organized in a clear, logical way. One slide or item of information seems out of place. | Some information is logically sequenced. An occasional slide or item of information seems out of place. | There is no clear plan for the organization of information. | |
| **Originality** | Presentation shows considerable originality and inventiveness. The content and ideas are presented in a unique and interesting way. | Presentation shows some originality and inventiveness. The content and ideas are presented in an interesting way. | Presentation shows an attempt at originality and inventiveness on 1-2 slides. | Presentation is a rehash of other people's ideas and/or graphics and shows very little attempt at original thought. | |
| **Spelling and Grammar** | Presentation has no misspellings or grammatical errors. | Presentation has 1-2 misspellings, but no grammatical errors. | Presentation has 1-2 grammatical errors but no misspellings. | Presentation has more than 2 grammatical and/or spelling errors. | |
| **Use of Graphics** | All graphics are attractive (size and colors) and support the theme/content of the presentation. | A few graphics are not attractive but all support the theme/content of the presentation. | All graphics are attractive but a few do not seem to support the theme/content of the presentation. | Several graphics are unattractive AND detract from the content of the presentation. | |
| **Organization** | All parts of the task are completed fully and support the theme/content of the presentation. | All parts of the task are completed partially and support the theme/content of the presentation. | Some slides designed do not support the theme/content of the presentation. | Several parts of the task are missing. Slides designed do not support the theme/content of the presentation. | |

## 3.6 RESEARCH PROCEDURE

Procedure for data collection was divided into three phases; pre-treatment phase, treatment phase and post-treatment phase as shown in Figure 3.2

Figure 3.2 is a diagrammatic representation of the three phases of the research procedure.

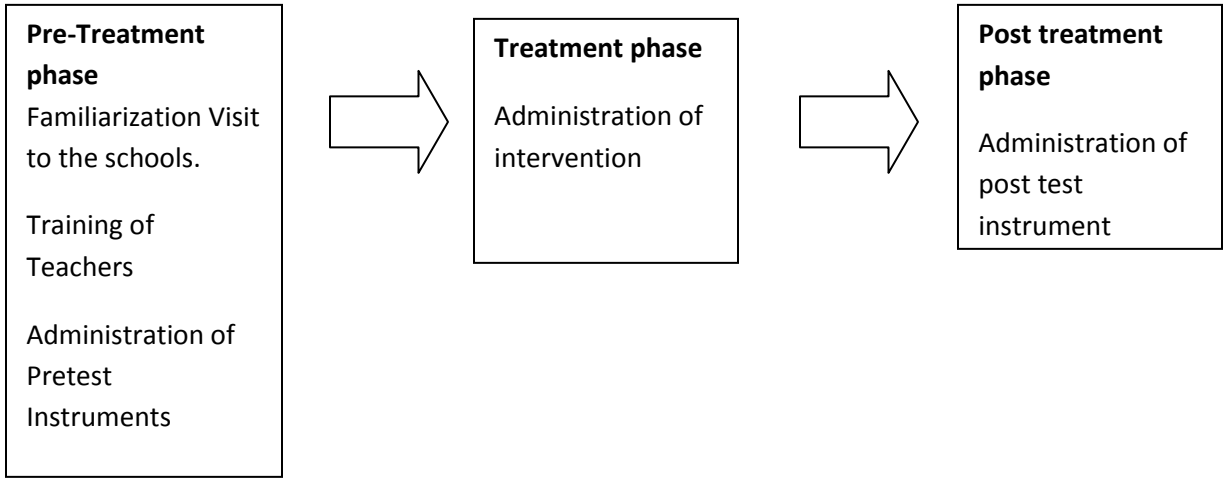


**Figure 3.2: Diagram showing the phases of research procedure**

### 3.6.1 Pre-treatment Phase

This Phase lasted for four (4) weeks. The first week was used for familiarization visits to the selected schools with introductory letters that was obtained from the Department of Teacher Education, University of Ibadan, for the formal introduction of the researcher to the appropriate school heads and Biology teachers who were to be research assistants for the study. In the second week, the Biology teachers were trained using the instructional guide and CD that the students were to use during treatment. In the third week, the teachers were scrutinized to be sure they were familiar with the use of the strategy. The fourth week was used for the administration of pre test instruments in each of the schools by the research assistants. Copies of the selected schools' Biology time-tables were also obtained to enable the Researcher to properly plan the administration of treatment before data collection.

### 3.6.2 Training of Teachers

The researcher took time to train the teachers in the use of the teacher's guide provided so as to have uniformity. The areas of disparity of ideas were discussed and the reasons the guide should be used as expected was explained. The teachers were trained to teach with the Instructional Guides (IGTAI and IGTCFM) in the Experimental Groups and IGTMCM in the control groups.

### 3.6.3 Pre test

The instruments (SEAS, STECKB, SPEPS and CST) were administered to the students to test their level of acquisition of knowledge of environmental education concepts in Biology so as to be able to compare the effect of the treatment on them. The pre-test was administered to the various groups (experimental and control) in all the schools involved in this study in the following order : Students' Environmental Attitude Scale (SEAS) followed by Students' Environmental Concept Knowledge test in Biology (SECKT), Students' Perceived Environmental Practices Scale (SPEPS) and Cognitive Style Test **(**CST).

### 3.6.4 Treatment Phase

The students were subjected to the conventional method of teaching, cognitive flexibility and anchored instructional strategies by their Biology Teachers. The modified conventional method involves the use of lecture method while the experimental groups used both the lecture method, charts, pictures alongside with the use of computer presented hypertext (for experimental group 1) and anchors (for experimental group 2) to enhance their knowledge of the concepts that they were being taught. The treatments were carried out on all the SSII students in all the representative schools on the experimental and control groups. During this period, students were taught various aspects of the environmental concepts (air, water, land pollution and conservation of natural resources) by the research assistants, using the three strategies.

### 3.6.4a Experimental group A: Anchored Instructional Strategy

Step 1 – The class was divided into small groups with 5-6 students in each group.

Step 2 – The 'Anchor' (the subject matter) was presented in a realistic situation using power point slides.

Step 3 – Research assistant encouraged student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students were encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students developed solutions and discussed in groups before presenting ideas to the class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

**3.6.4b Experimental group B: Cognitive Flexibility Strategy**

The steps followed in using this method are as follows:

Step 1 – The class was divided into small groups with 5-6 students in each group.

Step 2 – The multiple hypertext representations of content was presented using power point slides.

Step 3 – The groups were encouraged to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students were encouraged to study the slides with emphasis on knowledge construction and not transmission of information.

Step 5 - Students developed solutions and discussed in groups before presenting ideas to the class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discussed the misconceptions of ideas and arranged the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

### 3.6.4c Modified Conventional Strategy

The steps include;

Step 1: The teacher introduced the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

The students were taken through the lessons of forty minutes duration each and this lasted for eight weeks.

### 3.6.5 Post Treatment Phase

The tests were administered on the subjects after the various treatments with the help of their Biology teachers in the school. The students' scripts were collected and marked by the researcher. The scores were used to determine the extent of the effect of anchored and cognitive flexibility instructional strategies on students' acquisition of knowledge, attitude and practices in environmental concepts in Biology.

## 3.7 Data Analysis

Data collected were analyzed using descriptive statistics, such as mean and standard deviation. Inferential statistics - Analysis of Covariance (ANCOVA) was carried out on the post test scores with the pre test scores as covariates. Estimated Marginal Means was used to determine estimated marginal means of the different groups. Scheffe post hoc test was used to determine where significant main effects were obtained.

# CHAPTER FOUR

## RESULTS AND DISCUSSION

The result of this study and the summary in the tables are hereby presented in this chapter using the research hypotheses as guide.

### 4.1.1 DESCRIPTIVE STATISTICS ASSOCIATED WITH TREATMENT

Table 4.1 displays the descriptive statistics of the students' knowledge, attitude and practices scores. It comprises the mean score, standard deviation and number of students involved in the research.

**Table 4.1: Summary of Descriptive Statistics Associated with Treatment**

| | **Knowledge scores** | | | **Attitude scores** | | | **Practices scores** | | |
|---|---|---|---|---|---|---|---|---|---|
| | AIS | CFS | MCS | AIS | CFS | MCS | AIS | CFS | MCS |
| No. of cases | 145 | 151 | 128 | 145 | 151 | 128 | 145 | 151 | 128 |
| Pre test Mean | 12.67 | 12.97 | 11.34 | 61.80 | 61.17 | 58.31 | 47.14 | 47.88 | 47.45 |
| Pre test S.D | 4.14 | 3.50 | 3.31 | 5.39 | 6.38 | 8.29 | 6.34 | 7.97 | 7.31 |
| Posttest Mean | 18.68 | 13.95 | 9.27 | 63.22 | 63.97 | 61.36 | 50.46 | 48.15 | 48.12 |
| Posttest S.D | 1.28 | 3.65 | 2.36 | 5.13 | 6.59 | 5.41 | 5.30 | 5.93 | 5.90 |
| Mean Gain | 6.01 | 0.98 | -2.07 | 1.42 | 2.8 | 3.05 | 3.32 | 0.27 | 0.67 |

- AIS – Anchored Instructional Strategy
- CFS – Cognitive Flexibility Strategy
- CS – Conventional Strategy
- S.D – Standard Deviation

A detailed study of the Table reveals that in knowledge acquisition, the mean score of the modified conventional strategy group was less than that of experimental group II (Cognitive flexibility strategy) and experimental group I (Anchored instructional Strategy). The post test scores improved for Anchored Instructional Strategy in knowledge, attitude and practices scores with 6.01, 1.42 and 3.32 respectively. Similarly, Cognitive Flexibility Strategy post test scores showed improvement with 0.98, 2.8 and 0.27 respectively. In the case of modified conventional strategy, the posttest scores do not show improvement for knowledge of environmental concepts but there were slight improvements for attitude and practices scores.

Figures 4.1, 4.2 and 4.3 display the bar charts of the magnitude of descriptive statistics of the students' knowledge; attitude and practices scores associated with treatment and the control groups as presented earlier in Table 4.1.

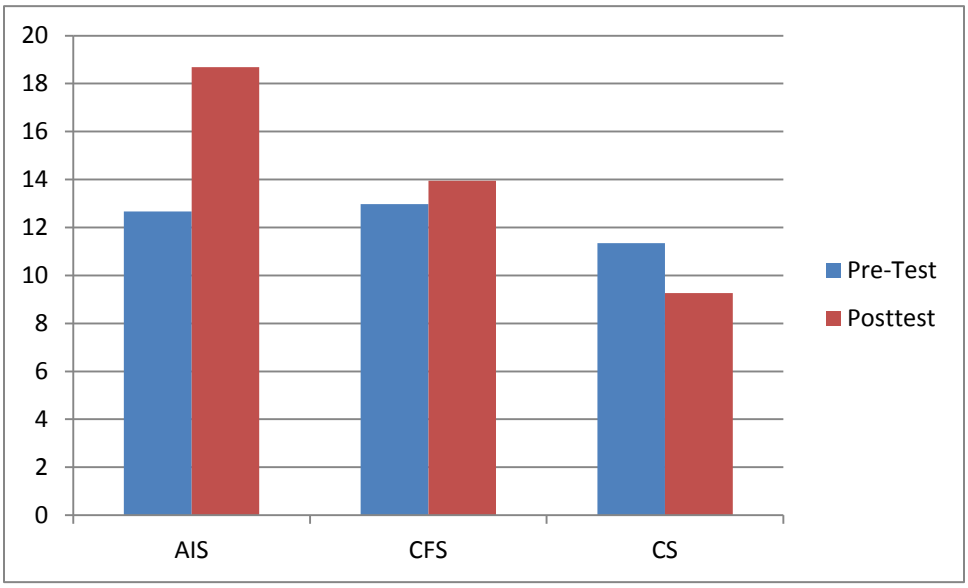


**Fig 4.1: Bar Chart Showing Descriptive Statistics Associated with Treatment on Knowledge of Environmental Concepts Mean Scores.**

- AIS – Anchored Instructional Strategy
- CFS – Cognitive Flexibility Strategy
- CS – Conventional Strategy

In figure 4.1, a bar chart showing descriptive statistics associated with treatment on environmental knowledge mean scores reveal at a glance a clear picture that both strategies used as treatment (Anchored Instructional Strategy and Cognitive Flexibility Strategy) improved the

students' knowledge of environmental concepts while there was no improvement for the control group. However, there was the need for further statistical clarification, using the Analysis of Covariance - an inferential statistical method to test the hypotheses in order to show if the difference in the mean scores were significant or not. It was also used to partial out the initial differences that may exist between the groups, since intact classes were used.

Figure 4.2 presents the bar chart of the descriptive statistics of students with respect to environmental attitude.

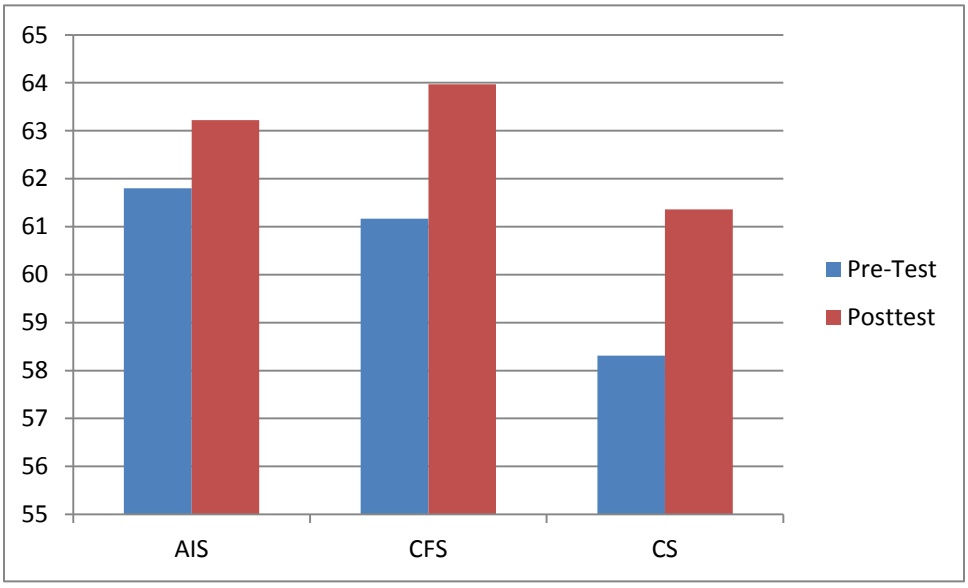


**Fig 4.2: Bar Chart Showing Descriptive Statistics Associated with Treatment on Attitude Mean Scores.**

- AIS – Anchored Instructional Strategy
- CFS – Cognitive Flexibility Strategy
- CS – Conventional Strategy

**Figure 4.3 presents the bar chart of the descriptive statistics of students with respect to environmental practices**

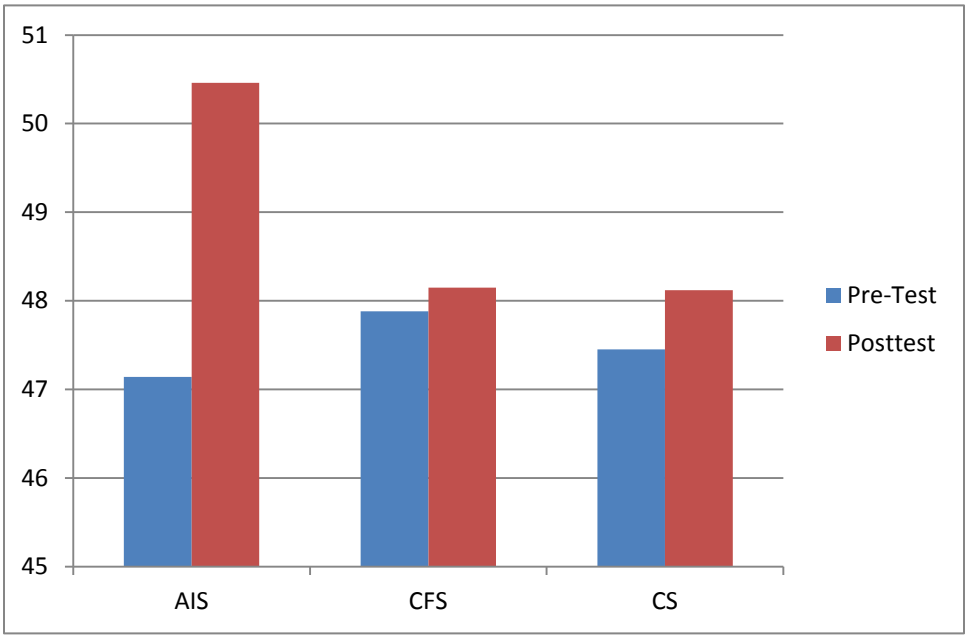


**Fig 4.3: Bar Chart Showing Descriptive Statistics Associated with Treatment on Environmental Practices Mean Scores.**

- AIS – Anchored Instructional Strategy
- CFS – Cognitive Flexibility Strategy
- CS – Conventional Strategy

A detailed study of the chart revealed that with respect to environmental practices of students in relation to the environment, the total mean score of the experimental groups was greater than that of the control groups.

### 4.1.2. Descriptive Statistics Associated with Gender

Table 4.2 displays the descriptive statistics of the students' knowledge, attitude and practices scores with gender.

**Table 4.2: Summary of Descriptive Statistics Associated with Gender**

| | Knowledge scores | | Attitude scores | | Practices scores | |
|---|---|---|---|---|---|---|
| | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE |
| No of cases | 240 | 184 | 240 | 184 | 240 | 184 |
| Pre-test mean | 12.50 | 12.21 | 60.44 | 60.62 | 47.39 | 47.64 |
| Pre-test S.D | 3.84 | 3.60 | 7.04 | 6.64 | 7.20 | 7.30 |
| Posttest mean | 14.41 | 13.82 | 63.04 | 62.77 | 48.80 | 49.10 |
| Posttest S.D | 4.54 | 4.68 | 5.73 | 6.04 | 5.70 | 5.95 |
| Mean Gain | 1.91 | 1.61 | 2.60 | 2.15 | 1.41 | 1.46 |

S.D – Standard Deviation

Data in table 4.2 show that the male students performed better than their female counterparts in knowledge of and attitude to environmental concepts in Biology while the female scored higher in environmental practices.

Further statistical clarification on the differences in the scores to show whether they are significant or not was needed. Therefore, Analysis of Covariance - an inferential statistical method was used to test the hypotheses in order to show if the difference in the mean scores were significant or not. The mean gains in descending order are male students had higher mean gain than female students.

Figures 4.4, 4.5 and 4.6 displayed the bar charts showing the magnitude of descriptive statistics of the students' achievement, attitude and practices scores associated with gender as presented in Table 4.2.

**Figure 4.4 is the bar chart showing descriptive statistics associated with knowledge by to gender.**

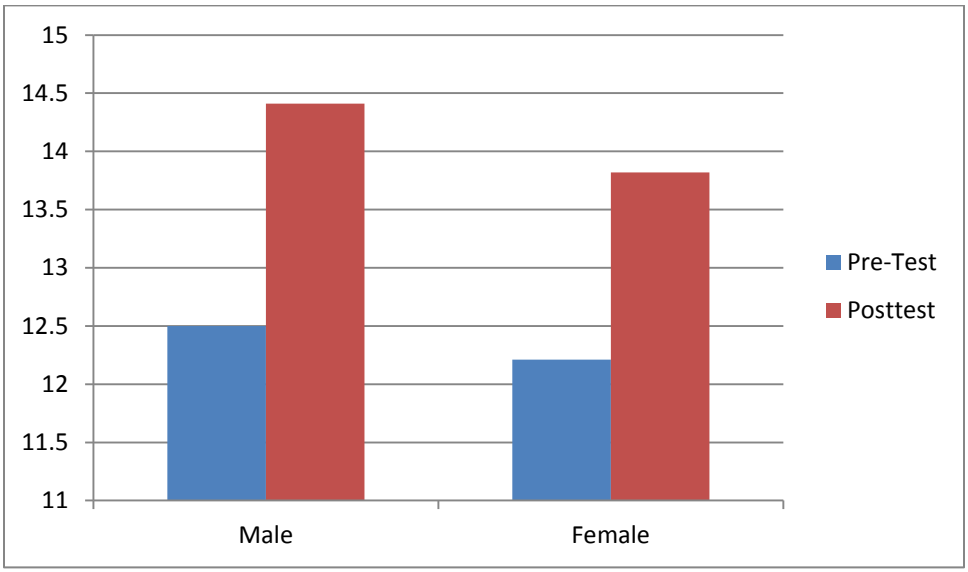


**Fig 4.4: Bar Chart Showing Descriptive Statistics Associated with Knowledge by Gender**

There were improvements in male and female posttest knowledge scores 1.91 (Pretest mean = 12.50, Posttest mean =14.41) and 1.61 (Pretest mean =12.21, Posttest mean =13.82) respectively.

**Figure 4.5 is the bar chart showing descriptive statistics associated with attitude by to gender.**

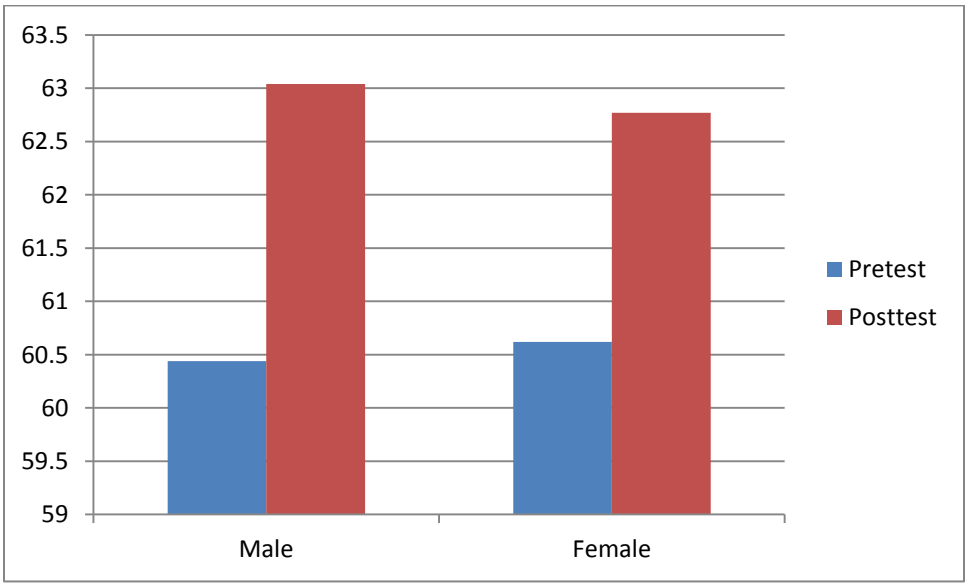


**Fig 4.5: Bar Chart Showing Descriptive Statistics Associated with Attitude by Gender**

There were no improvements in male and female posttest attitudinal scores -3.89. (Pretest mean =60.46, Posttest mean = 56.57) and -2.14. (Pretest mean =59.65, Posttest mean = 57.15) respectively.

**Figure 4.6 is the bar chart showing descriptive statistics associated with practices by to gender.**

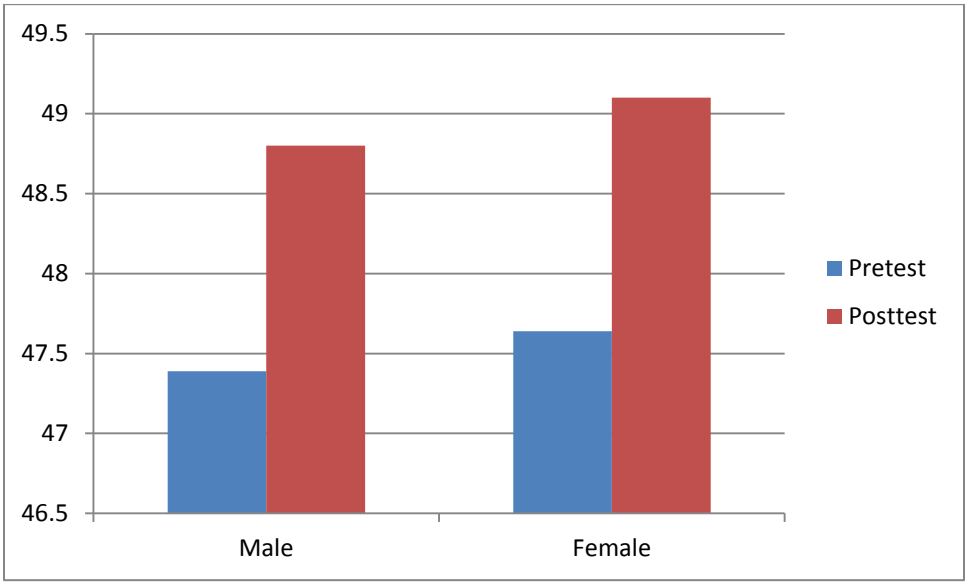


**Fig 4.6: Bar Chart Showing Descriptive Statistics Associated with Practices by Gender**

In Figure 4.6, there were improvements in male and female practices scores 1.41 (Pretest mean =47.39, Posttest mean = 48.80) and 1.46 (Pretest mean = 47.64, Posttest mean = 49.10) respectively. These gains in mean scores were subjected to further statistical clarifications to test if they are significant or not.

### 4.1.3: Descriptive Statistics Associated with Cognitive Style

Table 4.3 displays the descriptive statistics of the student's knowledge, attitude and practice scores associated with cognitive style.

**Table 4.3: Summary of Descriptive Statistics Associated with Cognitive Style**

| | **Knowledge scores** | | **Attitude scores** | | **Practice scores** | |
|---|---|---|---|---|---|---|
| | Innovators | Adaptors | Innovators | Adaptors | Innovators | Adaptors |
| No of cases | 208 | 216 | 208 | 216 | 208 | 216 |
| Pre-test mean | 13.11 | 11.67 | 61.72 | 59.37 | 47.68 | 47.32 |
| Pre-test S.D | 3.48 | 3.85 | 6.44 | 7.08 | 7.69 | 6.78 |
| Posttest mean | 14.69 | 13.64 | 63.92 | 61.97 | 49.08 | 48.79 |
| Posttest S.D | 4.47 | 4.69 | 5.47 | 6.07 | 5.78 | 5.84 |
| Mean Gain | 1.58 | 1.97 | 2.20 | 2.6 | 1.40 | 1.47 |

S.D – Standard Deviation

There were improvements in the Mean knowledge, attitude and practices scores of both innovators and adaptors. The adaptors show greater improvement in all the scores than their counterparts, the innovators.

Figures 4.7, 4.8 and 4.9 displayed the bar charts showing the magnitude of descriptive statistics of the students' achievement, attitude and practices scores associated with cognitive style as presented in Table 4.3.

Figure 4.7 is a Bar chart showing descriptive statistics of knowledge associated with Cognitive Style.

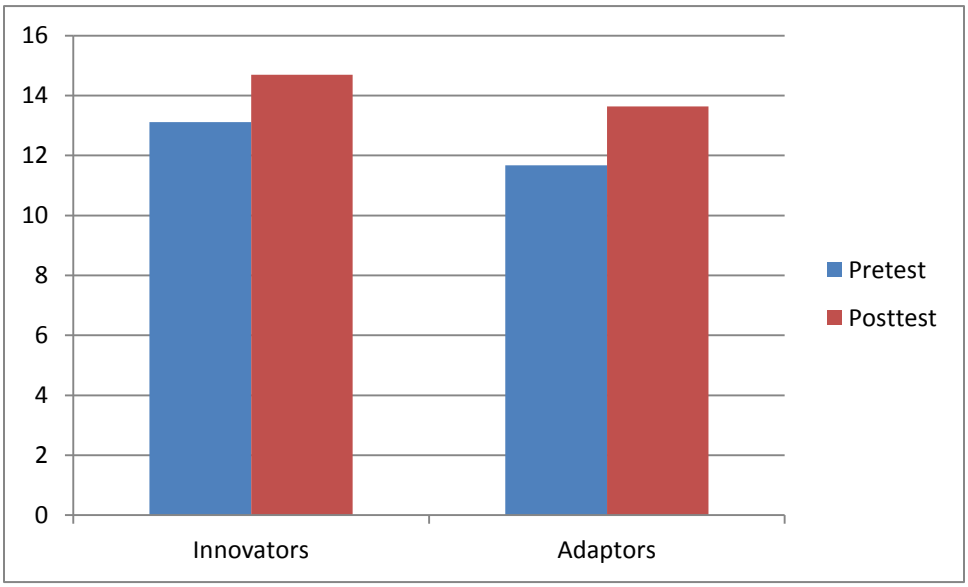


**Fig 4.7: Bar Chart Showing Descriptive Statistics of Knowledge Associated with Cognitive Style**

There were improvements in the mean knowledge scores of innovators by 1.58 (Pretest mean = 13.11, Posttest mean = 14.69) and adaptors by 1.97 (Pretest mean =11.67, Posttest mean =13.64).

Figure 4.8 revealed the Bar chart showing descriptive statistics of attitude associated with cognitive style.

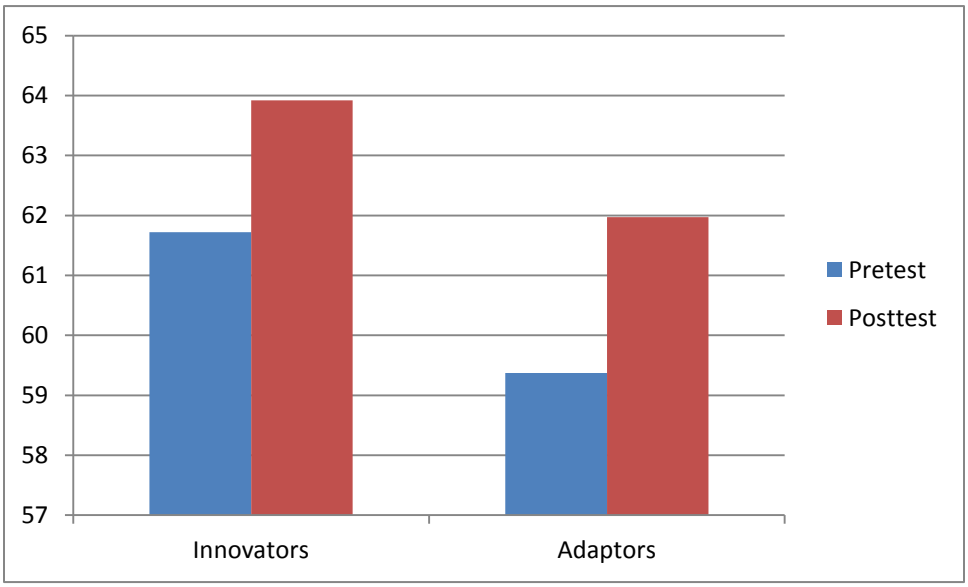


**Fig 4.8: Bar Chart Showing Descriptive Statistics of Attitude Associated with Cognitive Style**

The Innovators showed improvement in Mean attitudinal scores by 2.20(Pretest mean =61.72, Posttest mean = 63.92). The adaptors also had improvement in the Mean attitudinal scores of students by 2.6 (Pretest mean = 59.37, Posttest mean = 61.97).

Figure 4.9 is a bar chart showing descriptive statistics of practices associated with cognitive Style.

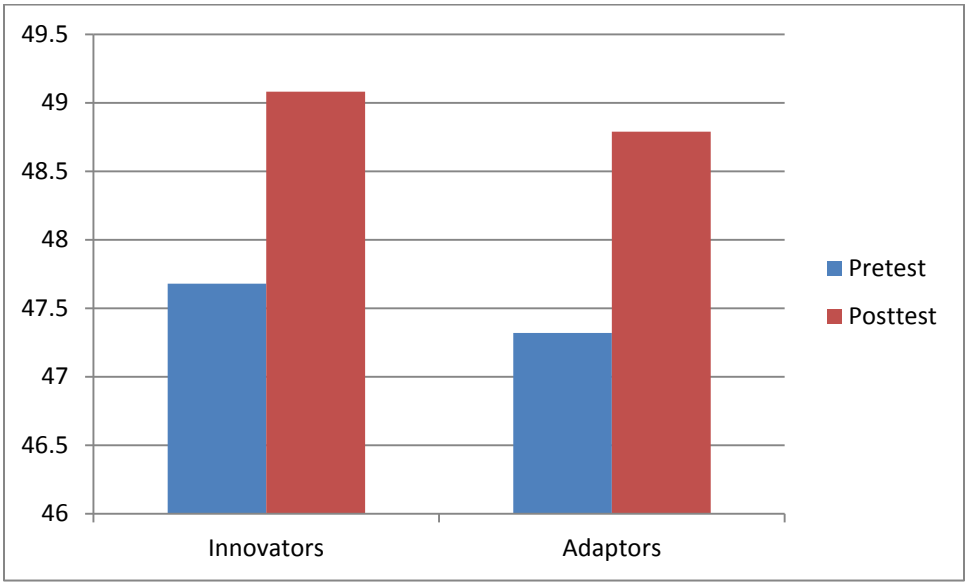


**Fig 4.9: Bar Chart Showing Descriptive Statistics of Practices Associated with Cognitive Style**

The mean practice scores of innovators improved by 1.40 (Pretest mean =47.68, Posttest mean = 49.08) than that of adaptors 1.47 (Pretest mean = 47.32, Posttest mean = 48.79)

## 4.2 TESTING OF HYPOTHESES

**Ho1: There is no significant main effect of treatment on students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

### 4.2.1 Main Effect of Treatment on Students' Knowledge of Environmental Concepts

Table 4.4: ANCOVA Table Showing the Main and Interaction Effects of Treatment, Gender and Cognitive style on Students' Posttest Knowledge

| Source | Sum of Squares | DF | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 6200.373 | 12 | 516.698 | 76.702 | .000* | .691 |
| Pretest Knowledge | 99.759 | 1 | 99.759 | 14.809 | .000* | .035 |
| Main Effect: | | | | | | |
| Treatment Group | 5433.684 | 2 | 2716.842 | 403.307 | .000* | .662 |
| Gender | .133 | 1 | .133 | .020 | .888 | .000 |
| Cognitive style | 26.732 | 1 | 26.732 | 3.968 | .047* | .010 |
| 2-way Interactions: | | | | | | |
| Treatment x Gender | 13.328 | 2 | 6.664 | .989 | .373 | .005 |
| Treatment x Cognitive style | 6.312 | 2 | 3.156 | .469 | .626 | .002 |
| Gender x Cognitive style | .586 | 1 | .586 | .087 | .768 | .000 |
| 3-way Interactions: | | | | | | |
| Treatment x Gender x Cognitive style | 1.447 | 2 | .723 | .107 | .898 | .001 |
| Error | 2768.662 | 411 | 6.736 | | | |
| Total | 8969.035 | 423 | | | | |

**4.2.1a Ho1a-There is no significant main effect of treatment on students' knowledge of environmental concepts.**

The result of 3x2x2 Analysis of Covariance (ANCOVA) as presented in Table 4.4 reveals that there was a significant main effect of treatment on students' knowledge of environmental concepts. ($F_{(2,421)}$ =403.307 .P<0.05, $\eta^2$=.66). The effect of 66.2% was fair. This means that there is a significant difference in the achievement of students exposed to anchored instruction, cognitive flexibility and modified conventional strategies (control group). Therefore, hypothesis 1a is rejected. The mean scores of students across the experimental groups and control group is presented below.

**Table 4.5: Estimated Marginal Means of Post test Knowledge of Environmental Concepts Score by Treatment and Control Group**

| Treatment group | Mean | Std Error |
|---|---|---|
| Anchored Instruction | 18.64 (44%) | .222 |
| Cognitive Flexibility | 13.85 (33%) | .213 |
| Modified Conventional | 9.47 (23%) | .235 |

The Table 4.5 reveals the performance of each group. It shows that Anchored Instruction had the highest post test environmental concept knowledge mean scores ($\bar{x}$ =18.64) followed by the cognitive flexibility instruction treatment group ($\bar{x}$=13.85) while students in the Modified Conventional strategy group had the least adjusted mean ($\bar{x}$ =9.47). This shows that the treatment had a positive effect on the students' acquisition of environmental concept knowledge. The source of the significant difference obtained was traced using Scheffe post-hoc test as shown in Table 4.6.

**Table 4.6: Scheffe Post-hoc Tests Analysis of Post-test Knowledge Score by Treatment**

| Treatment | N | Mean | 1. 1Anchored Instruction | 2.Cognitive Flexibility | 3. Conventional |
|---|---|---|---|---|---|
| 1Anchored Instruction | 145 | 18.64 | | * | * |
| 2. Cognitive Flexibility | 151 | 13.85 | * | | * |
| 3.Modified Conventional | 128 | 9.47 | * | * | |

*Pairs of group significantly different at P<.05

The result from the post-hoc analysis in Table 4.6 shows that Anchored Instruction strategy group was significantly different from Cognitive Flexibility and Modified Conventional strategies in their acquisition of knowledge of environmental concepts. The direction of increasing effect of instructional strategy (treatment) on knowledge of environmental concepts was: Modified Conventional strategy (9.47) < Cognitive Flexibility Strategy (13.85) < Anchored Instructional Strategy (18.64). Therefore, the significant effect of treatment on knowledge was due to the significant difference between anchored instruction and cognitive flexibility and conventional strategy and cognitive flexibility and conventional strategy.

Figure 4.10 is a pie chart showing main effect of treatment on students' knowledge of environmental concepts.

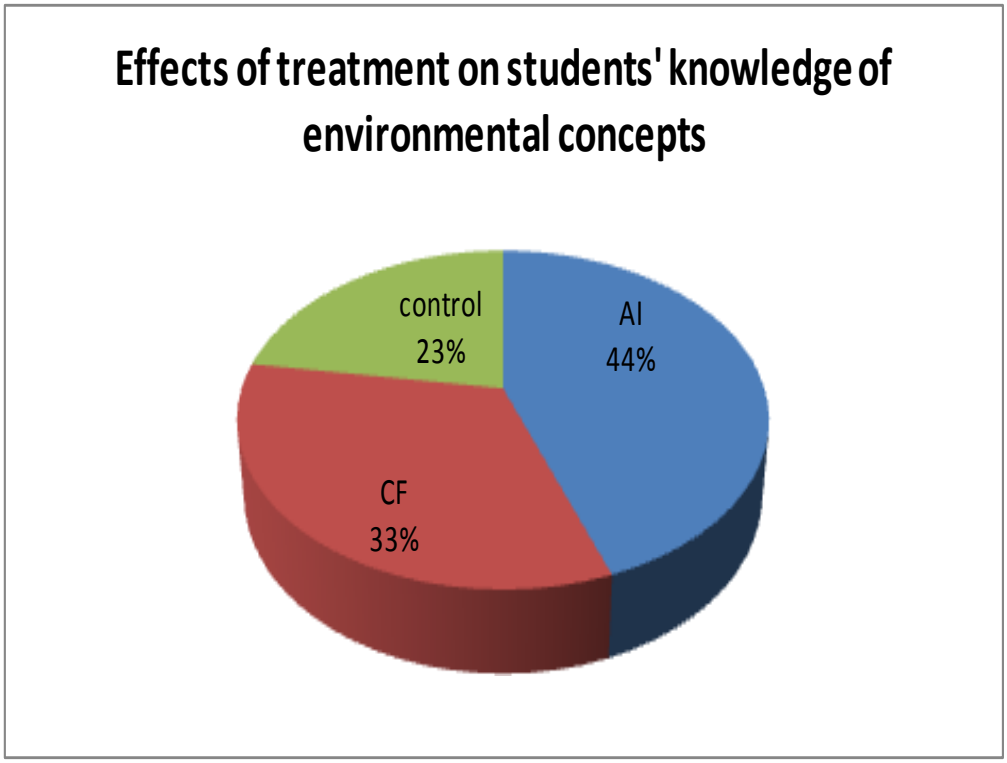


**Figure 4.10: Main Effect of Treatment on Students' Knowledge of Environmental Concepts.**

This was further expressed by the pie chart presented in figure 4.10 where Anchored Instruction contributed 44% to knowledge, Cognitive Flexibility Strategy contributed 33% and lecture method contributed 23% to knowledge gained by the students on environmental concepts in Biology.

### 4.2.1b Main Effect of Treatment on Students' Attitude to Environmental Concepts

Table 4.7: ANCOVA Table Showing the Main and Interaction Effects of Treatment, Gender and Cognitive Style on Students' Posttest Attitude

| Source | Sum of Squares | DF | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1284.101 | 12 | 107.008 | 3.321 | .000* | .088 |
| Pretest Attitude | 96.507 | 1 | 96.507 | 2.995 | .084 | .007 |
| Main Effect: | | | | | | |
| Treatment Group | 336.119 | 2 | 168.060 | 5.216 | .006 | .025 |
| Gender | 2.575 | 1 | 2.575 | .080 | .778 | .000 |
| Cognitive style | 300.129 | 1 | 300.129 | 9.315 | .002* | .022 |
| 2-way Interactions: | | | | | | |
| Treatment x Gender | 71.816 | 2 | 35.908 | 1.114 | .329 | .005 |
| Treatment x Cognitive style | 140.992 | 2 | 70.496 | 2.188 | .113 | .011 |
| Gender x Cognitive style | 62.447 | 1 | 62.447 | 1.938 | .165 | .005 |
| 3-way Interactions: | | | | | | |
| Treatment x Gender x Cognitive style | 50.842 | 2 | 25.421 | .789 | .455 | .004 |
| Error | 13242.633 | 411 | 32.221 | | | |
| Total | 14526.733 | 423 | | | | |

### 4.2.1b Ho1b: There is no significant main effect of treatment on students' attitude to environmental concepts.

The result of the 3x2x2 Analysis of Covariance on Table 4.7 reveals that there was no significant effect of treatment on students' attitude to environmental concepts. ($F_{(2,421)}$ =5.216,P>0.05, $\eta^2$=.025).This means that there was no significant difference in the attitude of students exposed to anchored instruction, cognitive flexibility strategies and modified conventional strategies.

Therefore, hypothesis 1b was not rejected. The mean scores of students across the experimental groups and control group is presented below.

**Table 4.8: Estimated Marginal Means of Posttest Attitude Score by Treatment and Control Group**

| Treatment group | Mean | Std Error |
|---|---|---|
| Anchored Instruction | 63.13 (33%) | .489 |
| Cognitive Flexibility | 63.85 (34%) | .465 |
| Modified Conventional | 61.62 (33%) | .515 |

A further clarification on Environmental Attitude using the Estimated Marginal Means (EMM)as shown in Table 4.8 revealed that the Experimental groups I (Anchored Instruction) and II (Cognitive Flexibility) had higher mean scores ($\bar{x}$ = 63.13) and ($\bar{x}$ = 63.85) respectively than the conventional method group($\bar{x}$ = 61.62). The treatment is observed to have contributed to students' predisposition towards the environment but the difference was not significant.

The result from Table 4.8 shows that Cognitive Flexibility strategy group was significantly different from Anchored Instruction strategy and Modified Conventional strategies in their attitude to environmental concepts. The direction of increasing effect of instructional strategy (treatment) on Attitude to environmental concepts was: Modified Conventional strategy < Anchored Instructional Strategy < Cognitive Flexibility Strategy. This was further expressed by the pie chart presented in figure below where Anchored Instruction contributed 33%, Cognitive Flexibility Strategy contributed 34% and lecture method contributed 33% to students' attitude to environmental concepts in Biology.

Figure 4.11 is a pie chart showing main effect of treatment on students' attitude to environmental concepts.

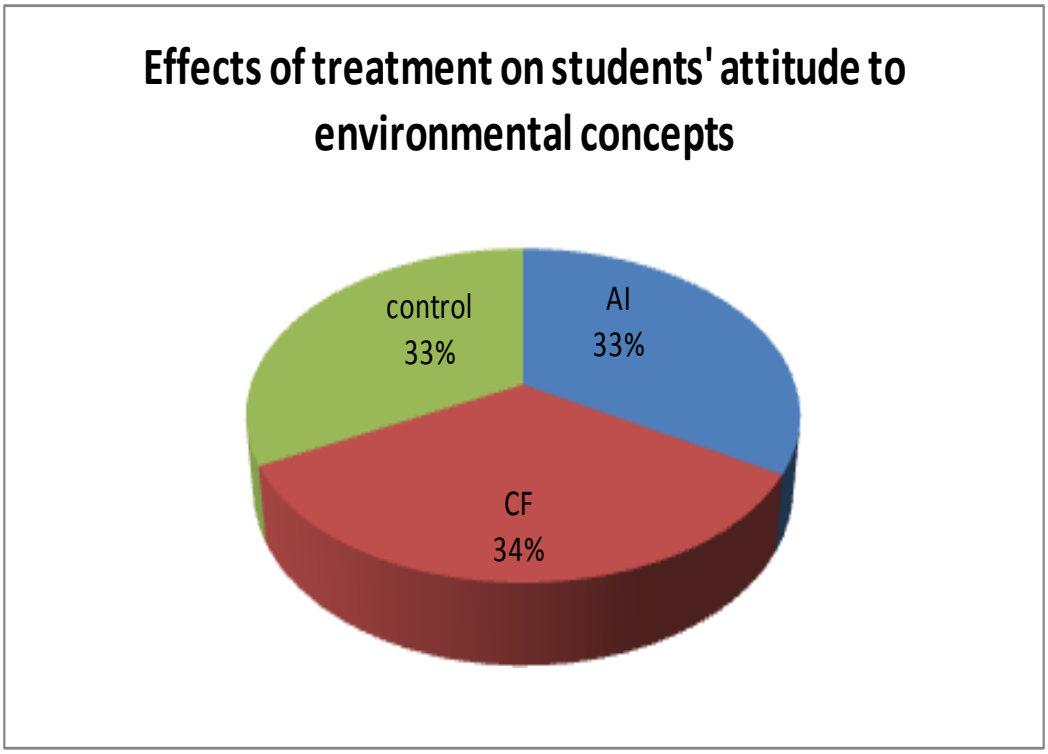


Figure 4.**11: Main Effect of Treatment on Students' Attitude to Environmental Concepts.**

### 4.2.1c Main Effect of Treatment on Students' Environmental Practices.

Table 4.9: ANCOVA Table Showing the Main and Interaction Effects of Treatment, Gender and Cognitive Style on Students' Posttest Environmental Practices

| Source | Sum of Squares | DF | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 738.389 | 12 | 61.532 | 1.870 | .036 | .052 |
| Pretest Practice | 2.095 | 1 | 2.095 | .064 | .801 | .000 |
| Main Effect: | | | | | | |
| Treatment Group | 583.438 | 2 | 291.719 | 8.866 | .000* | .041 |
| Gender | 15.101 | 1 | 15.101 | .459 | .498 | .001 |
| Cognitive style | 2.584 | 1 | 2.584 | .079 | .779 | .000 |
| 2-way Interactions: | | | | | | |
| Treatment x Gender | 55.742 | 2 | 27.871 | .847 | .429 | .004 |
| Treatment x Cognitive style | 134.177 | 2 | 67.089 | 2.039 | .131 | .010 |
| Gender x Cognitive style | .115 | 1 | .115 | .003 | .953 | .000 |
| 3-way Interactions: | | | | | | |
| Treatment x Gender x Cognitive style | 6.066 | 2 | 3.033 | .092 | .912 | .000 |
| Error | 13522.627 | 411 | 32.902 | | | |
| Total | 14261.017 | 423 | | | | |

### 4.2.1c Ho1c: There is no significant effect of treatment on students' environmental practices.

The result of the 3x2x2 Analysis of Covariance on Table 4.9 revealed that there was a significant effect of treatment on students' environmental practices ($F_{(2,421)}$ =8.866,P<0.05, $\eta^2$=.04).This means that there is a significant difference in the environmental practices of students exposed to Anchored instruction, Cognitive Flexibility and modified conventional strategies. Therefore,

hypothesis 1c is rejected. The magnitude of the mean scores of students across the experimental groups and control group is presented in Table 4.10.

**Table 4.10: Estimated Marginal Means of Posttest Environmental Practices Score by Treatment and Control Group**

| Treatment group | Mean | Std Error |
|---|---|---|
| Anchored Instruction | 50.63 (34%) | .49 |
| Cognitive Flexibility | 48.15 (33%) | .47 |
| Modified Conventional | 48.05 (33%) | .51 |

A further clarification on Environmental Practices using the Estimated Marginal Means (EMM) as shown in Table 4.10 revealed that the Experimental groups I (Anchored Instruction) and II (Cognitive Flexibility) had higher mean scores ($\bar{x}$ = 50.63) and ($\bar{x}$ = 48.15) respectively than the conventional group($\bar{x}$ = 48.05). The treatment is observed to have contributed to students' predisposition towards the environment in terms of their practices. The source of the significant difference obtained was traced using Scheffe post-hoc test as shown in Table 4.11.

**Table 4.11: Scheffe Post-hoc tests Analysis of Post-test Environmental Practices Score according to Treatment Group**

| Treatment | N | Mean | 1. 1Anchored Instruction | 2.Cognitive Flexibility | 3. Modified Conventional |
|---|---|---|---|---|---|
| 1Anchored Instruction | 145 | 50.63 | | * | * |
| 2. Cognitive Flexibility | 151 | 48.15 | * | | |
| 3.Modified Conventional | 128 | 48.05 | * | | |

*The mean difference is significant at the <.05 level

The result from the post-hoc analysis in Table 4.11 revealed that Anchored Instruction strategy group was significantly different from both the Cognitive Flexibility strategy and Modified Conventional strategies in their attitude to environmental concepts. The direction of increasing effect of instructional strategy (treatment) on students' environmental practices was: Modified Conventional strategy < Cognitive Flexibility Strategy < Anchored Instructional Strategy. This was further expressed by the pie chart presented in figure 4.11 where Anchored Instruction contributed 34% to knowledge, Cognitive Flexibility Strategy contributed 33% and lecture method contributed 33% to the students' environmental practices.

Figure 4.12 is a pie chart showing main effect of treatment on students' environmental practices.

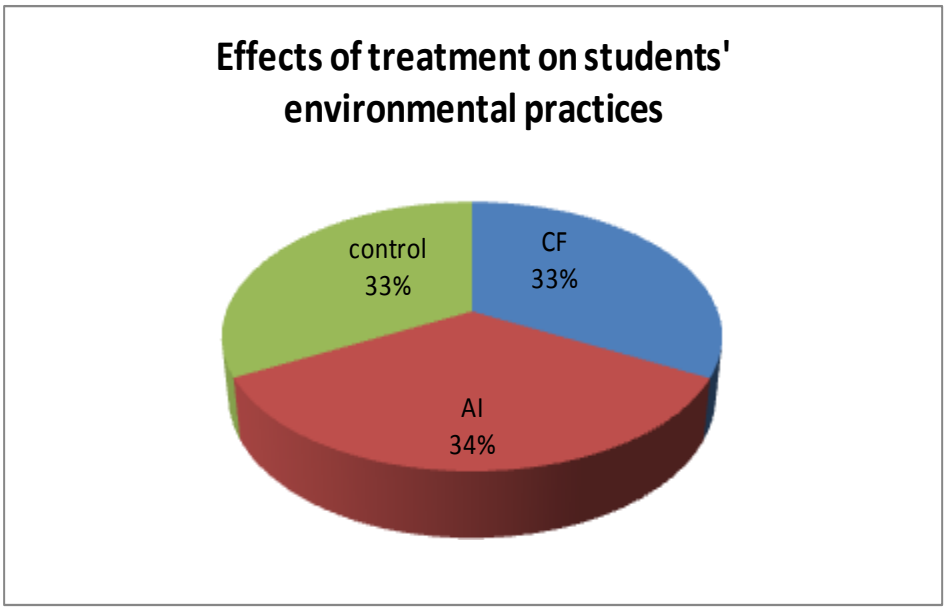


**Figure 4.12: Main Effect of Treatment on Students' Environmental Practices**.

**Ho 2: There is no significant main effect of gender on students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

**4.2.2a: Main Effect of Gender on Students' Knowledge of Environmental Concepts**.

**Ho2a- There is no significant main effect of gender on students' knowledge of environmental concepts.**

Table 4.4 shows that the main effect of gender on students environmental knowledge was not significant ($F_{(1,411)}$ =0.020, P>0.05, $\eta^2$=.00). Therefore, Ho 4 was not rejected. That is, there was no significant difference between male and female students' knowledge of environmental concepts.

**Table 4.12: Estimated Marginal Means of Post test Knowledge Scores by Gender**

| **Gender** | Mean | Std Error |
|---|---|---|
| Male | 14.01 | .17 |
| Female | 13.97 | .19 |

Male students had higher mean score ($\bar{x}$=14.01) than the female students ($\bar{x}$=13.97) but the difference was not significant. The males are, therefore, not significantly better in acquisition of knowledge of environmental concepts than their female counterpart.

**Ho 2b: There is no significant main effect of gender on students' Attitude to Environmental concepts.**

Table 4.7 revealed that the effect of gender on participants attitude to environmental concepts was not significant ($F_{(1,422)}$ =0.080, P>0.05, $\eta^2$=.00). Therefore, hypothesis Ho 2b was not rejected.

**Table 4.13: Estimated Marginal Means of Posttest Attitude Scores by Gender**

| **Gender** | Mean | Std Error |
|---|---|---|
| Male | 62.95 | .37 |
| Female | 62.79 | .42 |

Male students however had higher mean score ($\bar{x}$=62.95) than the female students ($\bar{x}$=62.79) but the difference was not significant. The males are, therefore, not significantly better in their predisposition towards environmental concepts than their female counterpart.

**2.2c Main Effect of Gender on Students' Environmental Practices**

**Ho 2c: There is no significant main effect of gender on students' Environmental practices.**

From Table 4.9, there was no significant effect of gender on participants' environmental practices ($F_{(1,411)}$ =0.459, P>0.05, $\eta^2$=.01). The effect size of 1% was negligible. Hence, hypothesis 2c was not rejected.

**Table 4.14: Estimated Marginal Means of Post test Practices Scores by Gender**

| **Gender** | Mean | Std Error |
|---|---|---|
| Male | 48.75 | .37 |
| Female | 49.14 | .43 |

Male students had lower mean score ($\bar{x}$=48.75) than the female students ($\bar{x}$=49.14) but the difference was not significant. Although the female had a higher mean score, which shows that the treatment had helped in improving their environmental practices, this does not mean that they are significantly better in their predisposition, in terms of their practices towards environmental concepts than their male counterparts.

**Ho3: There is no significant main effect of cognitive style on students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

**4.2.3a: Main Effect of Cognitive Style on Students' Knowledge of Environmental Concepts.**

**Ho3a- There is no significant effect of cognitive style on students' knowledge of environmental concepts.**

Table 4.4 shows that the main effect of cognitive style on students' environmental knowledge was significant ($F_{(1,411)}$ =3.968, P<0.05, $\eta^2$=.01). That is, there was a significant difference between innovators' and adaptors' knowledge of environmental concepts. Therefore, hypothesis 3a was rejected.

**Table 4.15: Estimated Marginal Means of Post test Knowledge Scores by Cognitive Style**

| **Cognitive style** | Mean | Std Error |
|---|---|---|
| Innovators | 14.25 | .19 |
| Adaptors | 13.73 | .18 |

Innovators had a higher mean score ($\bar{x}$=14.25) than the adaptors ($\bar{x}$=13.73). This difference was significant. This shows that the innovators are significantly better in acquisition of knowledge of environmental concepts than the adaptors.

**4.2.3b Main Effect of Cognitive Style on Students' Attitude to Environmental Concepts.**

**Ho 3b: There is no significant main effect of cognitive style on students' attitude to environmental concepts.**

Table 4.7 revealed that the effect of cognitive style on participants attitude to environmental concepts was significant ($F_{(1,411)}$ =9.315, P<0.05, $\eta^2$=.02). Therefore, hypothesis Ho 2b was rejected

**Table 4.16: Estimated Marginal Means of Post test Attitude Scores by Cognitive style**

| **Cognitive style** | Mean | Std Error |
|---|---|---|
| Innovators | 63.74 | .41 |
| Adaptors | 62.00 | .39 |

Innovators had higher mean score ($\bar{x}$=63.74) than the adaptors ($\bar{x}$=62.00). The difference was significant. The innovators are, therefore, significantly better in their attitude towards environmental concepts than the adaptors.

**4.2.3c Main Effect of Cognitive Style on Students' Environmental Practices.**

**Ho 3c: There is no significant main effect of cognitive style on students' environmental practices.**

From Table 4.9, there was no significant effect of cognitive style on participants' environmental practices ($F_{(1,411)}$ =0.079, P>0.05, $\eta^2$=.00). Hence, hypothesis 3c was not rejected.

**Table 4.17: Estimated Marginal Means of Posttest Practices Scores by Cognitive style**

| **Cognitive style** | Mean | Std Error |
|---|---|---|
| Innovators | 49.02 | .41 |
| Adaptors | 48.86 | .39 |

Innovators had higher mean score ($\bar{x}$=49.02) than adaptors ($\bar{x}$=48.86) but the difference was not significant. Although the innovators had a higher mean score, which shows that they had better performance with respect to environmental practices, this does not mean that they are significantly better in their predisposition in terms of their practices towards environmental concepts than the adaptors.

**Ho4: There is no significant interaction effect of treatment and gender on students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

**4.2.4a: Interaction Effect of Treatment and Gender on Students' Knowledge of Environmental Concepts.**

**Ho4a- There is no significant interaction effect of treatment and gender on students' knowledge of environmental concepts.**

Result from Table 4.4 shows that there was no significant 2- way interaction effect of treatment and gender on students' knowledge of environmental concepts ($F_{(2,421)}$ =0.989, P>0.05, $\eta^2$=.01). This shows that treatment does not interact with gender to have an effect on students' environmental knowledge. On the basis of this finding, the hypothesis was therefore not rejected.

**4.2.4b Interaction Effect of Treatment and Gender on Students' Attitude to Environmental Concepts.**

**H04b: There is no significant interaction effect of treatment and gender on students' attitude to environmental concepts.**

Table 4.7 reveals that there was no significant interaction effect of treatment and gender on students' attitude scores ($F_{(2,411)}$ =1.114, P>0.05, $\eta^2$=.005). The effect size of 0.5% was negligible. Hence, hypothesis 4b was not rejected.

**4.2.4c Interaction Effect of Treatment and Gender on Students' Environmental Practices.**

**Ho 4c: There is no significant interaction effect of treatment and gender on students' environmental Practices.**

Table 4.9 reveals that there was no significant interaction effect of treatment and gender on students' environmental Practices ($F_{(2,411)}$ =0.847, P>0.05, $\eta^2$=.004). The effect size of 0.4% was negligible. Hypothesis 4c was hereby not rejected.

**Ho5: There is no significant interaction effect of treatment and cognitive style on students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

**4.2.5a: Interaction Effect of Treatment and Cognitive Style on Students' Knowledge of Environmental Concepts**

**H05a: There is no significant interaction effect of treatment and cognitive style on students' environmental achievement.**

Table 4.4 reveals that the 2-way interaction effect of treatment and cognitive style was not significant on subjects' knowledge of environmental concepts scores **(**$F_{(2,411)}$ =0.469, P>0.05, $\eta^2$=.002). The effect size of 0.2% was negligible. Therefore, hypothesis 5a was not rejected

**4.2.5b Interaction Effect of Treatment and Cognitive Style on Students' Attitude to Environmental Concepts.**

**H05b: There is no significant interaction effect of treatment and cognitive style on students' attitude to environmental concepts.**

Table 4.7 reveals that the interaction effect of treatment and cognitive style on students' attitude scores was not significant ($F_{(2,411)}$ =2.188, P>0.05, $\eta^2$=.011). The effect size of 1.1% was negligible. Hence, hypothesis 5b was not rejected.

**4.2.5c Interaction Effect of Treatment and Cognitive style on Students' Environmental Practices.**

**Ho 5c: There is no significant interaction effect of treatment and cognitive style on students' environmental practices.**

Table 4.9 shows that there was no significant interaction effect of treatment and cognitive style on students' environmental practices ($F_{(2,411)}$ =2.039, P>0.05, $\eta^2$=.01). The effect size of 1% was negligible. This finding necessitated the non rejection of hypothesis 5c.

**Ho6: There is no significant interaction effect of gender and cognitive style on students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

**4.2.6a: Interaction Effect of Gender and Cognitive Style on Students' Knowledge of Environmental Concepts**

**H06a: There is no significant interaction effect of gender and cognitive style on students' knowledge of environmental concepts.**

Table 4.4 reveals that there was no significant interaction effect between gender and cognitive style on students' knowledge of environmental concepts. ($F_{(1,411)}$ =0.087, P>0.05, $\eta^2$=.000). Hence, the hypothesis was not rejected.

**4.2.6b Interaction Effect of Gender and Cognitive Style on Students' Attitude to Environmental Concepts.**

**H06b: There is no significant interaction effect of gender and cognitive style on students' attitude to environmental concepts.**

Table 4.7 reveals that there was no significant interaction effect of gender and cognitive style on students' attitude to environmental concepts ($F_{(1,411)}$ =1.938, P>0.05, $\eta^2$=.005). Therefore, hypothesis 6b was not rejected.

**4.2.6c Interaction Effect of Gender and Cognitive Style on Students' Environmental Practices**

**H06c: There is no significant interaction effect of gender and cognitive style on students' environmental practices**

Table 4.9 reveals that there was no significant interaction effect of gender and cognitive style on students' environmental Practices. ($F_{(1,411)}$ = 0.003; P>.05; , $\eta^2$=.000). Hence hypothesis 6c was not rejected.

**Ho7: There is no significant interaction effect of treatment, gender and cognitive style on Students'**

**(a) knowledge of environmental concepts,**

**(b) attitude to environmental concepts and**

**(c) environmental practices.**

**4.2.7a: Interaction Effect of Treatment, Gender and Cognitive Style on Students' Knowledge of Environmental Concepts.**

**H07a: There is no significant interaction effect of treatment, gender and cognitive style on students' knowledge of environmental concepts**.

From Table 4.4, it was revealed that the 3- way interaction effect of treatment, gender and cognitive style on subjects' achievement scores was not significant ($F_{(2,411)} = 0.107$; $P>.05$; $\eta^2=.001$). This shows that they do not interact to have an effect on students' environmental knowledge**.** The effect size of 0.1% is negligible. Hence, hypothesis 7a was not rejected.

**4.2.7b Interaction Effect of Treatment, Gender and Cognitive Style on Students' Attitude to Environmental Concepts.**

**H07b: There is no significant interaction effect of treatment, gender and cognitive style on students' attitude to environmental concepts.**

From table 4.7, the 3-way interaction effect of treatment, gender and cognitive style on students attitude to environmental concepts was significant ($F_{(2,411)} = 0.789$; $P>.05$; $\eta^2=.004$). Hypothesis 7b was not rejected.

**4.2.7c Interaction Effect of Treatment, Gender and Cognitive Style on Students' Environmental Practices**

**H07c: There is no significant interaction effect of treatment, gender and cognitive style on students' environmental Practices**.

From table 4.9, the 3-way interaction effect of treatment, gender and cognitive style on students' environmental Practices was not significant ($F_{(2,411)} = 0.092$; $P>.05$; $\eta^2=.000$). Hypothesis 7c was not rejected.

## 4.3 DISCUSSION

Research studies previously carried out on Anchored instruction and cognitive flexibility have shown them to be very effective in impartation of knowledge, attitude and skills in the lives of various individuals at different educational levels. This present study was carried out to extend the scope these various studies that have been carried out. The study investigated the effects of Anchored Instruction and Cognitive Flexibility Strategies on secondary school students' knowledge, attitude and practices in environmental concepts in Biology. It also examined the moderating influence of gender and cognitive style on the students' environmental learning outcomes.

### 4.3.1 Effect of treatment on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

The findings in this study showed that there was a significant difference in the achievement of students in their knowledge of environmental concepts, attitude to environmental concepts and environmental practices in Biology, when they were exposed to Anchored instruction and cognitive flexibility strategies, as opposed to those in the conventional lecture group as shown in Tables 4.4, 4.7 and 4.9. The Anchored Instructional Strategy was the most effective, followed by the Cognitive Flexibility Instructional strategy while the Modified conventional Strategy was the least effective. Although the two strategies taught the same concepts in different modes, the Anchored Instructional Strategy was found to be more effective than the Cognitive Flexibility Instructional Strategy. This may be attributed to the fact that in a typical classroom, using anchored instruction, students work together to formulate strategies for solving the sub-problems embedded in the anchor. The anchored problems are of high interest because of their ability to directly immerse students in a rich array of problem contexts that can be re-explored, which helps to eliminate the barriers many students with low achievement, are confronted with when attempting typical text-based problems. The dynamic nature of the presentation enables students to notice subtleties in the mix of the visual cues, which are missing in text-based problems using their critical thinking skills to observe and extract facts that can be recalled for future use on generating solutions they think, are plausible. The students were allowed to construct their own knowledge of the concepts selected for the study as they individually, or in their groups, use their

thinking skills to observe, recall fact and collect relevant information from the anchor slide which they try to define, explain and debate on. They also evaluated, summarized and drew conclusions on the lessons all by themselves with minimal teacher interference. These real life activities must have enormously influenced and impacted their environmental achievement. This result supports the findings of Young and Barab (1999), Bottge et al (2002), Hsin-Yih, C.S. (2002), Reith et al (2003), who found significant improvement among students taught with anchored instruction. Thus, the strategy has been found to be effective in improving students' achievement.

The findings further show that there was better improvement in the learning outcomes of the participants treated with Cognitive Flexibility than their counterparts treated with the Modified Conventional method. This strategy has also been found to improve the acquisition of knowledge and achievement of students tremendously in the areas of knowledge transfer. This is supported by the submissions of Yuh-Tyng (2012), Martin and Anderson (2009) and Jacobson and Spiro (1995). Cognitive flexibility facilitates the cognitive development useful for learning and the knowledge acquisition by students. Cognitive flexibility hypertext used in instructional design suggests that students can face complexity of learning situation more easily with multiple representations of the same information in various contexts to acquire the necessary mental developments. The poor performance of the conventional lecture strategy group may be connected to the fact that the strategy is teacher centred which does not offer students the opportunity to develop abilities to interact, communicate, think and solve problems. This is because the modified conventional method often subjects the learners to the position of passive recipient of fact handed down to them by the teacher.

The data also revealed that the treatment used produced a positive effect on the students' attitude to environmental concepts in the two experimental groups. The students in the cognitive flexibility strategy had a significantly higher mean score in their attitude test followed by those in the anchored instructional strategy and lastly by those in the conventional method. This may be due to the nature of the presentation which had in it motion and sounds depicting the effects of the environmental problems. As a result, the real life situation looks so real that the need to find a plausible solution seems very important. The findings agree with the submissions of Adesoji (2008) who submitted that acceptable methods of instruction are capable of changing

students' attitude towards science. The result also falls in line with the submission of Noibi (1990) that environmental knowledge is a precondition to changing attitude and that both knowledge and attitude are important to change human action towards the environment. These findings are also supported by Olagunju (2002) who suggested that every strategy for successful education on environmental management should be geared towards a change of attitude. Any strategy that will be successful in this area should aim at developing positive environmental attitude and action among people, seeking to stimulate people's awareness about their behavioural patterns and how best to get involved in pollution management activities, and a development of a training programme that goes beyond theory but incorporates practical activities. The findings of this study support the research work of Ojo (2009) and Oduwaiye (2009) that students' achievement and attitudes correlated highly. The findings of this study further establish the fact that acceptable methods of instruction are capable of changing students' attitude towards science.

This study also revealed higher environmental practices scores for the learners exposed to the Anchored instruction and Cognitive Flexibility than those in the Modified Conventional Strategy. This implies that those in the Anchored instruction and Cognitive Flexibility groups acquired better environmental practices than their counterparts in the control group. This is likely to be as a result of the nature of the critical thinking involved in the two experimental instructional strategies which emphasized active learner participation. This corroborates the findings of Ngothor, Fincham and Quinn (2004), Ojo (2009), Ogunbiyi (2006), Abiona (2008), in their various researches on environmental practices. They reported significantly high environmental practices of adults and adolescent learners exposed to their various learning strategies. This result is expected because attitudes correlate positively with practices (Ifegbesan 2010). Furthermore, the participation of the students in experimental group in activities that led to removal of misconceptions on the concept presented to students in the class involved a lot of critical thinking and evaluation of each other's input. Similarly, the variety of ideas and views presented by the groups to the entire class generated a wider scope of information in relation to the concepts learnt, as well as improved their spellings on Environmental Education concepts. These real life activities must have influenced and, as such, impacted their environmental achievement.

### 4.3.2 Effect of gender on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

The results in Tables 4.4, 4.7 and 4.9 to test hypothesis two shows that gender had no significant main effect on students' knowledge of environmental concepts.

Although the male students performed better than their female counterparts, the difference was not significant. This corresponds with the submissions of Abiona (2008), Owoyemi (2007), Bora (2003), Raimi and Adeoye (2002) and Olagunju (1998), who in their various research findings indicated no significant difference in the acquisition of knowledge in terms of gender. This shows that gender does not influence knowledge acquired by the students. The reason for this insignificant effect could be attributed to the practical nature of the strategies, and the fact that both sexes were given the same opportunity to participate actively in the process of knowledge development and acquisition, which may have accounted for the near equal gain in knowledge. This finding is at variance with the findings of Bilesanmi-Awoderu (2002),Ogunleye (2002), Aremu and John (2005), Olatundun (2008) and Ojo (2009), which revealed significant gender difference.

Gender also had no significant effect on the attitude of the students to environmental concepts. Although the male students had a higher mean score, it was not significant. This shows that gender does not significantly influence the attitude of students to environmental concepts. This also reveals that the female students are now having positive attitude to technology and their environment.

Although the male students had a higher mean score, there was no significant effect of gender on students' environmental practices. This result supports the findings of Ojo (2009) and Abiona (2008), who in their research found no significant effect of gender on students' environmental practices. These findings are supported by Olagunju's (2002) result which suggested that every strategy for successful education on environmental management should be geared towards a change of the attitude. Any strategy that will be successful in this area should aim at developing positive environmental attitude and action among people, seeking to stimulate people's awareness about their behavioural patterns and how best to get involved in pollution management activities. It should involve a development of a training programme that goes beyond theory but incorporates practical activities.

### 4.3.3 Effect of cognitive style on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices

Tables 4.4 and 4.7 show that there was significant main effect of cognitive style on the students' knowledge of and attitude to environmental concepts in Biology across the groups. The innovators were significantly better than the adaptors in their acquisition of knowledge and attitudinal change towards the environment. This may be as a result of their critical thinking skills and ability to look beyond conventional methods to approach and solve problems which had been improved on by the use of the anchored instruction and cognitive flexibility strategies. Cognitive style has been observed to have positive effects on the way and manner in which students receive and process information. This is in agreement with the submissions of Ige (2001) and Awolola (2009). Olagunju and Ogundiwin (2008) found that cognitive style has a significant main effect on the attitude of students towards pollution in Biology. It also had significant influence on students' achievement in Physics Okwo and Otubah (2007), in Biology Okwo and Tartiyus (2004), Okwo and Tartiyus (2006). However, the result disagrees with the findings of Awofala, Balogun and Olagunju (2011) that students with Non-analytic cognitive style had significantly higher mean achievement score than students with Analytic cognitive style. The significant positive effect of cognitive style on students' achievement and attitude to environmental concepts shows a noticeable influence the cognitive style has on knowledge acquisition and attitudinal change. Unfortunately, cognitive style did not have any significance influence on students' environmental practices. The influence of cognitive style made no noticeable contribution to students' environmental practices in this study.

### 4.3.4 Interaction effect of treatment and gender on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

Tables 4.4, 4.7 and 4.9 revealed that there was no significant two-way interaction effect of treatment and gender on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices. The results suggest that gender does not necessarily make any contribution to the achievement of learners in Biology. The findings show that learning outcomes of boys and girls in term of knowledge of environmental concepts, attitude to environmental concept and environmental practices in Biology are not different. That

means both male and female have the same potential to compete irrespective of any instructional strategy introduced to teach environmental concepts in Biology at the secondary school level. Thus, what determines the attitude and achievement of students in Biology is the method of instruction adopted by the teacher. This outcome tally with the findings of Abiona (2008) who found no significant interaction effect of treatment and gender on students' knowledge of, attitude towards and practices in sewage disposal and water treatment. Also Ojo 2009 found a similar result on students' environmental knowledge, attitude to and practices on disease control.

### 4.3.5 Interaction effect of treatment and cognitive style on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

Tables 4.4, 4.7 and 4.9 revealed that there was no significant two-way interaction effect of treatment and cognitive style on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices. The results suggest that the interaction effect of treatment and cognitive style do not make contribution to the achievement of the learners.

### 4.3.6 Interaction effect of gender and cognitive style on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

The results in Table 4.4, 4.7 and 4.9 reveals that there was no significant interaction effect of cognitive style and gender on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices. The studies of Okwo and Otubah (2007) revealed that the interaction effects of cognitive style and gender was significant on students' achievement in Physics essay test. This shows that the cognitive style is not contingent on gender. Therefore, irrespective of whether the students were male or female and whether they are adaptors or innovators does not influence the acquisition of environmental knowledge, attitude to environment and environmental practices in this study. What determines the attitude and achievement of students in environmental concepts in Biology is the method of instruction.

### 4.3.7 Interaction effect of treatment, gender and cognitive style on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

The results in Table 4.4, 4.7 and 4.9 revealed that the 3-way interaction effect of treatment, cognitive style and gender was not significant on Environmental knowledge and environmental attitude and Practices. The implication is that the two instructional strategies are effective irrespective of the gender and cognitive style of the students.

## 4.4 Summary of Findings

The findings of this study revealed the following:

1. There was a significant effect of treatment on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices. These findings suggest that both strategies (Anchored Instructional strategy and Cognitive flexibility strategy) enhanced students' knowledge, attitudes and practices of the students more than the Modified Conventional strategy. The anchored instructional strategy was more effective followed by the cognitive flexibility strategy while the modified conventional strategy was the least. The ascending order is represented as follows: Modified Conventional strategy < Cognitive flexibility strategy < Anchored instructional strategy

2. Students' gender had no significant effect on the knowledge of environmental concepts, attitude to environmental concepts and environmental practices. That is, there was no significant difference in the knowledge of environmental concepts, attitude to environmental concepts and practices of students that belong to male and female groups.

3. Cognitive style had a significant effect on the students' knowledge of environmental concepts and attitude to environmental concept. On the other hand, there was no significant effect of cognitive style on students' environmental practices, that is, there was no significant difference in the environmental practices of the students that belong to innovators' and adaptors' groups.

4. There was no significant interaction effect of treatment and gender on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

5. There was no significant interaction effect of treatment and cognitive style on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

6. There was no significant interaction effect of gender and cognitive style on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

7. The 3-way interaction effect of treatment, gender and cognitive style was not significant on students' knowledge of environmental concepts, attitude to environmental concept and environmental practices.

# CHAPTER FIVE

## SUMMARY, EDUCATIONAL IMPLICATIONS, RECOMMENDATIONS AND CONCLUSION

**5.0** This chapter presents the summary, educational implications, recommendations and conclusion made based on the findings of the study.

### 5.1 Summary

This study examined the effects of anchored and cognitive flexibility instructional strategies on secondary school students' knowledge, attitude and practices in Biology, in Ibadan, Nigeria. It also examined the moderating effect of gender of the students and their cognitive styles on learning outcomes in Biology.

A pretest-posttest control group, quasi-experimental design using a 3x2x2 factorial matrix was used for the research. Ten instruments were structured for this study out of which four were used for data collection. The ten instruments structured were:

(a) Students' Knowledge of Environmental concept Test (SKECT)

(b) Students' Environmental Attitude Scale (SEAS)

(c) Students Perceived Environmental Practices Scale (SPEPS)

(d) Cognitive Style Test (CST)

(e) Instructional Guide for Teaching with Anchored Instructional Strategy (IGTAIS)

(f) Instructional Guide for Teaching with Cognitive Flexibility Strategy (IGTCFS)

(g) Instructional Guide for Teaching with Conventional Strategy (IGTCMS)

(h) Evaluation Sheet for Assessing Teachers (ESAT) for Cognitive Flexibility Strategy (IGTCFS)

(i) Evaluation Sheet for Assessing Teachers (ESAT) for Anchored Instructional Strategy (IGTAIS)

(j) Evaluation Sheet for Assessing Teachers (ESAT) for Modified Conventional Strategy (IGTCMS)

Four hundred and twenty four (424) SS2 Biology students (240 males and 184 females), from nine intact classes participated in the study. Environmental concepts used for this study were the environment, pollution (air, water and land pollution), desertification, erosion and conservation of natural resources. The study was carried out in three phases. The first phase – the pre treatment phase- which covered a period of four weeks was used for the familiarization visit to the schools, training of teachers and administration of pretest instruments. The treatment phase which covered a period of eight weeks was used for the administration of intervention and the post treatment phase which covered a period of one week was used for the administration of post test instruments. This makes a total of twelve (13) weeks.

The data collected were analysed using Analysis of Covariance (ANCOVA), Estimated Marginal Mean (EMM) and Scheffe post-hoc analysis.

The findings of this study revealed:

1. There was a significant main effect of treatment on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

2. Gender had no significant effect on the students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

3. Cognitive style had significant effect on the students' knowledge of environmental concepts and attitude to environmental concepts but does not have significant effect on students' environmental practices.

4. There was no significant interaction effect of treatment and gender on students' students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

5. There was no significant interaction effect of treatment and cognitive style on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

6. There was no significant interaction effect of gender and cognitive style on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

7. The 3-way interaction effect of treatment, gender and cognitive style was not significant on students' knowledge of environmental concepts, attitude to environmental concepts and environmental practices.

## 5.2 Educational implication

Education, a process of teaching, training and learning, especially in schools or colleges, to improve knowledge and develop skills, is growth, rather than an end in itself. Therefore, to acquire effective education that would be useful throughout one's life time, there is need to put in place the use of viable and effective curriculum, teaching strategies and effective teaching materials /teaching aids.

The use of metacognitive teaching strategies, such as anchored instruction and cognitive flexibility strategies, which has its basic root in the theory of cognition, assumes that individuals are actively involved in the learning process. Learning involves the formation of mental associations that are not necessarily reflected in overt behaviour changes, and that learning is a process of relating new information to previously learned information. This has general educational implication, such as the fact that cognitive processes in one way or the other influence learning, and that as children grow, they become capable of increasingly more sophisticated thought. It also means that people organize the things they learn, and new information is most easily acquired when people can associate it with things they have already learned. Thus, people can control their own learning.

The exposure of the learners to Anchored and Cognitive Flexibility instructional strategies have been found to positively enhance students' environmental knowledge, attitudes and practices. The findings of this study have, therefore, revealed the importance of using these metacognitive teaching strategies that are learner-centered for effective learning to take place. This is because learners were allowed to take control and direct their learning processes.

The dynamic nature of learning, as revealed from the use of these strategies has made learning very interesting. As the learner learns, s/he develops knowledge and skill that is

different from the start. Nowadays where technology mediates the learning experience, there is a stronger need for the construction of technology-supported constructivist learning environments wherein students are required to work collaboratively with one another, and to move the teacher from podium to sideline, from leader to coach, from purveyor of knowledge to facilitator of personal meaning making (Tam, 2000). This, as evidenced in the use of anchored instruction and cognitive flexibility strategies, has helped students to acquire the environmental knowledge expected of them and also acquire the desired positive environmental attitude and practices. Thus, Constructivist principles provide a set of guiding principles to help designers and instructors create learner-centred, technology-supported collaborative environments that support reflective and experiential processes that bring about learning. The implications of this for interactive multimedia are that interactions and activities need to be designed to engage higher-order thinking and critical reflection. Anchored instruction and Cognitive Flexibility strategies fall within the social constructivist paradigm and support the basic assumptions of constructivism.

Anchored instruction and Cognitive Flexibility strategies are technology-based problem-solving teaching methods. Technology is used to present the story, anchor or hypertext because it is seen as a vehicle to engage students in the higher order thinking skills they will need to solve the problems. In social constructivist classrooms, collaborative learning is a process of peer interaction that is mediated and structured by the teacher. Discussion can be promoted by the presentation of specific concepts, problems or scenarios, and is guided by means of relevant and effectively directed questions, the introduction and clarification of concepts and information, and references to previously learned material. Constructivist teachers do not take the role of the "sage on the stage." Instead, they act as a "guide on the side," providing students with opportunities to test the adequacy of their current understandings. The expectation within a constructivist learning environment is that the students play a more active role in, and accepts more responsibility for, their own learning.

The learning environments are designed to provoke the kinds of thoughtful engagement that helps students develop effective thinking skills and attitudes that contribute to effective problem solving and critical thinking. It also emphasizes group or collaborative problem solving.

Straightforward, linear instruction, in the form of tutorials, lectures, and many other formats, will, according to cognitive flexibility theory, fail to accomplish important educational objectives in part because of oversimplification of the material presented. This oversimplification results in the inability to transfer knowledge across to new and varied domains (Spiro, et al., 1992, Boger-Mehall, 2011).

According to cognitive flexibility theory, the way students are taught has a significant influence on the type of cognitive structures they create. The way they store and structure the knowledge they acquire determines to a great extent how flexible they will be when they must use that knowledge. Encouraging cognitive flexibility requires a flexible teaching environment. Information must be presented in a variety of ways, as well as for a variety of purposes. Flexible instructional methods help students learn the contours and complexity of the material they are studying, and it helps them work with that content from several different perspectives (Spiro, et al., 1992, Boger-Menhall 2011). The computer, with appropriate supporting material, is well-suited to flexible instruction. It can provide the variability needed to present ill-structured knowledge domains and to help students explore more than one perspective on a topic or issue.

There is a great need to test the application of Anchored instruction and Cognitive Flexibility strategies in various knowledge domains. Incorporating these strategies into the curriculum would help to reveal its effectiveness in achieving educational objectives in all aspects of education, since it can be used alongside the lecture method. The use of technology by the teachers, especially in providing effective teaching materials as used in these two strategies, will further help to upgrade teachers in the appropriate use of technology for teaching and take their place in education worldwide.

## 5.3 Recommendations

Based on the findings of the study, the following recommendations were made:

- From the findings of this study, it is evident that it is possible to use metacognitive teaching strategies, such as Anchored Instruction and Cognitive Flexibility strategies, as an alternative method of instruction at the secondary school level.
- Anchored Instruction and Cognitive Flexibility learning strategies should be adopted as viable strategies for learning environmental concepts, since they involve students'

participation in their learning process. These strategies are viable for improving environmental knowledge, attitude and necessary practices needed by students in secondary schools.

- Students should be allowed to perform all tasks simple, complex or abstract and interact with all instructional resources in Biology classroom, in order for students to apply the acquired knowledge to solve problems.
- Teaching strategies such as Anchored Instruction and Cognitive Flexibility learning strategies that reduce the gender difference in environmental achievement, its attitudes and necessary practices as recorded in this research could be used as a basis for bringing about a reduction of anxiety in learning for both male and female students.
- There is need to integrate into the school science curriculum systematic ways in which practicing teachers and would-be teachers can be trained in the use of Anchored Instruction and Cognitive Flexibility learning strategies for teaching environmental and other concepts in Biology, so as to produce qualified and well groomed students for biological courses in higher institutions.
- Periodic and regular training, seminars and workshops should be organized for teachers to update their knowledge on current, innovative and more effective teaching strategies at the secondary school level.
- Curriculum planners should include Anchored Instruction and Cognitive Flexibility instructional strategies among the various strategies suggested for teaching science subjects in secondary schools.
- The Government should endeavour to provide computers (desktops and laptops) to teach other subjects apart from computer science so as to ensure that students are not technologically backward in fitting into the new trends of education worldwide. These computers should be well monitored to ensure their continuous availability and usability in the schools.

## 5.4 Conclusion

Learning is a process requiring effort by the learner to actively construct his or her own meaning that is consistent with prior ideas. Such ability requires that a learner should learn how to connect or integrate previous knowledge with new ones and also apply it to real life situations. Such learning is described as meaningful learning. For meaningful learning to take place, the concept presented to the leaner must be potentially meaningful and, hence, must provide opportunity for the learner to form non arbitrary relationships with existing conceptual framework (meaningful task). The findings of this study have shown that Anchored Instruction and Cognitive Flexibility strategies were effective in accomplishing these and even in improving the students' attitude to and achievement in environmental concepts in Biology than the traditional or conventional teaching method. Hence, Anchored Instruction and Cognitive Flexibility Strategies can be used to foster the learning of selected concepts in Biology, irrespective of students' gender and cognitive style.

## 5.5 Limitations to the study

Some constraints, which were encountered in the process of carrying out this study which may therefore limit generalizing of the results, are stated as follows:

The study was limited to only nine senior secondary schools within the Ibadan Metropolis, and the treatment covered a period of twelve weeks. There is, therefore, need to replicate this study on larger population in Oyo State and for an extended time lag. Also, only few selected environmental education concepts in biology were used for the study.

Also, out of the numerous effective metacognitive instructional strategies available, the study only made use of two strategies, which are the Anchored Instruction and Cognitive Flexibility strategies.

Although all the public schools used had computers, most of them were non functional which necessitated taking of additional laptops to the schools to ensure that the study was carried out as expected and planned.

Lastly, the study considered cognitive style and gender as moderator variables out of so many other moderator variables such as mental ability, students' age, parental involvement in

education, verbal ability and others. These limitations notwithstanding, the study has sufficient merit for the generalization of its findings.

### 5.6 Contributions of the Study to Knowledge

The study would form empirical evidence for subsequent researches in Biology and other science related disciplines. The findings would serve as a basic foundation for future studies in the area of Anchored Instruction and Cognitive Flexibility strategies and their proper utilization for effective teaching and learning of Biology in secondary schools.

No doubt, the study has established the fact the Anchored Instruction and Cognitive Flexibility instructional strategies if adopted will be effective in enhancing improved knowledge of environmental concepts, positive attitude to environmental concepts and positive environmental practices in Biology.

The findings of the study has provided information which if adopted will upgrade teachers' professional competences and classroom practices and motivate them to adopt and use strategies that enhance Biology achievement and the development of favourable attitude.

### 5.7 Suggestions for Further Studies

In view of the limitations of the study, the following suggestions are made for further research:

1. The study could be replicated to cover wider areas such as Oyo State, or the whole of South-West Geo-Political Zone of Nigeria.
2. The duration of the treatment could be extended beyond the period of thirteen weeks.
3. The study could be carried out in other subject areas or aspects of Biology.
4. The study could be replicated at the primary and tertiary levels of education.
5. The study could be replicated with students in the other geo-political zones of the country so as to make the findings more generalisable.
6. Further research could be conducted using other moderator variables such as age, mental ability, study habit, self-esteem, science process skills, school type, verbal ability,

parental educational background and parental involvement which could influence students' achievement and attitude to environmental concepts in Biology.

7. Other environmental concepts in Biology, such as ecology, acid rain ozone layer depletion and green house effect, including other aspects of Biology apart from environmental issues, could be involved, as this will enhance performance of our students in biological sciences.

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## APPENDIX IA

## STUDENTS' KNOWLEDGE OF ENVIRONMENTAL CONCEPT TEST (SKECT)

INTRODUCTION: This instrument seeks to find out your knowledge of environmental education concepts in Biology. Please complete each item.

**SECTION A:** Personal Data

Name of School:

Gender: Male ( ) Female ( ) Local Government:

SECTION B

Below are some questions on environmental problems and issues. Choose the answer that you consider correct for each question. Circle boldly one answer as your choice.

1. The cutting down of trees without planting another is known as

   (a) Loss of vegetation (b) Deforestation (c) Erosion (d) Pollution.

2. Conservation of natural resources may not include.

(a) Recycling of empty cans or bottles (b) setting up a game reserve (c) finding new energy sources (d) Over – fishing the seas and lakes

3. Which of the following agricultural activities has the least harmful effect on the environment? (a) application of fertilizers (b) practising crop rotation (c) Spraying herbicides(d) spraying pesticides.
4. Malaria which is a common disease in Nigeria is caused by _____ (a) A clean and Healthy environment (b) lack of proper use of nets. (c)a dirty environment (d) Improper dumping of solid wastes.
5. Which of the following is released from car exhaust to cause air pollution?
   (a) Carbon dioxide (b) carbon monoxide (c) Nitrogen dioxide (d) sulphur dioxide

6. Air pollution can be reduced by the following methods except
(a) building tall factory chimneys (b) passing waste gases through filters and absorbers (c) using lead-free petrol in cars. (d) recycling tins, can and bottles.

7. Oil spillage at sea resulting from the transportation of crude oil causes:
(a) death of marine life (b) coloration of the sea water (c) hindrance in the movement of ships (d) all of the above

8. The throwing of dirty things into the rivers and streams is called…
(a) loss of vegetation (b) water pollution (c) floods (d) erosion.

9. Pollution of the air and water are environmental problems because it
(a) destroys the environment (b) protects the environment (c) makes the environment look beautiful (d) makes the environment look neat.

10. Throwing wastes and dirty things into the rain can result into
(a) healthiness (b) flooding (c) removal of wastes (d) clean environment

11. Which of the following discharge could cause environmental pollution?
(a) refuse/solid waste (b) toxic waste (c) sewage (d) all of the above.

12. What should be done to conserve our natural resources?
(a) do not use natural resources (b) use natural resources wisely (c) restore natural resources(d) replace worn our resources

13. Which of these statements about pollution is Not Correct…
(a) it is indispensable in the environment (b) it causes diseases (c) it can result in depletion of natural resources (d) it can cause handicap of better and wise use of resources

14. Garbage thrown into water bodies
(a) gives off a bad smell (b) reduces number of fishes in the river (c) A & B (d) release oxygen for fish respiration.

15. _____ is a method adopted in conservation, where resource is processed to make it re-usable (a) recycling (b) non-renewable resource (c) inexhaustible item (d) non-renewable

16. _____is an example o disease caused by water pollution resulting from

impurities or contamination. (a) Typhoid (b) Malaria Fever (c) Sneezing (d) Coughing

17. Possible effect(s) of air pollution on human body include
    (a) Headaches (b) Nausea and Vomiting (c) Lung cancer (d) A, B & C.

18. Soil erosion can be prevented by ____
    (a) planting of trees (b) burning of bushes (c) floods (d) clean clearing of bushes.

19. Cutting down of trees and land clearing can cause the following except _____
    (a) soil erosion (b) growth and development (c) flooding (d) deforestation

20. Which of the following at is NOT a benefit of conservation of natural resources?
    (a) It permits nature studies (b) It preserves the beauty of nature
    (c)It is a source of revenue earning (d)It prevents the good use of resources

## APPENDIX IB

## MARKING GUIDE FOR STUDENTS' KNOWLEDGE OF ENVIRONMENTAL CONCEPTS TEST (SKECT)

1. D
2. B
3. C
4. B
5. D
6. D
7. B
8. A
9. B
10. D
11. B
12. A
13. C
14. A
15. A
16. D
17. A
18. B
19. D
20. D

## APPENDIX II

## STUDENTS' ENVIRONMENTAL ATTITUDE SCALE (SEAS)

INTRODUCTION: This instrument seeks to find out your attitude to environmental problems as expressed in the environmental education concepts in Biology. Please complete each item.

SECTION A: Personal Data

Name of School:

Gender: Male ( ) Female ( ) Local Government area:

SECTION B

The following statements are developed to measure student's attitude to environmental issues and problems. Please tick (✓) the appropriate options that best reflect your agreement or disagreement.

| | | Strongly Agree (SA) | Agree (A) | Disagree (D) | Strongly disagree (SD) |
|---|---|---|---|---|---|
| 1. | We need to acquire a life-long education and commitment to protecting the earth's environment | | | | |
| 2. | There is inter-dependence between man and the environment | | | | |
| 3. | We should let people know the relationship between individual, societal needs and environmental quality | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 4. | The consequences of our actions on the environment can be hazardous | | | | |
| 5. | Setting forest on fire or bush burning can render the soil infertile | | | | |
| 6. | Conservation of air is the protection and preservation of air in a way that it can sustain life and improve health and vitality | | | | |
| 7. | Our wastes should be treated and re-used for making useable materials | | | | |
| 8. | Cutting down trees without planting others is good for our country | | | | |
| 9. | Burning of refuse pollutes the environment | | | | |
| 10 | Dumping wastes in rivers and rain flood is the right way of disposing refuse | | | | |
| 11 | My family and I take active part in environmental sanitation to keep our environment neat. | | | | |
| 12 | There is no need for environmental sanitation day | | | | |
| 13 | Planting of trees and flowers makes the air clean and fresh to inhale | | | | |
| 14 | Everyone needs to acquire skills needed to prevent environmental disasters such as flood and soil erosion | | | | |
| 15 | Education helps us to learn how to prevent | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | further degradation of the environment | | | | |
| 16 | Boiling water before drinking is hygienic | | | | |
| 17 | The burning of refuse is a harmless way of disposing of our garbage | | | | |
| 18 | Air and water pollution is a serious problem in the world today | | | | |
| 19 | Solid waste disposal is the biggest environmental problem in Nigeria | | | | |
| 20 | We should all find ways of reducing environmental pollution | | | | |

## APPENDIX III

**STUDENTS' PERCEIVED ENVIRONMENTAL PRACTICES SCALE (SPEPS)**

INTRODUCTION: This Scale intends to investigate your practice towards environmental problems in Nigeria. Please complete each item.

SECTION A

Name of School:

Gender: Male ( ) Female ( )

SECTION B

These are some statements' about practices of students towards environmental pollution and conservation techniques. Please mark (X) in the box provided that matches the extent of your Practices with each statement. The letters stands for the following: - **VO - Very Often; O – Often; S – Seldom; N - Never**

| S/No. | How often do you do the following? | **VO** | **O** | **S** | **N** |
|---|---|---|---|---|---|
| 1. | Control Bush burning not to produce smoke that will disturb people. | | | | |
| 2. | Use air purifier like air fresheners to remove unpleasant odour in the air. | | | | |
| 3. | Stay away from unpleasant odour in the environment. | | | | |
| 4. | Treat your well/borehole | | | | |
| 5. | Drink treated water. | | | | |
| 6. | Caution people that are smoking on the road side. | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 7. | Read newspaper articles alerting people on the threats posed to our health by using polluted water | | | | |
| 8. | Providing dust bin for refuse disposal. | | | | |
| 9. | Sweep a dirty sandy place after wetting the soil. | | | | |
| 10. | Stay very close to heavy heaps of refuse in the environment. | | | | |
| 11. | Pick up wastes from the floor around you. | | | | |
| 12. | Observe environmental sanitation exercise. | | | | |
| 13. | Dispose refuse into the dustbin. | | | | |
| 14. | Educate people on conservation techniques. | | | | |
| 15. | Educate people on the importance of a hygienic environment. | | | | |

## APPENDIX IVA

## COGNITIVE STYLE TEST

INTRODUCTION: This instrument seeks to find out your preferred way of processing information especially in environmental concepts in Biology. Please complete each item.

SECTION A: Personal Data

Name of School:

Gender: Male ( ) Female ( ) Local Government area:

SECTION B

Study the picture slides shown on the computer you have carefully and suggest ways of finding solutions to the environmental problems portrayed in the slides in such a way that it will not constitute a problem to the environment. State also materials or items needed in solving the problems where necessary.


Rafael Macia/Photo Researchers, Inc.


Lester Lefkowitz/Corbis

## APPENDIX IVB

## MARKING GUIDE FOR COGNITIVE STYLE TEST (CST)

Students are expected to give the following suggestions as their answers

1a. The name of the problem observed in each picture (1marks)

1b Suggest possible solutions to the problem (novel ideas = 6marks; conventional ideas =3marks)

1c Suggest the materials needed such as

-The use of waste pickup truck,

- The use of chemicals

- Supply of dustbins,

- making laws and stating specific punishment for defaulters

- Giving out the materials to companies for recycling

- Burning in pits or incinerators

- Dumping wastes in the waste disposal bins in the public places for proper disposal by the collecting agents.

(Any 5 suggestions= 5marks)

To categorise students into groups using this marking guide, on the continuum of 0 – 15 marks

(a) Adaptors : Students with total marks $\leq 7$
(b) Innovators : Students with total marks $> 7$

## APPENDIX VA

## INSTRUCTIONAL GUIDE FOR TEACHING WITH ANCHORED INSTRUCTIONAL STRATEGY (IGTAIS)

CLASS: SS II

TOPIC: This was for each of the topics

OBJECTIVES: (For all the lessons) At the end of the lesson students should be able to;

i. define the concept

ii. enumerate environmental problems observed

iii. observe , gather and record data on environmental issues observed

iv. interprete and analyse data on environmental concepts being discussed

v. state the need for environmental education as related to the concept being taught.

DURATION: 80 minutes

PREVIOUS KNOWLEDGE: The students have acquired general knowledge/meaning of each of the concepts during classroom teaching.

TEACHING AIDS: The use of slide presentation on the computer that will serve as the anchor.

PRESENTATION:

STEP I: INTRODUCTION: The teacher should

State the topic

Explain the purpose of the study

Link the topic with previous knowledge or experience using related questions

Introduce and give a brief highlight of the new topic

STEP II: PRESENTATION OF THEORETICAL CONTENT

State information on topic in form of discussions, description of concepts, benefits and value inherent and associated problems as earlier discussed in class.

STEP III: STRATEGY IMPLEMENTATION

1 – The teacher anchors the subject matter in a power point representation and shows the slides to the students.

2 - The teacher encourage student groups to extract key issues, facts, data

3 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

4- Students develop solutions to the problem.

5 - Pros and cons of each idea are discussed

6- Use relevant questions to direct students in the process and notice their attitude towards what is being observed.

STEP IV: STUDENTS’ ACTIVITIES

Allow students’ discussion to evaluate their level of comprehension and assimilation.

STEP V: SUMMARY

Bring all the points together to provide an overview

EVALUATION: The teacher ask the students specific questions that

Relate to definition of the concept

Require an application of problem solving skills. .

ASSIGNMENT: Teacher would give class assignment and homework based on the next topic or concept.

## APPENDIX VB

**LESSON ONE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Environment

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

i. define environment,

ii. list some environmental problems

iii. observe , gather and record data on environmental issues observed

iv. list and explain some causes of environmental problems and suggest solutions to the problems

v. state the need for environmental education .

PREVIOUS KNOWLEDGE: The students are familiar with the term environment and have acquired general knowledge/meaning of each of the concepts during classroom teaching.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher divides the class into small groups.The teacher introduces the day's topic as "Environment" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 environmental problems.

(2) list 4 causes of environmental problems.

## APPENDIX V C

**LESSON TWO**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Water pollution

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

i. define water pollution,

ii. list some sources and causes of water pollution

iii. explain the effects of water pollution

iv. discuss how to eradicate water pollution

v. explain the need to educate people on air pollution.

PREVIOUS KNOWLEDGE: The students have been seeing polluted water bodies around and have acquired general knowledge on methods of purifying water.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Water Pollution" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 sources of water pollution.

(2) List 4 ways water pollution can be controlled.

## APPENDIX V D

**LESSON THREE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Air pollution

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

i. define air pollution,

ii. list some sources and causes of air pollution

iii. explain the effects of air pollution

iv. discuss how to eradicate air pollution

v. explain the need to educate people on air pollution .

PREVIOUS KNOWLEDGE: The students are familiar with series of activities around them that causes air pollution.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Air Pollution" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 sources of air pollution.

(2) List 4 ways air pollution can be controlled.

## APPENDIX V E

**LESSON FOUR**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Land/ Soil pollution

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

i. define land pollution,

ii. list some sources and causes of land pollution

iii. explain the effects of land pollution

iv. discuss how to eradicate land pollution

v. explain the need to educate people on the effects of land pollution .

PREVIOUS KNOWLEDGE: The students are familiar with series of activities around them that causes land pollution.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Land Pollution" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes of land pollution.

(2) List 4 ways land pollution can be controlled.

## APPENDIX V F

**LESSON FIVE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Erosion

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

i. define erosion,

ii. list and explain the types of erosion

iii. list some causes of erosion

iv. explain the effects of erosion

v. discuss how to prevent and control erosion

vi. explain the need to educate people on the effects of erosion.

PREVIOUS KNOWLEDGE: The students are familiar with the aftermath of erosion on roads.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Erosion" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes erosion.

(2) List 4 ways erosion can be prevented.

## APPENDIX V G

**LESSON SIX**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Desertification

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

i. define desertification,

ii. list some causes of desertification

iii. explain the effects of desertification

iv. discuss how to control desertification

v. explain the need to educate people on the effects of desertification.

PREVIOUS KNOWLEDGE: The students are familiar with some human activities such as cutting tree which may lead to desertification.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Desertification" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes desertification.

(2) List 4 ways desertification can be prevented.

## APPENDIX V H

**LESSON SEVEN**

CLASS: SS II

DURATION: 80 minutes

TOPIC: Conservation of natural resources

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

vi. define Conservation,

vii. explain Conservation of natural resources,

viii. list some natural resources that needs to be conserved

ix. explain how to conserve natural resources

x. explain the need to educate people on how to manage our natural resources.

PREVIOUS KNOWLEDGE: The students are familiar with the way some people waste the natural resources in the environment.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Conservation of natural resources" and does a brief introduction on the topic.

Step 2 – The teacher presents the 'Anchor' (the subject matter) in a realistic situation using slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - Students are encouraged to “play back” or “re-explore” story to retrieve necessary data for solving problems

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher arranges the main points logically to suit the content discussed

Step 8 – The teacher evaluates the lesson by asking the students questions on the content discussed according to the stated objectives and receives adequate feedback.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss the need for conserving natural resources.

(2) List 4 natural resources in the environment .

## APPENDIX VIA

## INSTRUCTIONAL GUIDE FOR TEACHING WITH COGNITIVE FLEXIBILITY STRATEGY (IGTCFS)

CLASS: SS 2

TOPIC: This was for each of the topics

OBJECTIVES: (For all the lessons) By the end of the lesson students should be able to;

i. define the concept

ii. enumerate environmental problems observed

iii. observe , gather and record data on environmental issues observed

iv. interprete and analyse data on environmental concepts being discussed

v. state the need for environmental education as related to the concept being taught.

DURATION: 80 minutes

PREVIOUS KNOWLEDGE: The students have acquired general knowledge/meaning of each of the concepts during classroom teaching.

TEACHING AIDS: Hypertext

REFERENCES: Modern biology, Round-up biology, Essential biology for senior secondary schools.

PRESENTATION:

STEP I: INTRODUCTION: The teacher should

1. state the topic
2. explain the purpose of the study
3. link the topic with previous knowledge or experience using related questions
4. introduce and give a brief highlight of the new topic

STEP II: PRESENTATION OF THEORETICAL CONTENT

The teacher divides the class into small groups. The teacher then provides the learners with activities on the topic in a multiple representation using slides of power point presentation.

STEP III: STRATEGY IMPLEMENTATION

Item 1- The students study the slides which emphasizes knowledge construction by the students and not transmission of information by the slides presented. Let there be a discussion on the problems or issues observed

Item 2- Students are encouraged to study the case and retrieve necessary data for solving problems.

Item 3 - Allow the students to have a close study and Use relevant questions to direct students in the process and notice their attitude towards what is being observed.

Item 4 - Allow students to suggest or proffer solutions to the problem

STEP IV: STUDENTS' ACTIVITIES

1. Ask relevant questions on the concept.
2. Allow students' discussion to evaluate their level of comprehension and assimilation.

STEP V: SUMMARY

Bring all the points together to provide an overview

EVALUATION: The teacher ask the students specific questions that

1. relate to definition of the concept
2. require an application of problem solving practices.

ASSIGNMENT: Teacher would give class assignment and homework based on the next topic or concept.

## APPENDIX VIB

**LESSON ONE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Environment

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

vi. define environment,

vii. list some environmental problems

viii. observe , gather and record data on environmental issues observed

ix. list and explain some causes of environmental problems and suggest solutions to the problems

x. state the need for environmental education .

PREVIOUS KNOWLEDGE: The students are familiar with the term environment and have acquired general knowledge/meaning of each of the concepts during classroom teaching.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Environment" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 environmental problems.

(2) list 4 causes of environmental problems.

## APPENDIX VIC

**LESSON TWO**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Water pollution

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

vi. define water pollution,

vii. list some sources and causes of water pollution

viii. explain the effects of water pollution

ix. discuss how to eradicate water pollution

x. explain the need to educate people on air pollution.

PREVIOUS KNOWLEDGE: The students have been seeing polluted water bodies around and have acquired general knowledge on methods of purifying water.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Water Pollution" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 sources of water pollution.

(2) List 4 ways water pollution can be controlled.

## APPENDIX VI D

**LESSON THREE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Air pollution

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

vi. define air pollution,

vii. list some sources and causes of air pollution

viii. explain the effects of air pollution

ix. discuss how to eradicate air pollution

x. explain the need to educate people on air pollution .

PREVIOUS KNOWLEDGE: The students are familiar with series of activities around them that causes air pollution.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Air Pollution" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 – The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 sources of air pollution.

(2) List 4 ways air pollution can be controlled.

## APPENDIX VI E

**LESSON FOUR**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Land/ Soil pollution

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

vi. define land pollution,

vii. list some sources and causes of land pollution

viii. explain the effects of land pollution

ix. discuss how to eradicate land pollution

x. explain the need to educate people on the effects of land pollution .

PREVIOUS KNOWLEDGE: The students are familiar with series of activities around them that causes land pollution.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Land Pollution" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 – The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes of land pollution.

(2) List 4 ways land pollution can be controlled.

## APPENDIX VI F

**LESSON FIVE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Erosion

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

vii. define erosion,

viii. list and explain the types of erosion

ix. list some causes of erosion

x. explain the effects of erosion

xi. discuss how to prevent and control erosion

xii. explain the need to educate people on the effects of erosion.

PREVIOUS KNOWLEDGE: The students are familiar with the aftermath of erosion on roads.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Erosion" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes erosion.

(2) List 4 ways erosion can be prevented.

## APPENDIX VI G

**LESSON SIX**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Desertification

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

vi. define desertification,

vii. list some causes of desertification

viii. explain the effects of desertification

ix. discuss how to control desertification

x. explain the need to educate people on the effects of desertification.

PREVIOUS KNOWLEDGE: The students are familiar with some human activities such as cutting tree which may lead to desertification.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Desertification" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes desertification.

(2) List 4 ways desertification can be prevented.

## APPENDIX VI H

**LESSON SEVEN**

CLASS: SS II

DURATION: 80 minutes

TOPIC: Conservation of natural resources

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

xi. define Conservation,

xii. explain Conservation of natural resources,

xiii. list some natural resources that needs to be conserved

xiv. explain how to conserve natural resources

xv. explain the need to educate people on how to manage our natural resources.

PREVIOUS KNOWLEDGE: The students are familiar with the way some people waste the natural resources in the environment.

TEACHING AIDS: Hypertext in power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Introduction: The teacher asks the students revision questions on the previous lesson.

Step 1: The teacher introduces the day's topic as "Conservation of natural resources" and does a brief introduction on the topic.

Step 2 – The teacher presents the multiple hypertext representations of content using power point slides.

Step 3 – Teacher encourages student groups to extract key issues, facts, and data from slides and jot down points on their paper.

Step 4 - The students study the slides which emphasize knowledge construction by the students and not transmission of information by the slides presented.

Step 5 - Students develop solutions and discuss in groups before presenting ideas to class.

Step 6 - Pros and cons of each idea are discussed

Step 7 - Teacher discusses the misconceptions of ideas and arranges the main points logically to suit the content discussed

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss the need for conserving natural resources.

(2) List 4 natural resources in the environment .

## APPENDIX VII A

## INSTRUCTIONAL GUIDE FOR TEACHING WITH THE MODIFIED CONVENTIONAL METHOD (LECTURE METHOD) (IGTMCM)

TOPIC: This was for each of the topics

OBJECTIVES: (For all the lessons) At the end of the lesson students should be able to;

i. define the concept
ii. enumerate environmental problems
ii. state the need for environmental education as related to the concept being taught.

DURATION: 40 minutes

PREVIOUS KNOWLEDGE: The students have acquired some level of general knowledge/meaning of each of the concept in their previous class.

INSTRUCTIONAL MATERIALS: Some charts and pictures showing some environmental problems.

PRESENTATION:

STEP I: INTRODUCTION: The teacher should

1. state the topic
2. explain the purpose of the study
3. link the topic with previous knowledge or experience using related questions
4. introduce and give a brief highlight of the new topic

STEP II: PRESENTATION OF THEORETICAL CONTENT

State and explain information on topic in form of discussions, description of concepts, benefits and value inherent and associated problems using the teaching aids. This should involve an interaction by the students with the instructional materials.

STEP III: STRATEGY IMPLEMENTATION

i. Teacher would give information on the concept to the students.

ii Teacher allows a discussion on the problem or issue

iii Teacher asks students relevant questions on the discussion.

STEP IV: STUDENTS' ACTIVITIES

1. Ask relevant questions on the concept.
2. Allow students' discussion to evaluate their level of comprehension and assimilation.

STEP V: SUMMARY

Bring all the points together to provide an overview of the concept discussed.

EVALUATION: The teacher asks the students specific questions that

1. relate to definition of the concept
2. require an application of problem solving skills.

ASSIGNMENT: Teacher would give class assignment and homework based on the next topic or concept.

## APPENDIX VII B

**LESSON ONE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Environment

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

xi. define environment,

xii. list some environmental problems

xiii. observe , gather and record data on environmental issues observed

xiv. list and explain some causes of environmental problems and suggest solutions to the problems

xv. state the need for environmental education .

PREVIOUS KNOWLEDGE: The students are familiar with the term environment and have acquired general knowledge/meaning of each of the concepts during classroom teaching.

TEACHING AIDS: Charts, textbook.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 environmental problems.

(2) list 4 causes of environmental problems.

## APPENDIX VII C

**LESSON TWO**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Water pollution

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

xi. define water pollution,

xii. list some sources and causes of water pollution

xiii. explain the effects of water pollution

xiv. discuss how to eradicate water pollution

xv. explain the need to educate people on air pollution.

PREVIOUS KNOWLEDGE: The students have been seeing polluted water bodies around and have acquired general knowledge on methods of purifying water.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 sources of water pollution.

(2) List 4 ways water pollution can be controlled.

## APPENDIX VII D

**LESSON THREE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Air pollution

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

xi. define air pollution,

xii. list some sources and causes of air pollution

xiii. explain the effects of air pollution

xiv. discuss how to eradicate air pollution

xv. explain the need to educate people on air pollution .

PREVIOUS KNOWLEDGE: The students are familiar with series of activities around them that causes air pollution.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 sources of air pollution.

(2) List 4 ways air pollution can be controlled.

## APPENDIX VII E

**LESSON FOUR**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Land/ Soil pollution

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

xi. define land pollution,

xii. list some sources and causes of land pollution

xiii. explain the effects of land pollution

xiv. discuss how to eradicate land pollution

xv. explain the need to educate people on the effects of land pollution .

PREVIOUS KNOWLEDGE: The students are familiar with series of activities around them that causes land pollution.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes of land pollution.

(2) List 4 ways land pollution can be controlled.

## APPENDIX VII F

**LESSON FIVE**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Erosion

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

xiii. define erosion,

xiv. list and explain the types of erosion

xv. list some causes of erosion

xvi. explain the effects of erosion

xvii. discuss how to prevent and control erosion

xviii. explain the need to educate people on the effects of erosion.

PREVIOUS KNOWLEDGE: The students are familiar with the aftermath of erosion on roads.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes erosion.

(2) List 4 ways erosion can be prevented.

## APPENDIX VII G

**LESSON SIX**

CLASS: SS II

DURATION: 40 minutes

TOPIC: Desertification

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

xi. define desertification,

xii. list some causes of desertification

xiii. explain the effects of desertification

xiv. discuss how to control desertification

xv. explain the need to educate people on the effects of desertification.

PREVIOUS KNOWLEDGE: The students are familiar with some human activities such as cutting tree which may lead to desertification.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss 4 causes desertification.

(2) List 4 ways desertification can be prevented.

## APPENDIX VII H

**LESSON SEVEN**

CLASS: SS II

DURATION: 80 minutes

TOPIC: Conservation of natural resources

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

xvi. define Conservation,

xvii. explain Conservation of natural resources,

xviii. list some natural resources that needs to be conserved

xix. explain how to conserve natural resources

xx. explain the need to educate people on how to manage our natural resources.

PREVIOUS KNOWLEDGE: The students are familiar with the way some people waste the natural resources in the environment.

TEACHING AIDS: Power point slides presentation.

REFERENCES: Modern biology for senior secondary schools, Round-up biology for senior secondary schools, Essential biology for senior secondary schools.

PRESENTATION:

Step 1: The teacher introduces the lesson by asking questions based on their previous knowledge

Step 2: Teacher presents the topic and discusses the content of the lesson.

Step 3: Teacher directs students to write the blackboard summary of the subject matter taught in their note books.

Step 4: Teacher evaluates the lesson by asking students some questions in class

Step 5: Teacher gives homework/ assignment on the topic discussed.

EVALUATION: The teacher asks the students questions on the content discussed according to the stated objectives and receives adequate feedback. Misconceptions are corrected and short notes are written for the students.

ASSIGNMENT: (1) Discuss the need for conserving natural resources.

(2) List 4 natural resources in the environment .

## APPENDIX VIII A

## EVALUATION SHEET FOR ASSESSING TEACHERS (ESAT) FOR ANCHORED INSTRUCTION, COGNITIVE FLEXIBILITY AND MODIFIED CONVENTIONAL STRATEGIES

Name of school:

Local government area:

| Item | Activities | V.G 5 | G 4 | AV 3 | P 2 | V.P 1 |
|---|---|---|---|---|---|---|
| 1 | Introduction: Ability to link new topic to previous knowledge | | | | | |
| 2 | Clearly stated instructional objectives | | | | | |
| 3 | Presentation/ description of concept | | | | | |
| 4 | Mastery of subject-matter by the teacher | | | | | |
| 5 | Variety and effectiveness of procedures / strategies | | | | | |
| 6 | Effective use of instructional guide given to the group | | | | | |
| 7 | Questioning skills: Use of relevant questions on the concept | | | | | |
| 8 | Reflection of real life environmental problems through the cognitive flexibility strategy | | | | | |
| 9 | Provision operation of relevant instructional materials | | | | | |
| 10 | Suitability and utility of instructional materials | | | | | |
| 11 | Skills and language of communication of the | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | environmental issues | | | | | |
| 12 | Involvement of students in classroom discussion | | | | | |
| 13 | Initiating ideas of concepts in students | | | | | |
| 14 | Motivating students to suggest or proffer solutions to problems where necessary | | | | | |
| 15 | Identification of new environmental knowledge, attitude and problem solving skills gained in the evaluation | | | | | |
| 16 | Potentiality of the lesson in developing good environmental attitude in students | | | | | |
| 17 | Attainment of lesson objectives | | | | | |
| 18 | Relevant assignments or activities based on the environmental concept taught | | | | | |