IMPACT OF COLLATERAL AND ANALOGY STRATEGIES ON PRE-CONCEPTIONS AND PERFORMANCE IN EVOLUTION CONCEPTS AMONG NIGERIA CERTIFICATE IN EDUCATION STUDENTS NORTH CENTRAL, NIGERIA

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NIGERIA

JANUARY, 2017

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN SCIENCE EDUCATION DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF EDUCATION.

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JANUARY, 2017

DECLARATION

I hereby declare that this thesis entitled Impact of Collateral and Analogy Strategies on Preconceptions and Performance in Evolution Concepts among Nigeria Certificate in Education Students North Central, Nigeria has been written by me. It is a true record of my research work which has not been presented in any previous work before for a higher degree or published in a book. In the course of writing this thesis, various sources of information had been consulted and these had been fully acknowledged by means of references.

JIYA Alice **Date**

CERTIFICATION

This thesis entitled "Impact of Collateral, Analogy Strategies on Preconceptions and Performance in Evolution Concepts among Nigeria Certificate in Education Students, North Central Nigeria" by Alice JIYA Ph.D/EDU/21288/2012-2013 meets the regulation governing the award of the degree of Doctor of Philosophy (Ph.D) in Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my beloved husband Mr Michael S. Jiya and my children Samuel, Doris, Judith and Theophilus.

ACKNOWLEDGEMENTS

I give Almighty God all the glory, honour and adoration for He is a merciful and faithful God who gave me the opportunity and sustained me through this programme. I wish to appreciate most sincerely Dr. (Mrs) S.B. Olorukooba my major supervisor for her guidance, objective, constructive criticism, suggestions and cooperation without which this work would never have been completed. Your love, patience and words of encouragement are highly appreciated. Mum, a mother indeed thanks a lot and may Almighty God reward you abundantly. I wish to express my sincere gratitude to Dr. (Mrs) F.K Lawal my second supervisor for her advice. Your contributions, moral support and encouragement are highly appreciated. M ay God reward you.

I also wish to express my sincere thanks to Prof. (Mrs) M.A Lakpini my third supervisor for her advice. Your moral support, contributions and encouragement are highly appreciated. May our heavenly Father reward you. I am also grateful to Prof. A.I. Usman for his advice, contributions and words of encouragement which added quality to the work. I appreciate my lecturers Prof. A.A.M. Shaibu, Dr. (Mrs) T.E. Lawal, Prof. J.S. Mari, Dr. S.S. Bichi, Dr. M.M. Atadoga, Dr. S.S Obeka for words of encouragement, advice, moral support which added quality to the work.

My sincere thanks go to all my colleagues from school of sciences and the college management of college of education Minna for granting me permission to carry out the study. I appreciate the cooperation of examination officers and all 300 level biology students in colleges of education Kastina-Ala, Ilorin and Akwanga for their cooperation during the course of this study. May God Almighty reward each and every one of you abundantly.

Also my sincere appreciation goes my beloved mother Mrs Rhoda Tsado for her prayers and encouragement, Dr A. Mohammed, my sisters, sisters' in-law, brothers,

aunties, brother in-laws, friends, Marcus, relatives and well wishers for their encouragement and prayers which contributed to the completion of this work.

Finally, I am most grateful to my beloved and wonderful husband Michael S Jiya whose love, motivation, words of encouragement and financial support saw me through the work. My thanks go to all my beloved children Samuel, Doris, Judith and Theophilus who supported and prayed for my successful completion of the programme. I appreciate you all.

ABBREVIATIONS

The following abbreviations used for the study are presented as follows.

NCE: Nigeria Certificate in Education

BIO: Biology

UPTE: Unscientific Preconception Test on Evolution

EPT: Evolution Performance Test

NCCE: National Commission for Colleges of Education

OPERATIONAL DEFINITION OF TERMS

The following are definitions of terms as used in this study by the researcher;

Analogy Teaching Strategy: is a strategy that serves like a bridge linking the gap between the prior knowledge of students and the new science concepts to be learnt by introduction of something familiar to explain unfamiliar science concept.

Analogy: is comparison of something unfamiliar with something familiar in order to explain a shared principle.

Collateral Teaching Strategy: is a strategy that helps in resolving problem of conflict between culture and science as it attempts to help students cope with science learning, without doing violence to their particular cultural beliefs and experiences.

Lecture Method: The method of teaching where the teacher does most of the talking while the learner only listens most of the time and take down notes.

Performance: The overall measure of students accomplishment in a given test after a period of instruction or teaching, usually weighted as scores.

Preconception: is an idea or opinion formed before enough information is available to form it correctly.

Unscientific preconception: they are ideas that cannot be proved scientifically.

LIST OF TABLES

Table Page

3.1: Population of the Study....86

3.2: Schools Sampled for Pilot Study 87

3.3: Sample of the Study....88

3.4: Table of Specification for EPT based on Bloom's Cognitive Taxanomy 91

4.01: Frequency and Percentage of Unscientific Preconception Types found on Students' scripts....105

4.02: Pretest-Posttest Mean Scores from Unscientific preconception test on Evolution for E1, E2 and Control Groups 106

4.03: Means and Standard Deviations of Posttest Scores form Unscientific Preconceptions for E1, E2 and Control Groups....106

4.04: Summary of ANOVA Statistics for Posttest Mean Scores for E1, E2 and Control Groups....107

4.05: Scheffe's test for Mean Scores Multiple Comparisons among E1, E2 and Control Groups....108

4.06: Pretest-Posttest Mean Scores of Evolution Performance Test for E1, E2 and Control Groups....109

4.07: Means and Standard Deviation of Posttest Performance Scores for the E1, E2 and Control Groups 110

4.08: Summary of ANOVA for the Posttest Mean Performance Scores for E1, E2 and Control Groups 111

4.09: Summary of Scheffes test for Means Performance Scores of Multiple Comparisons between E1, E2 and Control Groups 111

4.10: Pretest-posttest Mean Scores for Unscientific Preconceptions Test for Male and Female in E1, E2 and Control Groups 112

4.11: Gender-Related Difference in the Mean Scores on unscientific Preconceptions between Male and Female in E1, E2 and Control Groups 113

4.12: Summary of ANOVA for Posttest Mean Scores on Unscientific Preconceptions between Male and Female Students in E1, E2 and Control Groups 114

4.13: Result of Scheffes test for posttest unscientific Scores of Multiple Comparisons between Male and Female in E1, E2 and Control Groups.....114

4.14: Pretest-Posttest Mean Scores of Evolution Performance Test of Male and Female Students for E1, E2 and Control Groups.....115

4.15: Gender-Related Difference in the Mean Performance Scores between Male and Female in E1, E2 and Control Groups 116

4.16: Summary of ANOVA for Posttest Mean Performance Scores of Male and Female Students in E1, E2 and Control Groups 117

4.17: Result of Scheffes test for Performance Scores of Multiple Comparisons between Male and Female Students in E1, E2 and Control Groups 117

LIST OF FIGURES

Figure Page

2.1: Flowchart of the Teaching-With-Analogy.....45

2.2: The Collateral Teaching Strategy Model.....58

2.3: Flowchart of CTS.....59

3.1: Research Design.....84

3.2: Flowchart of Teaching- With- Analogy (TWA).....96

3.3: Flowchart of CTSM.....100

LIST OF APPENDICES

Appendix Page

A: Unscientific Preconception Test on Evolution (UPTE) For NCE III Biology Students 148

B: Marking scheme [Unscientific Preconception Test on Evolution (UPTE)] 150

C: Evolution Performance Test (EPT) 154

D: Evolution Performance Test (EPT) Marking Scheme 163

E: Experimental Group One (Analogy Teaching Strategy Model) 164

F: Experimental Group Two (CTS Model) 190

G: The Control Group 209

H: ANOVA Analysis of Variance for unscientific preconception test of students in evolution concepts in the State colleges of education in North Central, Nigeria 227

I: Analysis of Variance (ANOVA) statistics for Pretest EAT was given in order to determine the level of significant among five colleges of education with higher unscientific preconception. 228

J: Item Analysis of EPT Test items 229

K: Students Unscientific Preconceptions from the Student Scripts 231

TABLE OF CONTENTS

Title Page i

Declaration ii

Certification iii

Dedication iv

Acknowledgements v

Abbreviations vii

Operational Definition of Terms viii

List of Tables ix

List of Figures xi

List of Appendices xii

Table of Contents xiii

Abstract xvii

CHAPTER ONE : **THE PROBLEM**

1.1 Introduction 1

1.1.1 Theoretical Framework 10

1.2 Statement of the Problem 12

1.3 Objectives of the Study 14

1.4 Research Questions 14

1.5 Null Hypotheses 15

1.6 Significance of the Study 16

1.7 Scope of the Study 17

1.8 Basic Assumptions 18

CHAPTER TWO : **REVIEW OF RELATED LITERATURE**

2.1 Introduction....19

2.2 Teaching of Evolution Concept at NCE level....20

2.3 Students' Academic Performance in Evolution Concepts....23

2.4 Concept of Preconception....27

2.4.1 Types of Preconceptions in Science....30

2.4.2 Preconceptions and Students' Academic Performance in Science....32

2.4.3 Unscientific Preconceptions in Science Concepts....37

2.5 Concepts of Analogy Teaching Strategy and Science....39

2.5.1 Advantages of Analogy for Teaching....46

2.6 Concepts of Collateral Teaching Strategy and Science....50

2.6.1 Types of Collateral Learning Strategy....60

2.6.2 Advantages of Collateral Strategy for Science Learning....64

2.7 Gender and Academic Performance in Science....65

2.8 Overview of Similar Studies....67

2.9 Implication of Literature Reviewed for the Present Study....81

CHAPTER THREE : **METHODOLOGY**

3.1 Introduction....83

3.2 Research Design....84

3.3 Population of the Study....85

3.4 Sample and Sampling Procedure....86

3.5 Selection of Evolution Concepts Taught....88

3.6 Instrumentation....89

3.6.1 Unscientific Preconception Test on Evolution (UPTE)....89

3.6.2 Evolution Performance Test (EPT)....90

3.6.3 Validation of the Instrument 91
3.7 Pilot Testing 92
3.7.1 Reliability of the Instruments 92
3.7.2 Item Analysis of EPT 92
3.8 Administration of Treatment 93
3.8.1 Analogy Teaching Strategy 94
3.8.2 Collateral Teaching Strategy 96
3.8.3 Control Group 100
3.9 Data Collection Procedure 101
3.10 Procedure for Data Analysis 101

CHAPTER FOUR : **DATA ANALYSIS, RESULTS AND DISCUSSION**

4.1 Introduction 104
4.2 Answering Research Questions and Testing Null Hypotheses 105
4.2.1 Comparison of the Mean Scores of Unscientific Preconceptions Test on Evolution for E1, E2 and Control Groups 107
4.2.2 Comparison of Mean Performance Test Scores for E1, E2 and Control groups 110
4.2.3 Test for Gender-Related Difference in the Mean Scores on Unscientific Preconceptions between Male and Female in E1, E2 and Control Groups 113
4.3 Summary of Major Findings 118
4.4 Discussion of the Results 119

CHAPTER FIVE : **SUMMARY, CONCLUSION AND RECOMMENDATIONS**

5.1 Introduction 125
5.2 Summary 125
5.3 Summary of Findings 127

5.4 Conclusion 127

5.5 Contributions to Knowledge 128

5.6 Recommendations 129

5.7 Limitations of the Study 130

5.8 Suggestions for Further Studies 131

References 132

Appendices 148

ABSTRACT

This study investigated the impact of collateral and analogy teaching strategies on preconceptions and performance in evolution concepts among Nigeria Certificate in Education Students North Central Zone, Nigeria. The study adopted the pretest, posttest quasi-experimental control group design. Three groups were involved, the experimental group E1, experimental group E2 and control group. The subjects in the experimental group E1 were taught evolution concepts using Analogy Teaching Strategy, the experimental group E2 were taught using Collateral Teaching Strategy while the control group students were taught using lecture method for the period of six weeks. The target population for the study was made up of 1211 NCE III Biology students out of which a sample of 383 made up of 228 males and 155 females were randomly sampled after establishing their equivalence using pretest. The two validated instruments used for data collection were Unscientific Preconception Test on Evolution (UPTE) with the reliability coefficient of 0.69 and Evolution Performance Test (EPT) with the reliability coefficient of 0.76. Five research questions were stated and four null hypotheses were used for the study. The data collected were subjected to statistical analysis at $p \leq 0.05$ level of significance. Descriptive statistics were used to answer the research questions while ANOVA statistic was used to test the hypotheses on unscientific preconceptions and performance. Some of the major findings were: five types of unscientific preconceptions were identified among NCE III biology students; there was no significant difference in the unscientific preconceptions among students when taught using collateral and analogy teaching strategies but significant difference existed in the students taught using collateral and lecture in favour of collateral and also between students taught using analogy and lecture method in favour of analogy teaching strategy. Based on the findings it was concluded that NCE III Biology students learn evolution concepts better when taught using analogy and collateral teaching strategies than with lecture group. It was therefore recommended that Analogy and collateral teaching strategies should be used by teachers of Biology in teaching as they help to shift unscientific preconceptions students' harbor and creates a suitable foundation for subsequent meaningful learning, of the concepts.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

There is a nation-wide anxiety over the fall in students' academic performance in science subjects. This has been of great concern to science educators who have observed that learning science hardly follows the nature of science (Richard, 2001; Mohammed, 2013). What rather obtains in the teaching and learning of science in most schools is shallow rooted instruction which in most cases leads to superficial acquisition of knowledge that cannot be appropriately applied in and out of school situations. This according to Olatoye (2008) has rendered science learning difficult, uninteresting, and abstract and in some cases meaningless thus making the progress of science and technology in the country stagnant.

Biology is one of the science subject students study in both secondary schools and higher institutions in Nigeria. It is a branch of science that deals with the study of living things. Biology as a subject is of paramount importance to any nation including developing ones like Nigeria. Lawal (2011) stated that biology is a prerequisite subject for the study of many fields of learning that contributes immensely to the technological growth of the nation. These fields of learning include medicine, pharmacy, forestry, agriculture, biotechnology and nursing among others.

Science education researchers like Ogunleye (1999) reported that a number of concepts in biology including evolution, genetics and ecology contain topics which pose difficulty for biology students to understand. Also Maduabum (1994) and Jiya (2011) discovered that the major problem area of teaching biology, that contribute to students' poor performance is rooted in the difficulty in the nature of some of its concepts like genetic, ecology and evolution, among others. Chew (2004) believed that biology

concepts can sometimes be difficult particularly when describing things that cannot be seen or abstract concepts that cannot be fully comprehended for the first time. Chew (2004) also reported that students have the notion that evolution concepts in biology are boring and require only memory work to get one through. Some students find evolution concepts irrelevant, while others find them extremely technical with difficult terms littering every sentence in a typical biology text. Usman (2008) stated that many students are said to have wrong perceptions about evolution concepts on the basis of how they were taught biology in schools. To further support Usman (2008), Kampourakis (2014) is of the view that one of the learner factors that affect meaningful learning in biology generally is the wrong perception of evolution concepts held by the students. Bernardo (2007); Ogonnaya (2011) and Kampourakis (2014) in their separate studies opined that biological science has more conflicts in the classroom with cultural and religious believes especially evolution concepts than any other biology concepts.

Evolution concepts are aspect of biology curriculum, which students of Nigeria Certificate in Education (NCE) study at 300 level (NCE Minimum Standard, 2012). It is however considered to be an abstract and difficult topic to learn. Its abstract and difficult nature has contributed to poor academic performance among the students of NCE (Danmole & Femi-Adeoye, 2004). Evidence of the students' poor performance can be seen in the NCE III result on evolution course Bio 325 as shown in Table 1.

Table 1.1: Results of NCE III Students in BIO 325 Evolution (2010-2014)

Year	Total No.	No. pass	% pass	No. fail	% fail
2010	103	40	38.83	63	61.17
2011	130	49	37.69	81	62.31
2012	320	129	40.31	191	59.69
2013	208	63	30.29	125	69.71
2014	220	90	40.91	130	59.09

Source: Examination Office COE Minna, (2014).

From Table 1.1, students' failure in evolution course increases which could be that students have unscientific preconceptions and limited knowledge on evolution concepts that needs to be overcome before their performance can be improved.

The studies of Bichi (2002), Usman (2008) have also revealed that the method used mostly in teaching science subjects (specifically biology) in schools is the lecture method. This method according to Bichi (2002), Malachy and Ononugbo (2006) simply promotes rote learning and memorizations which hardly supports conceptual understanding of the subject matter on the part of the learner hence continuous poor performance in evolution concepts. Therefore, there is need to look for better strategies that will help overcome students' unscientific preconceptions and also to improve their performance in evolution concepts. According to Kampourakis and Zogza's (2007) research has established that students in general enter their science classes with preconceptions about the natural world that do not align with scientific facts and that often cause a misunderstanding of the scientific concepts being taught. Hornby (2006) view preconception as opinion or conception formed in advance of adequate knowledge or experience, especially prejudice or bias. These preconceptions denote the ideas students bring into classroom before teaching is done. Dike (2008) therefore advocates for changes in instructional practices that would take cognizance of such preconceptions.

Studies of Krishnan and Howe (1994), Demircioglu, Ayas and Demircioglu (2005) identified that learners personally constructed knowledge may be different from currently accepted scientific views. Such views according to Demircioglu, Ayas and Demircioglu (2005) are referred to as alternative conception, preconception, prior conception, pre-instructional beliefs, intuitive ideas, naïve conceptions, untutored beliefs, misconceived notions and alternative framework. Read (2004) is of the view that preconceptions and alternative frameworks have been proposed as better terms for

students' personal views that are at odds with modern scientific theories. Although many preconceptions are detrimental to learning, there may be other preconceptions that are largely in agreement with accepted physical theory. Therefore preconceptions are the ideas that students have before coming into science class, these preconceived ideas may be right in line with scientific views as such will serve as the bases for new knowledge or experiences that can be built upon. Read (2004) added that if students' preconceived idea is wrong that is, unscientific and not in line with scientific views, the preconceived idea needs to be corrected first before new knowledge can be learnt. This is in line with Hodge (1993) findings that preconceived ideas that are not in agreement with accepted scientific ideas or theory are referred to as misconceptions and must be corrected before new knowledge is learnt. Misconceptions are experiences encountered in daily life, traditional instructional language, teachers, misunderstandings of theory, mismatches between teachers and students knowledge of science. Eniayeju, Eniayeju and Lakpini (2004) described misconceptions as idiosyncratic personal ideas, erroneous belief or alternative views of scientific principles arising from teaching normal language usage, and everyday experiences of the world.

According to Lawal (2009) misconceptions are wrong notions of facts learners have on certain scientific concepts. She also sees it as mismatch in students' intellectual development. Learning process occurs as observed by Cameron (2007) when students' unscientific preconceptions or indigenous beliefs are contrasted with different conception encountered in the science classroom he/she alters the ideas by reconstructing the original schemata under the influence of the newly encountered schema. In other words, students modify or reject their original schema because it makes sense to do so.

Okebukola (2002) confirms that the existence of unscientific preconception in the learner is clear evidence that new concepts cannot be learned as an alternative model that

explains a phenomenon already existing in the mind. Okebukola (2002) called these unscientific preconceptions as preconceived notions and non-scientific belief. Okebukola (2002) stresses further that these unscientific preconceptions needed extra efforts on the part of the teacher to effect any correction in the learner. This is due to the dampening effects wrong (unscientific) preconception has on the learning of science. This is also in support of Wasagu's (1999) observation that for several years now, scientific knowledge has not been an integral part of African social life because the minds of many Africans are loaded with power of witchcraft and superstitious beliefs in providing explanations to natural phenomena. An example is the replacement of indigenous reasons for recurrent infant mortality in a home by a scientific reason such as sickle cell. If a student who holds the "*Abiku*" or "*Ogbanje*" conception comes in contact with the sickle cell phenomenon in a biology class, the sickle cell idea is very likely to challenge the "Ogbanje" and "Abiku" unscientific preconception. The result will likely be a discarding of the unscientific preconceptions with the plausible and intelligible scientific concepts. In addition to identifying students' preconception, Zhou (2010) proposed various models and strategies to facilitate teaching for conceptual change.

In order to improve students' performance, it has become necessary to seek for strategies that will enhance better academic performance among learners as well as overcome wrong conception of the content of science, biology in particular. Examples of these strategies according to Okoronka (2004) include analogy, concept mapping, problem solving, think and do, vee mapping, advance organizers, semantic networking, collateral learning, cooperative learning, among others. Analogy is a process of identifying similarities between two concepts, the familiar concept is called the analogy and the unfamiliar science concept is called the target. According to Treagust (1993), the goal of Analogy is to transfer ideas from a familiar concept (the analogy) to an unfamiliar

one (the target). If both the analogy and the target share some similar features, an analogy can be drawn between them.

Ruhl (2003) also stated that analogy is a comparison of something unfamiliar with something familiar in order to explain a shared principle. Ruhl (2003) describes analogy like a bridge that spans the gap between what a teacher wants students to learn and what the students already know. An analogy builds on the framework of the learners existing knowledge so they are not starting from scratch. Lagoke (2000), Jiya (2011) in their separate studies revealed that a growing amount of research has shown that the use of analogy in science teaching and learning promotes meaningful understanding of complex scientific concepts, and also helps students to overcome misconception of science concepts that they may harbor. Foxwell and Menasce (2004), James and Schamann (2007), Diber and Duzgun (2008) reported that analogies are essential in human cognition, reasoning learning, communication, problem solving and they have profound broad effects on how the world is viewed and understood. Sani (2006) reported three benefits of the use of analogy as a teaching technique for abstract concepts. These include providing visualization of abstract concepts, helping to compare similarities of the students' real world with the new concept and motivating the learner.

There are several strategies of Analogy that can be used by the science teacher, examples of analogy models include Zeitoun's (1984) General Model of Analogy Teaching (GMAT), Dupin and Joshua's (1985) Four Phases Conceptual Change Model (FPCC), Clement (1987) Bridging-Analogy (BA), Glynn's (2007) Teaching-With-Analogy (TWA) model. In this study, the Teaching-with-Analogy Model of Glynn (2007) adopted emerged as the best suited for use in colleges of education biology classrooms, because it focuses on the learner in class presentation of the analogy, and can be easily implemented and evaluated. Above all, it puts into consideration the prior knowledge of

the learner, which constructivist like Miller (1989) believed that for meaningful learning to take place students involvement in integrating new information or knowledge with pre-existing is necessary.

Another influential teaching strategy that may help students to correct unscientific preconception and improve performance in science learning is collateral teaching strategy. Spindler (1987) and Wolcott (1991) explained that teaching science is viewed as cultural transmission and learning science as culture acquisition. According to NB (2007), culture is the accumulated habits, attitudes and beliefs of a group of people that defines their general behaviour and way of life. Looking critically at the influence of cultural background on learning science, it becomes important for science teachers and biology in particular, to address learner's background issues like language, customs and experiences that students from different communities bring to science classroom. Thus, biology teachers are faced with increasing complex problems of creating a suitable learning situation for biology students with varied cultural backgrounds especially when teaching topics like evolution that has to do with beliefs on how life originated.

Igbokwe (2009) stressed that the problem is further complicated by the fact that most of Nigeria's classroom today are made up of children of varied cultural background and diverse world-views. The implication of this is that students can interpret the same science phenomena in different ways depending on their cultural belief or their world-view of the phenomena. Abonyi (2002) stated that the current approaches to science instruction in Nigeria have been criticized as being incapable of bridging the gap between the initial background of the learner and the new field of knowledge. Learning science involves negotiating meaning, comparing what is known to new experiences and resolving discrepancies between what is known and what seems to be implied by new experiences.

In Africa, there is conflict between some of the students' everyday life and the world of science. This is even more in Nigeria where there are large numbers of ethnic groups. Modo (2002) reports that the Nigerian society is made up of over350 ethnic groups each with its own different belief and cultural practices that mark it out as a unique entity. The believes and cultural practices according to Jegede and Okebukola (1993) influences students' attitudes, thoughts, behavior and consequently, the desire to study and learn science.

Glens (1999) noted that one of the major influences on science education identified by students in developing countries is their feeling that school science is like a foreign culture to students. Their feelings according to Aikenhead (1997) stems from the fundamental differences between the culture of science class room and their indigenous cultures. Interestingly, Costa (1995) stated that a number of students in industrialized countries share this feeling of foreignness as well. Cultural clashes between students' life-world and the world of science classroom challenge science educators who embrace science for all; hence they advocate the need for an emerging priority for the 21st century to develop culturally sensitive curricula and teaching methods that reduce the foreignness felt by students. The effectiveness with which students move between their life-world culture and the culture of science or school science depends on the assistance students receive in making those transitions easier.

Ogawa (1995), Jegede (1995), Sutherland and Dennick (2002), Akuma (2005) suggested that collateral teaching strategy is a means of resolving problem of conflict between culture and science as it attempts to help students cope with science learning without doing violence to their particular cultural beliefs, norms and experiences. Ogawa (1995) also added that collateral teaching is a strategy that enables learners to understand science concepts while maintaining their world view. The task of science teaching is to

help all children acquire scientific knowledge, interest, skills, attitudes and ways of thinking without violating their cultural believes and experience. Jegede (1997) is of the opinion that collateral teaching strategy is the cognitive explanation of border crossing. Border crossing, according to Aikenhead (1996) involve students' experiences with school science in terms of students' "crossing border" from the subcultures associated with his/her socio-cultural environments into the subcultures of science. In learning science concepts within a traditional socio-cultural environment,

Fakudze (2004) proposes a Collateral Teaching Strategy Model (CTSM) which was the combination of three theoretical constructs, of Aikenhead's (1996), Border Crossing; Jegede's (1995) Collateral Learning, and Oguniyi's (1995) contiguity learning. The CTSM uses the information processing model depicted by Eggen and Kauchak (1994) and Johnstone (1997) as its basic framework. The CTS can be used to describe how a scientific concept presented in a science classroom is learned or rejected by a student. In this study analogy and collateral teaching strategies are employed to teach evolution concepts.

Considerable amount of research focused on gender differences in school science learning. Abudraheem (2012) reported that one of the most topical issues in current all over the world has been that of gender differences and academic performance among students in schools. Over the years, there has been a growing awareness of the role of a woman at home, in schools and community in general. Duniya (2009) opined that gender issues in science education as it affects performance remains unresolved. However, worries have equally been expressed about the role of women in the political, social, cultural, psychological, economic, spiritual, science and technological development of nations.

Lentz (1992), Lagoke *et al.* (1997), Usman (2000) and Mohammed (2011) in their individual -studies noted that boys performed better than girls on activities that require manipulations and also boys are more mechanically and scientifically inclined than girls. Olorukooba, Lawal and Jiya (2012) also revealed that there is a significant difference in the performance and retention of male and female students in favour of the male students at NCE level when taught using analogy teaching strategy.

However others like Mari (1994) observed that female students performed better on their understanding of science process skills than male students. Also, Klainin, Fenshaim and West (1989) reported that the performance of girls is significantly better than that of boys in chemistry and physics in Thailand. Driver (1980) reported higher achievement of girls in mathematics and physical sciences than boys while Bichi (2002), Danmole and Femi-Adeoye (2004) in their separate studies found that there are no gender differences in performance in science. From these studies, there is no conclusive statement on gender related issues investigated by the researchers and the studies cited concentrated in teaching method, attitude among others at SSS level. This study therefore seeks to investigate the impact of analogy and collateral teaching strategies on unscientific preconceptions and academic performance in evolution concepts in terms of gender.

1.1.1 Theoretical Framework

The theoretical basis guiding the study of analogy and collateral teaching strategies to teach concepts of evolution is the cognitive constructivism theory of Ausabel meaningful learning. The constructivist model sees the learner as coming into learning not as complete blank slates upon which knowledge is written, but rather sees the learner as coming into learning with already formulated knowledge ideas and understandings. The previous knowledge becomes the raw materials for the new knowledge to be created.

As such learning in the constructivist model says that the learner compares new information taught to him/her to the knowledge and understanding he or she already has of the same phenomenon. This study of analogy and collateral teaching strategies relates with constructivist model that put into consideration students prior knowledge as foundation for subsequent learning that is new science concept to be learnt

David Ausabel is a cognitive psychologist who studied learning theory. Ausubel is credited with the learning of advanced organizers. Ausubel believes that meaningful learning is crucial for classroom instruction. Meaningful learning, according to Ausubel, entails new knowledge that relates to what one already knows and that can easily be retained and applied. According to Ausubel (1963), meaningful learning takes place only when the learners' prior knowledge is related to the new materials to be learnt. Advance Organizer entails the introductory materials with high level of generality that introduces new materials and facilitates learning by providing an anchoring idea to which the new idea can be attached. Cognitive theorists believe that it is essential to relate new knowledge to existing information learned. Teachers can facilitate learning by organizing information presented so that new concepts are easily relatable to concepts already learned.

The overarching ideas in Ausubels theory is that knowledge is hierarchically organized and that new information is meaningful to the extent that it can be related to what is already known. Since science is learning by doing, the body of knowledge to be taught to the learner must be well structured to incorporate learners' prior knowledge. This implies that teachers of science should be able to effectively link and bridge the gap between the body of knowledge the learner possesses and the new materials to be learnt or introduced. Where such links do not exist, rote learning is the result. Ausubel was able to differentiate between rote and meaningful learning. Meaningful learning occurs only

when the learner has mental representation of an object or concept to be learnt. Therefore, the theory of Ausubel was adapted for this study.

Yager (1995) suggested that use of analogy and collateral teaching strategies could help students to build meaningful relations between what they already know and what they are setting out to learn. In general, activity of building relations plays a critical role in constructivist views of learning science, thereby involving students in the construction of knowledge and the creation of new ideas from what they already know. This activity builds relationship between existing knowledge and new knowledge and plays an important role when interpreting students learning as a process of conceptual change (Demanstes, Good & Peebles, 1996). These theoretical speculations about the role analogy and collateral plays in conceptual change set the stage for empirical explorations of the contribution of analogy and collateral to conceptual change in science learning (Wushishi, 2006). According to Igboko and Ibeneme (2006), constructivism can be defined as processes where learners actively take knowledge, connect it to previously assimilated knowledge and construct own interpretation. Where the conception a learner already has is faulty, it is described as being erroneous. Studies according to Haslam and Treagust (1987), Lawal (2009) have shown that such erroneous conceptions or unscientific views have serious threat on learners' understanding of scientific concepts. This study therefore was hinged on the cognitive constructivist theory and Ausubels theory of meaningful learning.

1.2 Statement of the Problem

Several factors have been identified by researchers as being responsible for the persistent poor performance in evolution concepts among science students. Researchers like Bichi (2002), Greg (2007), NAS (2008) and Kampourakis (2012) in their separate studies, identified students' difficulties in understanding evolution concepts. Some of the

difficulties include misconceptions held about theories in evolution, controversies about religious bias and socio-cultural beliefs as well as teachers' failure to use effective teaching strategies that would enhance the teaching and learning of the subject. According to Goldberg and Thompson-Schill (2009), Kampourakis (2014), evolution concepts are rather counter-intuitive ideas that generate unscientific preconceptions in students, make its theories difficult for them to understand, abstract in nature as well as having cultural and religious bias which has resulted in students performing poorly in evolution concepts at NCE level.

Further research studies by Hokayem and Boujaoude (2008); Athanasious and Papadopoulou (2011) on undergraduate students from various countries and religious backgrounds have also revealed that students often perceive conflict between their worldviews and what evolutionary theory suggests. Therefore, students fail may be as a result of teachers using ineffective teaching methods that cannot help overcome unscientific preconceptions and boost their performance in evolution concept. In fact, Treagust (1993), Greg (2007), Jiya (2011) and Ogonnaya (2011) stated that unscientific preconceptions and poor performance of students in evolution concepts may be overcome if the teacher provides a bridge (link) between the unfamiliar concepts (evolution concepts in particular) and the knowledge which the students already possess. Analogy and collateral teaching strategies has been found to enhance students' performance. Both strategies put into consideration the prior knowledge of learners which is able to bring about meaningful learning as a result of students' involvement in integrating new information with pre-existing knowledge. Specifically, this study seeks to investigate the impact of analogy and collateral teaching strategies on NCE III biology students' unscientific preconceptions and academic performance in evolution.

1.3 Objectives of the Study

The main objectives of this study are to examine the impact of analogy and collateral teaching strategies on identified unscientific preconceptions and academic performance in evolution concepts among NCE III biology students. The study has the following objectives to:

1. identify the unscientific preconceptions in evolution concepts held by NCE III biology students;
2. determine the impact of analogy, collateral teaching strategies and lecture method on unscientific preconceptions in evolution concepts among NCE III Biology students;
3. determine the impact of analogy, collateral teaching strategies and lecture method on academic performance in evolution concepts among NCE III biology students;
4. find out the impact of analogy, collateral teaching strategies and lecture method on identified unscientific preconceptions in evolution concepts among male and female NCE III biology students; and
5. determine the impact of analogy, collateral teaching strategies and lecture method on academic performance in evolution concepts among male and female NCE III biology students.

1.4 Research Questions

The study seeks to answer the following research questions:-

1. What are the common unscientific preconceptions NCE III biology students hold on evolution concepts?
2. What is the difference in the unscientific preconceptions score in evolution concepts among NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method?

3. What is the difference in the mean scores in evolution performance test among NCE III biology students taught using analogy, collateral teaching strategies and those taught using lecture method.
4. What is the difference in the unscientific preconceptions score in evolution concepts between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture Method?
5. What is the difference in the mean scores in evolution performance test between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method?

1.5 Null Hypotheses

Research questions 2-5 converted to 1-4 Null hypotheses were tested in the course of this study at $p \leq 0.05$ levels of significance:

$H0_1$: There is no significant difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using collateral, analogy teaching strategies and lecture Method.

$H0_2$: There is no significant difference in the mean scores in evolution performance test among NCE III students taught using collateral, analogy teaching strategies and those taught using lecture method.

$H0_3$: There is no significant difference in the unscientific preconception mean scores in evolution concept between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method.

$H0_4$: There is no significant difference in the mean scores in evolution performance test between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method.

1.6 Significance of the Study

The main objectives of this study are to examine the impact of analogy and collateral teaching strategies on identified unscientific preconceptions and academic performance in evolution concepts among NCE III biology students. The results of the study would hopefully uplift the standard of Biology education at NCE level in the following ways:

i. It is hoped that the findings of this study would:

Teachers

ii. be beneficial to biology teachers in helping them select appropriate strategies for teaching evolution concepts most especially for students to overcome unscientific preconceptions they harbor from their cultural believes, and would thereby improve their academic performance.

iii. provide teachers in training with knowledge of other strategies that can be used to teach evolution concepts in the classroom e.g. analogy, collateral, learning among others.

iv. help teachers in finding out the types of unscientific preconceptions NCE III students hold about evolution concept e.g. counter intuitive ideas, social cultural beliefs and religious bias.

v. enhance professional development of teachers as it demands creative thinking in developing appropriate analogy and collateral strategies to suit a topic and formulate stories that rise sensory receptor of student to critical thinking.

Students

vi. provide students with scientific explanations to the unscientific preconceived ideas and erase from their minds all hindrances to science learning that can lead

them into excellent academic performance i.e. through the mapping and sensory register in both analogy and collateral strategies.

vii. help students to see the relationship between their society and school science.

Professional bodies

viii. be beneficial to Professional bodies such as Science Teachers Association of Nigeria, National Association Science Education Researchers, UNICEF and other researchers may use Analogy and Collateral teaching strategies by organizing conferences, workshops and seminars for both teachers in training and practicing teachers of science on how analogy and collateral strategies could be effectively used to promote the teaching of evolution in schools, thereby incorporating such into their curriculum design and instruction innovation programmers in science.

ix. The finding of the study will also add new knowledge to the existing literature.

1.7 Scope of the Study

The scope of the study is as follows:

The study was delimited to eight (8) State Colleges of Education in North Central Zone, Nigeria. These colleges are fully accredited by National Commission for Colleges of Education (NCCE) that governs these higher institutions of learning. The colleges are similar in terms of manpower and quality of staff since the board governing the institutions checks the facilities and manpower after every four years. The study was delimited to NCE III biology students of the eight (8) State Colleges of Education in north central, Nigeria, because this level of students study Bio 325 Evolution concept. The concepts taught include:

Adaptative radiation

Mutational changes as the causes of evolutionary change

Origin of life

Fossil and human evolution

Darwin's theories of natural selection, competition, survival of the fittest and struggle for existence.

These topics have been identified to be abstract and difficult to understand thereby causes intuitions that generate unscientific preconceptions (NCCE, 2012). The model of Analogy that was used for this study is Teaching-with-Analogy adapted from Glynn, (2007) and Collateral Teaching Strategy Model adapted from Fakudze, (2004).

1.8 Basic Assumptions

The following assumptions were made for the study:

1. Analogy and Collateral teaching strategies are not commonly used in teaching the concepts of evolution in the selected colleges.
2. Socio-cultural beliefs (preconceptions) exist among students about evolution concept which may negatively affect their learning of science effectively.
3. That the Analogy, Collateral Strategies and lecture method are appropriate for teaching the topics in evolution concepts

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This study aimed at determining the impact of analogy and collateral teaching strategies on unscientific preconceptions and academic performance in evolution concepts among NCE III biology students. In this chapter the literature reviewed related to the study are discussed under the following subheadings:

2.2 Teaching of Evolution Concepts at NCE level

2.3 Students' Academic Performance in Evolution Concepts

2.4 The Concept of Preconception

2.4.1 Types of Preconceptions in Science

2.4.2 Preconception and Students' Academic Performance in Science

2.4.3 Unscientific Preconceptions in Science

2.5 Concepts of Analogy Teaching Strategy and Science

2.5.1 Advantages of Analogy for Science Learning

2.6 Concepts of Collateral Teaching Strategy and Science

2.6.1 Types of Collateral Teaching Strategies

2.6.2 Advantages of Collateral for Science Learning

2.7 Gender and Academic Performance in Science

2.8 Overview of Similar Studies

2.9 Implications of Literature Reviewed for the Present Study.

2.2 Teaching of Evolution Concept at NCE level

The word biology is derived from the Greek words: bios, which means life and logy which means study of (Sarojini, 1993). Biology has been defined in several ways for example (Osuafor and Okonkwo, 2013) defined biology as the study of living organisms, divided into many specialized fields that cover the morphology, physiology, anatomy, behavior, origin and distribution. Biology as a science subject in the school curriculum is designed ultimately to produce educated individuals some of whom may take biological studies in their professional pursuits. Osuafor and Okonkwo (2013) described biology as a science of life which plays a very important role in the life of every living thing. Biology as a subject is of paramount importance to any nation including developing ones. These aspects of biology include genetics, ecology, cell structure, evolution among others.

Evolution is a main branch of biology. According to Ayinde and Amao (2001) it is a concept that is studied in biology at both secondary and tertiary levels of education in Nigeria. Evolution is a concept in which some eminent scientists of the past like Charles Darwin, Jean Baptise, Lamarck and others made their impact for which they are still remembered up till today. Biological evolution, the scientific principle that the diversity of life on earth has arisen via descent with modification from a common ancestry, has been recognized by all major scientific societies and science education organization as the central and unifying principle of the biological science. It is described as a unifying concept in the subject because it is in evolution that virtually all the other branches of biology have made some contributions. Evolution is also a course in biology in which theories are the main products of scientific studies. Ayo (2003) further buttress these points that evolution is the change in the characteristics of a population of species over several generations which resultant into formation of a new species.

Robert (1975) stated that evolution implies that species do change and that all organisms presently on earth have presumably evolved along a period of time from others which existed in the past. New species which evolved from previously existing ones are more advanced or better equipped than the older ones, hence their ability to adapt to the changing environment on the planet earth. Evolution is the central unifying theory and as Dozhansky (2005) famously stated, without evolution biology is a pile of sundry facts that make no meaningful picture as a whole.

Ayo (2003) reported that evolution also has important practical applications. For example in Agriculture ideas with the evolution of pesticide that is resistance in insects and other pests, and also agricultural scientists develop techniques that slow the evolutionary process in pest organisms. Likewise, medicine too responds to the rapid evolutionary potential of disease causing organisms such as bacteria (significant evolutionary change occurs in a very short time period in insects, bacteria, and other organisms with short life spans). Medical researchers use evolutionary principles to predict which flu strains are evolving more quickly, and information the scientists need to make next year's flu vaccine. The conservation management of rare and endangered species makes use of the evolutionary principles of population genetics. The rapid evolution of bacteria and fungi in polluted soils is used in the field of bioremediation, in which microorganisms are employed to clean up hazardous waste sites. Evolution even has application beyond biology. For example, certain computer applications make use of algorithms that mimic natural selection in biological system.

The content of the syllabus for NCE III Evolution Bio 325 in all colleges of evolution is as follows:-

1. Concept of Evolution
2. Evidence for Evolution

3. The geological timetable
4. Trends and theories of evolution including pre-Darwnism and Neo-Darwinism.
5. Darwins theory of Natural Selection
6. Competition with particular emphasis on competition for food, space and other resources among human population
7. Competition, variation and survival of the fittest
8. Mutational changes as causes of evolution
9. Adaptive radiation
10. Isolating mechanisms
11. The origin of life
12. Fossils and human evolution

Teaching can be defined as a vehicle for education. Olatunji (1996) described it as a social function that aims at necessary growth in others. Nwachi (1991) defined it as the imparting of knowledge from one person to another and the guiding of someone to behave in a particular manner. Frankena (1965) expressed that teaching cannot be done by just anybody because it involves (a) conscious and deliberate activities (b) less experienced or immature people to be taught and (c) a body of knowledge to be imparted. From the above characteristics, it is clear that teaching is unique. It is an occupation that needs to be given attention. The curriculum of NCE is designed to produce knowledgeable, highly motivated, professionals and effective teachers of biology who will be able to develop in students an appreciation and understanding of biological process and principles. The programme is also designed to develop confidence in the biology teacher and enhance his ability to adapt to the changing situations in science and the technologically oriented society.

The teaching of the above contents intend to achieve the following objectives in the learner

a. Biology as a process of inquiry into the living world

b. Critically analyse the activities of living things in their environment

c. Demonstrate practical skills in handling scientific apparatus

d. Demonstrate excellence and professional competence in teaching secondary school biology

e. Inculcate positive scientific attitudes and values in the society and

   Promote positive disposition towards biology, science and the scientific enterprise.

f. Apply concepts and methods acquired in the course in new area of study and in everyday situations.

g. Make a successful career in biology teaching.

h. Successfully undertaken a B.Ed/B.Sc(Ed.) degree programmes.

However students' performance in the subject is not impressive. This study therefore, will investigate the impact of analogy and collateral teaching strategies on NCE III students' unscientific preconception and academic performance in Evolution Concept in North Central Zone, Nigeria.

2.3 Students' Academic Performance in Evolution Concepts

Despite the fact that biological evolution is the central organizing principle of modern biology its theories are still unacceptable (NAS 2008). Researchers like Alters and Nelson (2002), Bowman (2008), Hokayem and Boujaoude (2008) observed that it is widely known that large numbers of students in our biology classes are woefully unprepared to undertake the study of evolution. The theory of evolution unifies all biology concepts. This idea is well summarized in Dohzhansky's (1973) aptly titled

paper, “Nothing in Biology makes sense except in the Light of Evolution”. Given the unifying and explanatory power of this theory, it would be reasonable to expect that its fundamental principles and concepts would be widely and generally understood, especially by those studying the life sciences.

However, as a large and continually growing body of research suggests, this is not the case (Chinsamy & Plaganyi, 2008; Pazz, Penteado & Kavalco, 2010; Cunningham & Wescott, 2009; Abraham, Meir, Perry, Herron, Maruca & Stal, 2009; Hokayem & Boulaoude, 2008; Nehm & Reilly 2007). However, according to Greg (2007) the teaching and learning of evolution has faced difficulties ranging from pedagogical obstacles to social controversy. These include two distinctive sets of problems: one arising from the fact that many evolutionary concepts may seem, at least initially, counterintuitive to students, and the other deriving from objections rooted in religion. Greg, (2007) clearly stated that despite the overwhelming acceptance of evolution among scientists and despite evolution’s centrality to modern biology, virtually all national polls indicate approximately one half of North American reject evolution-suggesting that they think scientists, textbooks, and teachers are simply wrong.

Bernardo and Clores (2007) reported that students’ understanding of evolution theory especially origin of life varied due to the following reasons.

a. rejection of the theory due to challenges of religious beliefs.
b. remaining skeptical about the theory due to ambivalence that emanated from conflicting theological ideas and misconceptions held about human evolution.
c. Prior beliefs and concepts that were commensurate to the accepted scientific concepts and beliefs about evolution made learning of evolution complicated.

Brumby’s study was conducted in Australia where very few previous studies on the acceptance and misconception related to evolution have been conducted. Brumby’s

(1984) study, which examined the misconceptions surrounding natural selections among Australian medical biology students revealed that questions about natural selection were answered correctly more often by students with a high school biology education. Additionally, the results indicated that a majority of students consider evolutionary changes occur out of need and that they do not merely exhibit simple errors of knowledge, but their "entire pattern of reasoning is faulty", which is a result of deep-seated misconceptions. Short (1994) issued an evolution questionnaire to Australian medical students before and after they took a course in evolution. In this study, the majority of students did not accept evolutionary theory before the course, and this non-acceptance correlated significantly with no high school biology education, religious belief and frequency of worship. Short's (1994) analysis indicated no statistically significant changes between the answers to any of the questions after the course in evolution was completed. In fact, Short (1994) suggests that the emotional and irrational beliefs about life are perhaps beyond the reach of scientific logic.

Bishop and Anderson (1990) issued pretest and post-test to undergraduate biology students, where they found that previous biology education has no influence on pre or post-test performance and that the students' acceptance on evolution was only slightly affected by instruction. Also Bishop & Anderson (1990) investigated students' ability to solve problems in Darwinian terms and found that students were unable to do so. Jensen and Finley (1996) also issued pre-and post course tests, and compared the results between groups of differing instruction methods. The results of Jensen & Finley (1996) indicated that a historically rich and problem-solving method of instruction significantly outperformed the more traditional pedagogical approach. Again Sindair, Pendarvis and Baldwin (1997) employed a pre and post course test, revealing that an active-learning style of instruction out-performed a more traditional approach. However, both groups still

demonstrated inadequate levels of evolutionary understandings. Cunningham and Wescott (2009) evaluated the evolutionary understanding of biological anthropology students with a pre-course questionnaire, with their results suggesting that students' understanding of evolution is limited even among those who accept the validity of evolutionary theory. The study demonstrates that even acceptance of evolutionary theory does not imply understanding and that misconceptions must be identified if instructors are to assist students in undergoing conceptual change.

A study by Kelly (1999) showed that ideas pertaining to the theory of evolution elicited a mixed reaction Australian society, but with the balance of opinion favoring a Darwinism explanation. Kelly indicated that religious and education are the key social differences in the acceptance of evolution and suggest that acceptance of evolution will gradually increase in Australian an older, less educated, more devout cohorts are replaced by younger, better educated has religious ones. Studies by Short (1994), Cunning and Wescott (2009) suggested that most presently used traditional methods of teaching evolution are relatively ineffective at dispelling misconceptions and increasing acceptance of evolution.

Buckberry and Burke's (2012) carried out study on improving the understanding of undergraduate biology students with an active pedagogical approach showed that students' learning and understanding of evolutionary theory improved throughout the course, it did not alter the beliefs of students who commented both before and after the course that religious theories provided adequate explanation for the diversity of life. Interestingly students who maintained this belief scored more poorly on the final examination than students who considered evolution as the best explanation for the diversity of life. If the student teacher has solid foundation at NCE level on content

knowledge, effective instructions which are actions and strategies he/she will be able to use it to achieve meaningful learning.

Use of appropriate instructional strategies in teaching/learning of evolution in Nigeria schools will help in realization of teaching objectives. The search for methods of teaching that would aid meaningful learning of evolution concepts among students thereby reduces their unscientific preconception in evolution concept. This study use analogy and collateral teaching strategies to teach evolution concepts to determine whether it has effect at shifting students' unscientific preconceptions and improving academic performance of NCE III Biology students in selected colleges of education in North Central, Nigeria.

2.4 Concept of Preconception

Preconception is the conceptions formed before receiving formal instruction in class. There are many ways to get humans to learn, as deep understanding of concepts is not always achieved when teaching students. Students often memorize through rote memorization, and usually they do not conceptually understand the concept because humans interpret their world based on the concepts that make up their own understanding of the world which is also referred to as their conceptual framework. This unique lens is a byproduct of the sum of all of an individual's experiences. Learners interpret the world based on what they know and often if these that they already know do not reorganized in their minds. As a result, humans do not learn the true nature of scientific phenomena.

According to Kampourakis and Zogza's (2007) research has established that students in general enter their science classes with a prior knowledge about the natural world that do not align with scientific facts and that often cause a misunderstanding of the scientific concepts being taught. This prior knowledge is referred to as preconceptions. Preconception can be sees as the ideas students has before learning or experiencing the

actual knowledge. Preconceptions are also opinion or conception formed in advance of adequate knowledge or experience, especially a prejudice or bias (www.thefreedictionary.com/preconception). According to Brown, Clement and Zietsman (1989) revealed that preconception can be right or wrong if right, that is, in line with scientific views then new knowledge can be built upon it. This is referred to as scientific preconceptions, where the preconception is not in line with scientific views, that is unscientific preconceptions, then it needs to be corrected before new knowledge or experience can be built upon it such type is referred to as wrong preconception or unscientific preconception.

Hornby (2006) defines preconception as ideas, opinions that are formed before you have enough information or experience. A number of preconceptions are detrimental to learning according to Brown and Clement (1987); they referred to students' ideas that are incompatible with currently scientific knowledge as misconception. Lawal (2009) sees misconception as wrong notions of facts learners have on certain scientific concepts, which they develop when integrating newly learned knowledge that could be abstract with previously held information which results in re-interpretation of the new knowledge to translate them to everyday experiences.

Eniayeju, Eniayeju and Lakpini (2004) described misconceptions as idiosyneratic ideas, erroneous beliefs or alternative views of scientific principles arising from teaching normal language usage, and everyday experiences of the world. Eniayeju, Eniayeju and Lakpini also see it as mismatch in students' intellectual development. Students' self-constructed conceptions which are unscientific have been referred to in the literature as misconceptions, alternative conceptions, preconceptions, naive conceptions etc (Demircioglu, Ayas and Demircioglu, 2005; Krishnan & Howe, 1994). Unscientific preconceptions are resistant to change persistent and difficult to extinguish even with

instruction designed to address them. Also, Haider (1997), Deposada (1997) opined that the unscientific preconceptions of learners may hold generally hinder their subsequent learning. So, learners' unscientific preconceptions should be taken into consideration in the developing of science curricula.

Moreover, it seems that unscientific preconceptions related to biology are never completely over written, despite even a deep understanding of biological processes or expert scientific knowledge. Goldberg and Tompson-Schill (2009), Okebukola (2002) stated that it would be improper for the teacher to insist that the learner dismisses the unscientific preconceived notions already there in their minds, rather the learner should be made to be convinced to discard the unscientific preconceived ideas by confronting their own beliefs with their associated paradoxes and limitations, then attempts to reconstruct the knowledge necessary to understand the scientific model being presented. In order to identify students' unscientific preconceptions, scholars like Piaget (1970) have proposed various strategies to facilitate teaching of evolution concepts these works normally derived from Piaget's cognitive developmental theory. The concepts Piaget used, including cognitive conflict, disequilibration and accommodation frequently appears in the existing literature. The teaching strategies share a common process that involves first creating cognitive conflict before providing a new framework. This study attempt to bridge the gap between personally held conception and the scientific view since studies have revealed that unscientific preconceptions are resistant to change therefore, Collateral and Analogy Teaching Strategies was used to teach evolution to NCE III biology students to determine the effect on unscientific preconceptions and academic performance.

2.4.1 Types of Preconceptions in Science

Preconception can be right or wrong ideas, where the ideas are right, it is in line with scientific views of the scientists' communities and where the preconception is wrong ideas it is not in line with scientific views and therefore referred to as unscientific preconceived ideas that need to be modified, before meaningful learning can take place. This study is concerned with the wrong preconceived ideas which are referred to as unscientific preconception or misconception.

Barke, Hazari, Yitbarek (2009) stated that ideas that are developed without having any prior knowledge of the subject are not necessarily wrong but can be described as alternative or preconcepts. Barke, Hazari, Yitbarek, (2009) further explained that self-developed concepts made by students do not often match up with today's scientific concepts and choosing to ignore students' preconceptions with the hope that someday they will overcome them on their own is inappropriate. Teachers need to aim to re-shape students preconceptions into coherent concepts. Pine (2001) suggest that when teachers are better informed about the types of false beliefs that students are likely to hold they are quicker and better at identifying them, at helping the students call them to mind and make them explicit and incorporating them into the process of conceptual change.

Preconception can be categorized into scientific and unscientific ideas, the unscientific can be referred to as misconception. The terms alternative conceptions and alternative frameworks have been coined to describe misconceptions or views of science that are at odds with concepts currently accepted by the community of scientists. It is commonly suggested that parents, teachers and the media all influence the development of misconceptions in science. In the same way that learning science can be considered to be a sequential process, so can lead to the development of misconception.

Kwen (2005) added that studies in students' alternative conceptions in science have a long history, being traceable back to Piagets early work on children's views of natural phenomena. Paiget (1970) reported that there is now a substantial body of literature documenting the various types of alternative conception or preconceptions held by students in various conceptual areas. Misconception can be described as ideas that provide an incorrect understanding of such ideas, objects, or events that are not in agreement with our current understanding of natural science. Misconception can occur in students understanding of scientific methods as well as in their organization of scientific knowledge. The National Research Council (NRC) (1997) presents five types of misconceptions that can interfere with learning of science:

1. Preconceived notions
2. Nonscientific beliefs
3. Conceptual misunderstanding
4. Vernacular misconceptions
5. Factual misconceptions

Some common misconceptions in science according to New York Science Teacher (NYST, 2010) are:

1. Objects float in water because they are lighter than water.
2. The bubbles in boiling water contain 'air" oxygen or "nothing'' rather than water vapor.
3. The moon does not rotate on its axis as it revolves around earth.
4. The phases of the Moon are caused by shadows cast on its surface by other objects in the solar system.
5. Seasons are caused by the Earths distance from the Sun.
6. Evolution is only a theory because it has not been proved.

7. Dinosaurs, human, and cavemen lived at the same time.
8. Human are responsible for the dinosaurs
9. The terms energy and force have the same meaning.
10. Batteries have electricity inside them. .

According to Okebukola (2002) unscientific preconception of natural phenomena indicates that new concepts cannot be learned, as an alternative model that explains a phenomenon already exists in the mind of the learner. He categorized these unscientific preconceptions into five. They are as follows:

a. Unscientific Preconceived notions, these he asserted are popular notions rooted in everyday experiences.
b. Non scientific beliefs e.g. views learnt from religion, culture, mythical teaching etc.
c. Conceptual misunderstanding, which arises when learner is not well taught to provide unscientific preconceived beliefs.
d. Factual misconceptions, these are falsities learnt at early age and retained unchallenged into adulthood.
e. Vernacular misconceptions.

This study therefore, investigates impact of collateral and analogy teaching strategies on unscientific preconceptions and academic performance in evolution concepts among NCE III biology students in North Central Zone, Nigeria.

2.4.2 Preconceptions and Students' Academic Performance in Science

Read (2004) stated clearly that much research has been done on identifying the pre-existing beliefs and misconceptions that students bring to the science classroom. Read, (2004) went further to say that unscientific preconception emphasizes the wrongness of a student's conception, it should be recognized that alternate term like naïve

theory are also value-laden. Asim (2002) investigated types of unscientific preconception among five primary pupils on the concept of pressure, heat and electricity. The researcher used a 28 items option multiple choice test on 164 primary five pupils in three co-educational primary schools in calabar. She followed up the multiple-choice item with an interview on fifteen of the children. Analysis of the incorrect responses revealed that over 60% of the children used for the study held unscientific preconceptions about these concepts under investigation. The present study is on impact of analogy and collateral teaching strategies on unscientific preconception and academic achievement among NCE biology students.

Lawal (2009) investigated effectiveness of conceptual change instructional strategy in remediating misconception in genetic concept among senior secondary schools. The researcher used a 40 item option multiple choice test on 285 senior secondary school students in ten (10) co-educational schools in Kano. She used forty (40) items questionnaire, fifteen (15) misconception tests with fifty (50) multiple-choice items. The finding showed that there is a significant difference between the academic achievement of the experimental and the control groups. The conceptual change instructional strategy is better at improving students' achievement in genetic concepts taught than the traditional instructional strategy. The mean scores value of 26.61 for the experimental group and 19.11 for the control group.

Kikas (2004) carried out a study on the prevalence of misconceptions and the consistency of their use across different task and topic areas and the difference between various groups of subject teachers. The group of subject teacher he used was physics and chemistry (which he called science teachers). Biology teachers he referred to as experts, primary teachers and lastly the fifth group made up of a heterogeneous group of teachers. These he called the humanities. They acted as the control group according to her the

humanities do not need the knowledge of science in their daily work. Her samples comprised of 30 science, 28 experts, 57 primary 32 trainees and 51 humanities. For data collection, questionnaires, which were made up of evaluation tasks and problem tasks? Kikas (2004) found from the study that misconceptions were common even among science and biology teachers in both the evaluation and problem task. In addition, she found that too many unscientific preconceptions were found among trainee and primary teachers.

Kikas, (2004) opined that if teachers who are expected to pass the correct knowledge to the learner are themselves harbouring very serious misconceptions, one wonders the type of knowledge they would pass to the learner. This again is a reason why Kikas (2004) sees teacher's fragmentary knowledge and misconceptions as obstacles in the teaching/ learning process. The above studies confirmed the existence of a number of unscientific preconceptions in all categories of learners, from primary through to tertiary even among teachers and pre-service teachers. This may be a reason for the massive failure in our schools today.

Demircioglu, Ayas and Demircioglu (2005) carried out a study on the effects on students' achievement and misconceptions of new teaching materials developed for the unit acids and bases. The sample consisted of eighty-eight students (88). Two groups were involved, the experimental and control groups. Two instruments; the Concept Achievement Test and Chemistry Attitude Scale were used to collect data before and after the study as pretests and post-tests, and t-test was used as statistical analysis. The results from the post tests indicated that the students in the experimental group, taught with the new teaching material showed significantly greater achievement in the unit than did the students in the control group. In addition, the experimental group had a significantly higher score than the control group with regard to their attitudes towards chemistry. The

result supported the notion that it is not easy to eliminate misconceptions just by employing traditional instructional methods, but students' participation in the practical activities has caused not only greater understanding but also greater interest in the study of chemistry.

Demircioglu, Ayas and Demircioglu (2005) went further to say that teachers should organize activities that encourage students to use their prior knowledge and experience, and also provide students with opportunities to apply the newly acquired concepts in a variety of situation. This study was relevant to the pre-situation. This study will be relevant to the present study because analogy and collateral strategies concerned with learner's prior knowledge and experiences. In this study, therefore analogy and collateral teaching strategies will be employed to find their effectiveness at correcting the unscientific preconceptions and academic performance among the subjects.

Hauder (1997) also carried out a study on prospective teachers conceptions of the conservation of matter and related concepts. He used a total of 9 senior chemistry teachers 6 were male while 3 were females, with average age of 22 years, and interviewed them on conservation of matter. The second part of the study used173 chemistry teachers. Hauder (1997) administered questionnaire that was prepared based on the results obtained at the earlier stage. The subjects comprised 83 senior and 90 junior prospective chemistry teachers. Hauder (1997) found that 61.85% of the subjects held misconceptions concerning atomic mass, while 15.03% had no understanding at all. Only 11.56% had sound understanding of the concepts. The most common misconceptions, is the mass of an iron atom is 55.85g. Only 43.93% of the subjects held misconception.

The researcher thus concluded that prospective chemistry teachers do not have an appreciation of the small size of atoms, which according to Hauder may affect the teachers understanding of the concept of conservation of atoms. Thus there was no

meaningful learning about the atomic mass by most of the subjects used for the study. The researcher went on to say that the subjects appeared to have stored the chemical terms in their memories, without internalizing it with their knowledge structure, which according to the researcher is the common case when students do not understand given concepts. The researcher inferred that students' misconceptions of atomic mass can be traced to defective instruction in which students are used to memorizing information from their chemistry courses to answer questions related to the field of chemistry. Therefore analogy and collateral teaching strategies will be employed to see their effectiveness on concepts of evolution to what the result will be.

Zhou (2010) suggested that studies have documented that preconceptions are apparently changed in school settings, but may quickly reassert themselves in the broader context of daily life. The researcher went further to describe a case in which a student struggled with Newton's 3rd law. The student knew what the law was, but she changed her answer numerous times between the physics class model and her common sense for one particular test question which asked whether a trunk or a car exerted a bigger force during a mutual collision between the two. The common-speech wording of the question brought up her common sense` larger objects exert a larger force". The event used to create cognitive conflicts provides a stage to construct scientific concepts as well. As a result of this engaging inquiry process, the new idea is more likely to be plausible and intelligible to students. The teacher needs to offer detailed discussion of these confusing phenomena and demonstrate how the scientific conception can apply to them. The focus of this step was to defend the scientific concepts. This study is in line with the present study as cognitive conflict is resolved through explanation which collateral learning emphasis. This study therefore investigate impacts of analogy and collateral strategies on concepts of evolution to see what the result will be

2.4.3 Unscientific Preconceptions in Science Concepts

It is no longer necessary to argue about whether or not students already have some knowledge about scientific concepts, before entering formal education, which will affect their school learning of science. Jill de Kock (2005) agrees and adds that students' science views are result of personal experiences, which can include watching television, reading books and oral language interactions in addition with interaction with adults. Thus, some students' everyday activities will have enabled them to learn some science even before entering preschool education. Kambouri (2007) went further to say that the difference is that when starting kindergarten the child comes in contact with science as organized body of knowledge instead of unstructured and random activities that can happen outside the school. Henriques (2002) reported that science education community generally accepts the idea that students enter the classroom with their own understanding of the world and that some of this knowledge is incorrect and remarkably resistant to change. This incorrect idea is referred to as unscientific preconception. Studies according to Kwen (2005) reported that students unscientific preconception in science have a long history, being traceable back to Piagets early work on students view of natural phenomena (Piaget, 1930). There is now a substantial body of literature documenting the various types of preconceptions held by students in various conceptual areas. The origin of preconceptions examined by many researchers that scientific ideas students had may be partially formed or scientifically inaccurate Among the sources of preconception suggested are the following some of which overlap:

Kwen (2005) was able to indentified unscientific preconceptions that teachers could cause among the learners during their interactions in classroom as shown on the following concepts in biology

i. Breathing and Respiration were confuse by primary4-6 students who are between the age of 10-12 years

ii. Plant Reproduction

iii. Cell Structure

iv. Human systems

Osborne and Cosgrove (1983) investigated students' preconceptions specifically in relation to phenomena associated with water and particularly students conceptions of the changes of the state of water. A series of events involving ice melting, water boiling, evaporating and condensing was shown to student in an individual interview situation. For each of events, students were asked to describe and explain what was happening and explain what had happened. The analysis of the interviews showed that students bring to science lessons strongly held views which relate to their experiences. These views appear to them as logical and sensible students have ideas about the changes of the state of water, but these ideas are quite different from the views of scientists and they can be influenced in unintended ways by science teaching.

Pine, Messer and John (2001) also carried out research into students' preconception in primary science and with regards to teachers' views on it. Their analysis revealed that students have a lot of preconceptions about science topics and these preconceptions are of considerable importance and cannot be ignored in the learning process, since they are foundations upon which knowledge is built. This is the main reason that teachers need to place as much emphasis on students' incorrect ideas as on their correct ones if they want to accomplish conceptual change in science.

Some studies design lists with students' common incorrect concepts. The following list is a mixture of such incorrect concepts in regard to water cycle as this is the target topic for this study.

- Rain comes from clouds sweating
- Rain comes from holes in clouds
- Rain occurs because we need it
- Rain falls from funnels in the clouds
- Rain occurs when clouds get scrambled and melt.

Therefore, this study investigated impact of collateral and analogy strategies on unscientific preconception in evolution concepts among NCE III biology students in North Central Nigeria.

2.5 Concepts of Analogy Teaching Strategy and Science

Analogy is common devices in everyday experience, spoken and written communication when trying to make familiar the unfamiliar. Abimbola, (2006) reported that there are several definitions of analogy as a method of describing things that are known in terms of things that are unknown. Also, Calik and Ayas opined that analogy involves transfer of schema from a familiar situation into an unfamiliar situation such that analogies can make individuals to acquire useful insight into unfamiliar domains. Harre (1972) has defined analogy as a relationship between two entities or processes, which allows making inferences about one of the things, usually about the one we know the least, on the basis of what we know of the other. Glynn (1991) also stated that analogy is a process of identifying similarities between different concepts. Glynn, Russel and Noah (1997) sees analogy as a method of teaching that helps children from initial mental models of key science concepts, by facilitating the introduction of the concepts in ways that are concrete, meaningful and relevant to children.

According to Aubusson, Harrison and Ritchie (2006) analogy is a process of identifying similarities between two concepts. The familiar concept is called the analogy and the unfamiliar science concept is called the target. Orgill and Bodner (2004) refer to

analogy as a comparison between two domains of knowledge one that is familiar and one that is not. The familiar domain is often referred to as the analogy domain; the domain that needs to be learned is usually referred to as the target domain. Thus, the purpose of an analogy is to transfer a system of relationships from a familiar domain to one that is less familiar. The strength of an analogy, therefore, lies less in the number of features the analogy and target domains have in common than in the overlap of relational structure between the two domains.

Onwukwe and Onwukwe (2010) clearly stated that use of analogy teaching strategy is a sure way of helping teachers and students to overcome difficulties associated with teaching and learning of science concepts. This is because some of the difficulty experienced by students in these topics no doubt stem from lack of insight in the internal workings as well as inter and intra-practice/phenomenal interactions that results in the observable outcomes. This is where analogy come into broaden understanding. Dunican, (2002) added that use of analogy helps learners to understand new concepts presented in class by calling up knowledge of concepts they have already mastered or become familiar with. Guerra-Ramos (2011) point out that analogies can support understanding by abstracting the important ideas from the mass of new information, making clear the system boundaries and introducing the appropriate language in which to frame a scientific explanation. For example, a cell making a protein molecule is likened to tradesmen building a house (Biermann, 1988) some analogies appear to be quite esoteric e.g. the ping-pong ball torture analogy for enzyme activity (Helser, 1991). The coconut shy analogy used for effective molecular Collision (Coll, 2009). As with any other teaching technique, the use of analogy in a classroom can have a negative effect, even when teachers follow guidelines that have been suggested for teaching with analogy (Treagust, 1993). Examples are electric current is alike water flowing in a pipe. Analogy is a double-

edged sword. They can foster understanding, but they can also lead to misconceptions Duit, Roths Komorek and Wilbers (2001) explain:

A growing body of research shows that analogy may be powerful tools for guiding students from their pre-instructional conceptions towards science concepts. But it has also become apparent that analogy may deeply mislead students' learning processes conceptual change, to put it into other words, may be both supported and hampered by the same analogy. Effective analogy fosters understanding and avoids preconceptions Thomas and Orgill (2007) reported that teachers made difficult or abstract concept understandable through use of analogy. Orgill and Bodner (2004) stated that analogy can play several roles in promoting meaningful learning. They can help learners organize information or view information from a new perspective. Analogy provides visualization and understanding of the abstract concepts by pointing to similarities in the real world (Sandra, 2004). Analogy can also play motivational role in meaningful learning. The use of analogy can result in better student engagement and interaction with a topic. Lemke (1990) asserted that students are three to four times more likely to pay attention to the familiar language of an analogy than to unfamiliar scientific language. The familiar language of an analogy can also give students who are unfamiliar or uncomfortable with scientific terms in a way to express their understanding and interact with a target concept. Thiele and Treagust (1994) all agreed that analogies can make new material interesting to students, particularly when the analogy relates new information to the students' real world experiences. They pointed out that analogy can also increase students' belief about their problem-solving abilities when the new problem or new information is related by analogy to a problem or information they have already been successful in solving or understanding.

Orgill and Bodner (2004) stated that analogy can play a role in promoting conceptual change by helping students overcome existing unscientific preconceptions. Orgill and Bodner (2004) agreed that analogy can help students recognize errors in conceptions they currently hold, reject those conceptions, and adopt new conceptions that are in line with those accepted by the scientific community. Analogy may make new ideas intelligible and initially plausible by relating them to already familiar information. If students can assimilate new information in terms of their existing knowledge, they are likely to be able to understand that information, relate it in their own words, and comprehend how that new information might be consistent with reality all necessary conditions for conceptual change. Orgill and Bodner (2004) carried out a study on biochemistry students' perceptions of analogy and their uses in biochemistry classes. They interviewed students who were taking or had taken at least one semester of biochemistry. 43 students were interview: 9 students from the 100-level biochemistry class, 23 students from the 300-level biochemistry class, and 11 upperclassmen and graduate students. Results show that most students liked analogy when used in class. This was true of students at all levels, from freshmen to graduate students, though students had different reasons for liking analogy and finding them useful. Most students they spoke with like their teachers to use analogies to explain or introduce difficult concepts in their biochemistry classes. They also find that analogies are entertaining and help them understand course information. Similar study is required at NCE level on use of analogy.

Use of analogy as constructivist instructional strategy has shown much promise in its application in science teaching. Analogies are of various types depending on the nature of what they represent and the problem they are intended to solve in the teaching/ learning situation. In this study, Teaching With-Analogy of Glynn (2007) was adopted. Teaching–With-Analogy (TWA) model was preferred to other Analogy models for this

study because the model simplifies a difficult concept or idea, provides a variety of approach to link an unfamiliar idea with a familiar idea and visualizes a structure or process. Above all, it puts into consideration the prior knowledge of the learner, which constructivists view that meaningful learning must necessarily involves students in integrating new information or knowledge with pre-existing knowledge (Millar, 1989).

Teaching–With-Analogy (TWA) Glynn (2007) model consists of six steps that the teacher carries out when drawing an analogy. The steps are as follows

Step I. Introduce the target concept

Step II. Review the analogy concept.

Step III. Identify the relevant features of target and analogy

Step IV. Map the similarities

Step V. Indicate where the analogy breaks down

Step VI. Draw conclusions

This study adopted TWA model, all the six steps were followed accordingly as follows:

Step I. Introduce the target concept.

This step can be anything from a brief introduction to a full explanation depending on how the analogy is to be utilized. If the analogy is to be used as an advance organizer, then the target concept would be introduced after the analogy. The analogy may also be used for reviewing the concept(s) in which case, the target concepts is fully taught at this stage.

Step II. Cue the student's memory to the analogous situation

This step involves the introduction of the analogy and determines the student level of familiarity through questioning and/or discussion. If student understanding is low, the analogy is modified or the process is aborted. The teacher should ensure

that there is at least one obvious similarity for the students between the analogy and the target.

Step III. Identify the features of the analog that are relevant

This step involves explaining the analogy to the students at a level that is appropriate to their understanding and accurately identified the features of the analogy that was used to build concepts in the Figure 2.1.

Step IV. Map the similarities between the analogy and the target concepts

Item by item, the analogy features are linked with the target concepts. There may be a one-to-one correspondence from analogy to target, two or more analogy features may converge on a single target concept or a single analogy attribute may develop two or more target concepts.

Step V. **Identify where the analogy breaks down**

During the mapping exercise, the students may suggest inappropriate links. Other invalid transfers that the teacher may be aware of can now be combined with the student's alternative conceptions for discussion at this point. These conceptions should be discussed so that the student can distinguish the valid from the invalid. This step can be integrated into the discussion at any appropriate point.

Step VI. Drawing conclusions about the target concept

As in all teaching, a succinct summary of what has been learned about the target concept from the analogy should be stated to facilitate student learning.

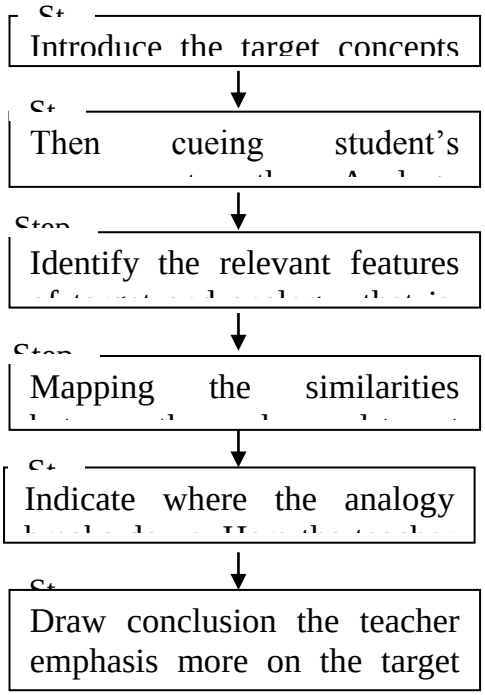


Figure 2.1: Flowchart of the Teaching-With-Analogy
Source: Glynn (2007)

This study therefore, investigates impact of collateral and analogy teaching strategies on unscientific preconceptions and academic performance in evolution concepts among NCE III biology students in North Central Zone, Nigeria.

2.5.1 Advantages of Analogy for Teaching

Use of analogy teaching strategies is a sure way of helping teachers and students to overcome difficulties associated with teaching and learning of difficult science concepts. This is because some of the difficulty experienced by students in these topics no doubt stem from lack of insight into the internal workings as well as inter and intra-particle/ phenomenal interactions that result in the observable outcomes.

Aubusson, Treagust and Harrison (2009) identified the following as advantages of the use of analogy in science teaching

1. Provide visualization of the abstract ideas by pointing to similarities in the real world.
2. Facilitates understanding of abstract concepts.
3. Arouse students' interest that may have motivation function.
4. They are valuable tools in conceptual change learning.
5. Encourage the teacher to take students prior knowledge into consideration.
6. Can reveal preconception in previously taught topics.

However, they also considers possible disadvantages due to the fact that analogy are never based on an exact fit between analogy and target.Their use requires considerable guidance and elaboration and if students hold preconceptions in the analogy domain, they will probably transfer them into the target domain. Therefore, a careful examination of all the aspects of an analogy seems to be a pre-requisite to using it effectively they have suggested that three (3) elements are essential for the appropriate use of analogy: the need to consider the students background so that the chosen analogy will be familiar to many students as possible, the shared attributes should be precisely identified by the teacher and the students, and where the analogy breaks down should be

explicitly identified. In other words, the teacher must be conscious of the limitations of the use of analogy: if the students are to gain from its potential.

Cosgrove and Osborne (1985) suggest a four (4) stage model for working through such impasses, one element in the process being the use of analogy. An appropriate analogy may serve to arouse relevant familiar concepts in long term memory. Thus, previously learned structural and organizational knowledge may interact constructively with the new challenging experience when the learner holds invalid or flawed concepts, as well as chosen, familiar analogy can act as an appropriate source of conceptual conflict for the student. In the process of restructuring knowledge, the student must first become dissatisfied with his/her prior view. For this to occur, students must be motivated to see the need to improve his or her understanding. Strike and Posner (1985) suggest that analogies can initiate new ideas and understandings within students' conceptual ecology. Strike and Posner recognized that not all new conceptions will even be considered, much less accepted. They list four criteria that ought to be met for conceptual change to occur. These are:

1. There must be dissatisfaction with existing conceptions.
2. The new conception must be minimally understood.
3. The new concept must appear initially plausible.
4. The new conception should suggest the possibility of a fruitful research program to open up new areas of inquiry.

The strategies assumed that conceptual change can be encouraged by providing opportunities for students to build up qualitative-intuitive understandings of phenomena before mastering qualitative principles. Such understandings are developed by forming analogy relations between a misunderstood target case and an "anchoring example"

which draws upon intuitive knowledge held by the students. They used the bridging strategies which consisted of four steps:-

1. The student misconception that is relating to the topic under consideration is made explicit by using a target question.
1. The instructor suggests a case, which he/she views an analogous which will appeal to the students' intuition.
2. The instructor asks the students to make an explicit comparison between the anchor and target cases in an attempt to establish the analogy relation.
3. If the student does not accept the analogy, the instructor then attempts to find a bridging analogy conceptually intermediate between the target and anchor.

The benefits of analogy as constructivism strategy according to educational broadcasting corporation (EBC, 2004) are:

- Children learn more, and enjoy learning more when they are actively involved, rather than as passive learners.
- Education works best when it concentrates on thinking and understanding, rather than on rote memorization. Constructivism concentrates on learning how to think and understand.
- Constructivist learning is transferable. In constructivist classroom, students create organizing principles that they can take with them to other learning settings.
- Constructivism gives students ownership of what they learn, since learning is based on students' questions and explorations, and often the students have a hand in designing the assessment as well. Constructivist assessment engages the students' initiatives and personal investments in their journals, research, reports, physical models and artistic representations. Engaging the creative instinct

develop students abilities to express knowledge to through a variety of ways. The students are also more likely to retain and transfer the new knowledge to real life.

- By grounding learning activities in an authentic, real world context, constructivism stimulates and engages students. Students in constructivist classrooms learn to question things and to apply their natural curiosity to the world.
- Constructivism promotes social and communication skills by creating a classroom environment that emphasizes collaboration and exchange of ideas. Students must learn how to articulate their ideas clearly as well as to collaborate on tasks effectively by sharing in groups projects.

Some advantages of using analogies are found below according to (Boo and Toh, 1997).

1. They are valuable tools in conceptual change learning
2. They provide visualization and understanding of the abstract by pointing to similarities in the real world.
3. They may incite pupil's interest and hence have a motivational effect.
4. They force the instructor to take into consideration pupil's prior knowledge and may reveal misconception in previously taught topics.
5. By allowing students to make use of analogies, they can take independent approach to learning and tackle an unfamiliar concept using analogical reasoning to build more cogent understanding.

Orgill and Bodner (2004) in their study also outline some advantages of analogies as teaching strategy

1. Analogies can play several roles in promoting meaningful learning.

2. They can help learners organize information or view information from a new perspective.
3. They provide concrete reference that students can use when thinking about challenging, abstract information.
4. Analogy can also play a motivational role in meaningful learning.
5. Analogy can result in better student engagement and interaction with a topic.
6. They can also increase students' beliefs about their problem solving abilities when the new problem or new information is related by analogy to a problem or information they have already been successful in solving or understanding.
7. Analogies can make new materials interesting to students, particularly when the analogy relates new information to the student's real world experiences.
8. Analogy can play a role in promoting conceptual change by helping students overcome existing misconception.

Finally, the purpose of an analogy is to help students learn a concept meaningfully by relating that concept to the students' prior knowledge.

2.6 Concepts of Collateral Teaching Strategy and Science

Potential Scientists are found in all cultures (Ogawa, 1995). In western countries, however, the enculturation of potential scientists into science classroom likely proceeds more harmoniously than for potential scientists in non-western cultures, students who are more likely to confront cognitive conflict between the tenets of their indigenous culture and the tenets of Science classroom. Fakudze (2004) suggested that this cultural view, to acquire the culture of science, students must intellectually shift from their everyday life-world with its traditional world view suppositions to that of school science, hence undergoing a process known as cognitive border crossing. According to Aikenhead

(1996) culture consists of norms, beliefs, values, expectations and convectional actions of a group.

Sutherland and Dennick (2002) observed that culture is one factor within the learners' social environment that is an area of interest to social constructivists' examinations of science learning. Collateral teaching strategy is suggested as a means of resolving this problem of conflict as it attempts to help students cope with science learning, without doing violence to their particular cultural beliefs and experiences (Akuma, 2005). The term collateral teaching strategy was first introduced by Olugbemiro (1995). According to Aikenhead and Jegede, the researchers sought to combine the idea of border crossings with the idea of collateral teaching, thereby offering a cognitive rationale of the way people can mentally transition themselves in the school science cultural experience and other lived experiences without doing harm to those daily cultures. According to Jegede (1995) collateral teaching as an accommodative mechanism for the conceptual resolution of potentially conflicting tenets within a person cognitive structure. Collateral teaching is the cognitive explanation of border crossing (Jegede, 1997). Also Ogawa (1995) defined collateral teaching as a strategy that enables learners to understand science concepts while maintaining their world view. The task of science teaching is to help all children acquire scientific knowledge, interest, skills, attitudes and ways of thinking without violating their cultural believes and experiences. Ogawa proposed three types of science namely: - Personal science (the result of personal believes), indigenous science (the communal beliefs and experiences of a micro-culture or cultural knowledge), and western modern science. Ogawa (1995) stated that teaching western modern science is enhanced when students become aware of their personal and indigenous sciences in a classroom. He referred to this as multiscience teaching. Collateral teaching strategy helps students to understand that there is more than one way

of understanding nature, and consequently they can use a suitable way without having to abandon their original beliefs. If science is introduced from the constructivist perspective, students will have the opportunity to realize that science is only one way of knowing, that has proved to be helpful, and will not feel a sense of violence (Akuma, 2005). According to Ogannaya (2011) collateral learning is the cognitive explanation of border crossing.

Science classroom presents challenges to students of various kinds and part of this challenge arise from cognitive conflicts that students feel in trying to reconcile their everyday life-world concepts with that of science. The indigenous concepts have developed from commonsense or from direct experiences and/or the culture. When these contrast with concepts learnt in the western science classroom, the student is faced with the task of constructing a new concepts in the long-term memory. Learning science meaningfully according to Jegede (1997) often involves cognitive conflicts of some kinds. In collateral teaching, students achieve meaningful learning as it takes the account of the multi-dimensional cultural world of the learner and helps him/her to resolve an existing conflict from the different cultures. In order to meet the learners needs of cultural driver students learning biological science in our classroom they plan; regular opportunities for all students to make sense of their experiences in ways that are personally meaningful. Science activities planned in this way will necessitate the use of many languages of students from various ethnic backgrounds present in the classroom. This is especially important for limited English proficient students. The means of facilitating the use of many languages could be through cooperative grouping with classmates who speak the same language, this provide them with opportunities to negotiate meaning of concepts. After the students have used their own languages and experiences to construct new meanings, they should be provided opportunities to negotiate meanings of the same concepts in English Language. This center on the notion

that in science and science teaching, there is no written law that a particular view directly and easily connects the experience of all the students at the same time (Igbokwe, 2009). The researcher further remarked that:

- Different students develop pre-conception and alternative frame works through interactions with their different environment.
- Students actively construct their own parameters of the world guided by previous perceptions which are often difficult to discard even after formal instructions.
- Learning may occur by either evolutional process (the modification of existing students' personal models) or revolutionary processes (the complete replacement of existing models with new ones).

However, since the cultural activities of each leaner as experienced from his/her cultural environment guide or influence his future observation and also determine what is learned, for effective learning of science concepts (Biological concepts in particular) to occur, the use of multicultural based model is vital.

Snively (1995) delineated 15 specific instructional strategies which can be used in a multicultural science classroom. These are:

- Use a variety of materials and resources, and ensure that racially stereotyped material is either eliminated or addressed in an anti-racist fashion.
- The oral narratives and heritage of the native community should become part of the school science experience.
- The similarities and differences and the strengths and limitations of the two traditions should be articulated and explored during instruction.
- Teachers should give attention to the language of science and help pupils who are accustomed to an oral tradition or who have language difficulties.
- Cultural imperialism should be acknowledged.

- Integrated discussions about science with history, morality, justice, equality, freedom and spirituality.
- Where possible, direct comparisons between classification schemes in both traditions should be made.
- Show pupils how concepts such as heat, snow and life cycles are culture-laden in both traditions.
- Instruction should provide sensory experiential pupil-centered learning.
- The pupils' world should be related to science instruction.
- Teachers should provide a multicultural view of science and technology by drawing upon a variety of cultures when teaching science.
- Activities should be designed to help students recognize the like hood of continual change, conflict, ambiguity, and increasing interdependence.
- Interactivity among pupils should encourage them to identify their own ideas and beliefs.
- Teaching strategies should emphasize solving science and technology problems, environmental problems, resource management, and sustainable society's problems.

As the principal tool of education is language, and the teachers' goal is to establish valid grounds for the learner to explore scientists' science, the meaning of individual words and expressions is a vibrant cog in this overall process of developing cogent understanding (Harrison, 2002). Whenever collateral is spoken or written, reference is being made to pictures and ideas in long-term memory. During learning, the child's unscientific preconceptions and misconception often act as a barrier to the reception of new, more valid proposition. As a result, three things are likely to occur according to Jacqueline and brooks (2004). They are:

1. The new information matches up with his previous knowledge pretty well as such the learner adds the new knowledge to his or her understanding. This knowledge is described as being as being in consonant with the previous knowledge. It cautioned that it may take some effort for it to happen, as it is a matter of finding the right fit e.g. like a puzzle
2. The new information does not match the previous knowledge as such described as being in dissonant. For learning to effectively take place, the student will have to change previous understanding to find a fit for the information. This it cautioned is much harder to correct.
3. The information does not match previous knowledge as such it is ignored. Rejected bits of information may not be absorbed by the learner, they may however be floating around waiting for the day the learners understanding has developed and as such permits it to be properly fitted.

The idea of meaningful learning carries with it the connotation of a cultural connection. When the culture of science is at odds with a student's life world, science instruction will tend to disrupt the students worldview by trying to force that students to abandon or marginalize his/her life world concepts(Aikenhead & Jegede, 1999). Constructivism is an instructional strategy which incorporates other desirable teaching strategies such as analogy and collateral in teaching. In this study, Collateral Teaching Strategy of Fakudze, (2004) was adopted. All the four steps were followed accordingly.

The CTS uses the information processing model depicted by Eggen and Kauchak (1994) and Johnstone (1997) as its basic framework. The model is divided into three main parts. The sensory register (SR), the working memory (WM) and the collateral learning that are joined by arrows. The model is used to describe how a scientific concept presented in a science classroom is learned or rejected by a student. The Learning Process

in Terms of the CTS, scientific concept presented in a science classroom receptors and sensory register. Students Sensory Register (SR) through receptors, the context of the scientific phenomenon being presented activates his/her schemata. The student pays attention and start to perceive the scientific concepts being presented by attaching meaning to the information received from his receptors by using prior knowledge and experience. For instance, we have cases of male circumcision as part of our traditional beliefs but cannot explain why males are circumcised in our society. In contrast, in science classroom reasons why males are circumcised are explained. The resultant world view schema will then be transferred to the working memory. The diagonal line across the working memory box shows the divide between traditional and scientific worldviews.

Learning within the Working Memory (WM) when the perceived worldview schema from the sensory register enters the working memory (WM), it lies contiguously with two or more other worldviews (traditional and/or commonsense – intuitive knowledge) that have been retrieved from his/her store via the feedback loop. The student's indigenous beliefs as well as his/her common sense-intuitive knowledge are contrasted with the scientific concept encountered by the science classroom and given a tentative status. The concepts (from the science lesson and traditional ideas) now lie contiguously and information is then processed by recalling, relating, collaborating the new with the old knowledge. The information received or the condition evoked by a given experience in the working memory to trigger off the assemblage of certain appropriate elements (e.g. neurotransmitters) in each macro thoughts capable of responding to the changed mental state. The success of this integrative and transformative cognitive process is what Ogunniyi (2000) calls contiguity learning.

Border Crossing and Transition between WM and collateral learning, the border crossing theory is used in the transition between the Working Memory and the store

ideas. The arrows between the WM and store ideas illustrate the various types of border crossings that occur when information is transferred from the WM into collateral learning. According to Fakudze (2002), the level of success of the integrative and transformative cognitive process determines the type of border crossing that will take place in the transition between the WM and store ideas.

- Managed border crossing would occur when the scientific world-view schema is dominant
- Impossible border crossing would occur when the traditional world-view schema is dominant.
- Hazardous border crossing occur when the worldview schemata have gained more or less equal supremacy or where the commonsense-intuitive schema is dominant.

Collateral Learning

The collateral learning theory is used in the store ideas. Once the information passes from WM to the store ideas, some permanent storing begins on the type of border crossing (Aikenhead, 1996) that took place in the transition from the WM. The storage takes place in the form of collateral learning. The different types of collateral learning are represented in four sections (Figure 2.2).

- Parallel collateral learning
- Secured collateral learning
- Dependent collateral learning
- No collateral learning

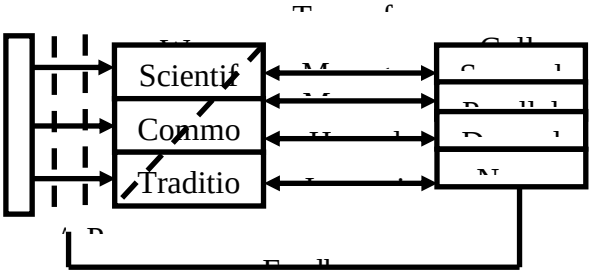


Figure 2.2: The Collateral Teaching Strategy Model
Source: Fakudze (2004).

Key:

SR: Sensory Register

WM: Working Memory

A: Attention

P: Perception

The following steps are involved when using Collateral Teaching Strategy Fakudze (2004) model

Step 1. Sensory Register (SR)

Introduction of the concept to be learnt through materials like pictures, diagrams, and questions related to the topic in the society.

Step 2. Working Memory (WM)

Presentation of the target concept is done.

Ideas gathered from the society are brought into science classroom and are related to the science concepts taught.

Step 3. Border Crossing and Transition between working memory and Collateral learning.

Questions were asked by the researcher based on the topic taught. From the answers given by the students, the types of border crossing that has taken place in the students, is identified by the researcher.

Step 4. Collateral learning

From the information passed from WM to the collateral learning, there is permanent storing of what students have learned depending on the type of border crossing. The storage takes place in the form of collateral learning.

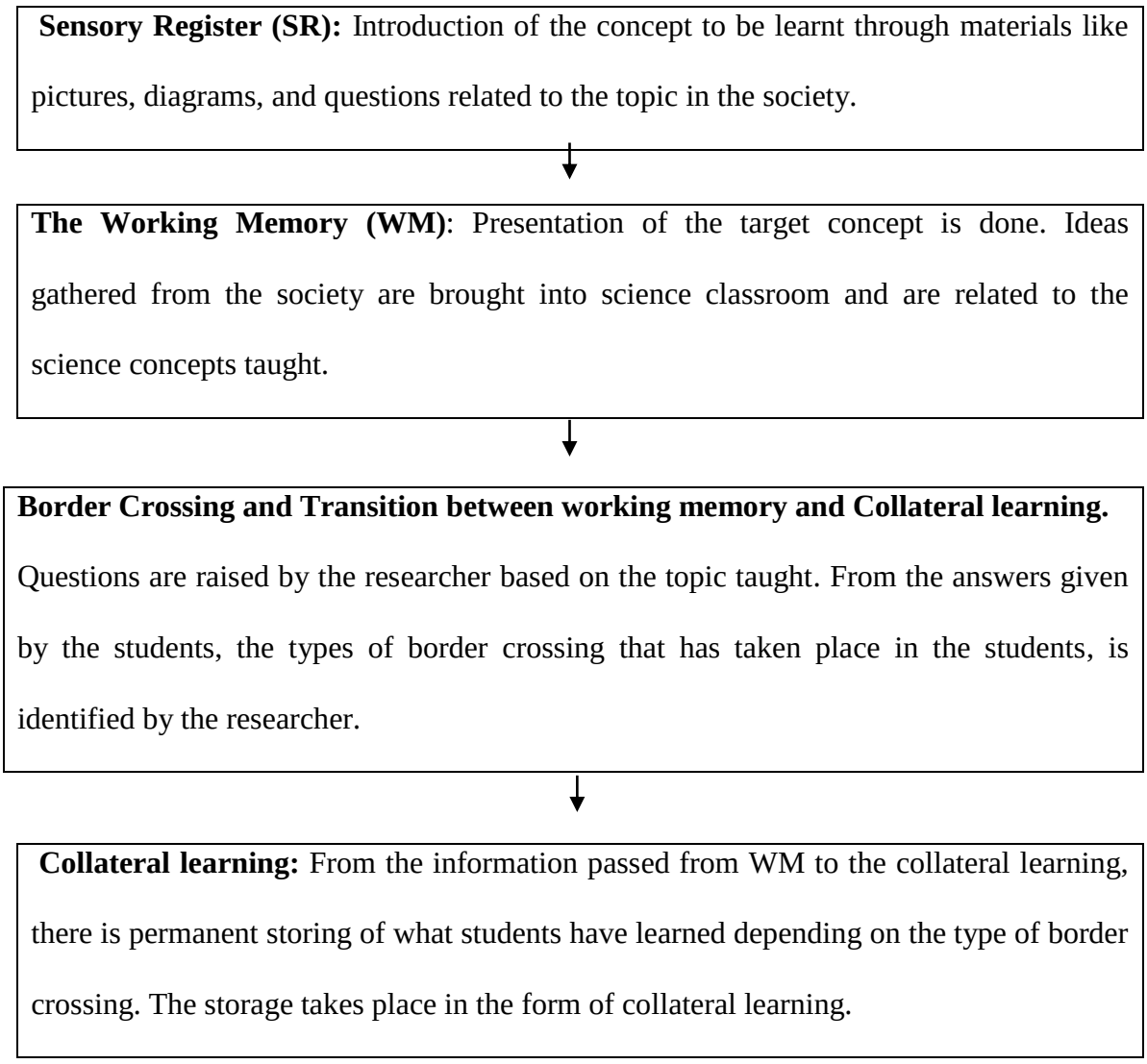


Figure 2.3: Flowchart of CTS
Source: Fakduze, 2004

2.6.1 Types of Collateral Learning Strategy

Learning science meaningfully according to Jegede (1997) often involves cognitive conflicts of some kinds. In collateral learning students achieve meaningful learning as it takes the account of the multidimensional cultural world of the learner and helps him/her to resolve an existing conflict from the different cultures. To learn science is to acquire the culture of science (Maddock, 1981; Wolcott, 1991). To acquire the culture of science, students must travel from their everyday life world of science found in their science classroom. Students' flexibility, playfulness and feelings of ease in the world of science will help determine the smoothness with which students cross the border into the culture of science. This smoothness will likely affect the degree of culture acquisition that takes place.

Different cultural processes are involved in the acquisition of science culture. When the culture of science generally harmonizes with a student's life world culture, science instruction will tend to support the students view of the world, and the process of enculturation tends to occur (Wolcott, 1991). Effective cultural border crossing is indeed a complex event; the cognitive experience of border crossing is captured by the theory of collateral learning (Jegede, 1995). The phenomenon to which collateral learning refers is universal and well known worldwide and the theory was proposed to explain why many pupils non-western and western, experienced culturally related cognitive dissonance in their science classes (Jegede, 1995).

Collateral learning generally involves two or more conflicting schemata held simultaneously in long-term memory. Jegede (1995, 1996, and 1997) recognized variations in the degree to which the conflicting ideas interact with each other and the degree to which conflicts are resolved. Basically, there are four (4) types of collateral learning acknowledge, are introduced here and then are clarified by examples that show

what role they play in learning science and biology in particular. These four (4) types of collateral learning are not separated categories, not along a spectrum depicting degrees of interaction and resolution. The process of collateral learning includes the followings.

1. Parallel Collateral Learning: At end of spectrum, the conflicting schemata do not interact at all with this technique; students will access one schema or the other depending upon the context. For example, a student in a biology class may understand the principles of evolution perfectly. His/her religious beliefs may cause the students to believe in creationism. Or student will use a scientific concept of energy only in school never in their everyday world where commonsense concepts of energy prevail (Solomon, 1983). These two conflicting concepts may be held in different schemata and cued based on the context. In the biology class or during examination, the student will perfectly expound the theories of evolution and obtain an excellent grade outside the science classroom it will never be used, rather the student refers to the holy book bible or Quran and creation in making his/her explanation of the origin of species. This is a very good case of collateral learning (Ogonnaya, 2009).
2. Secured Collateral Learning: At the opposite end of the collateral learning spectrum, conflicting schemata consciously interacts and the conflict is resolved in some manner here. The person will have developed a satisfactory reason for holding on to both schemata even though the schemata may appear to conflict, or else the person will have achieved a convergence toward community by one schema reinforcing the other, resulting in a new conception in long-term memory. The student develops a reason that causes him to hold both concepts. In fact, the conflicting concepts reinforce one another. An example may be found in a student believing in the impending destructions of the earth proclaimed by Christians and

Muslims. At the same time, student may believe in recent scientific speculations of the earth getting closer to the sun (or Ozone layer depletion), which may eventually destroy it, or the increasing scientific evidence that a giant mate or may hit the earth in the near future. These seem to be contrasting but somehow mutually reinforcing. In view of this, Lowe (1995) cited in Ogonnaya, 2009 in his Solomon island study, argued for a supplicated view of learning beyond the simple dichotomy of "Science Versus Traditional Knowledge", his proposed view would empower students for life in the 21st Century. Tobin (1991) in Ogonnaya called this technique "empowerment" as it is associated with students setting conflicts between scientific claims and students, everyday notions of common.

3. Dependent Collateral Learning:- This lies between the two extremes of parallel and secured collateral learning, learning occurs when a student's preconception or indigenous belief is (a) contrasted with a different conception encountered in the science classroom, (b) gives a tentative status and then either (c) altered by reconstructing the original schema under the influence of the newly encountered schema, or (d) rejected and replaced by a newly constructed schema because it makes sense to do so. Dependent collateral learning is similar to the piagetian accommodation-assimilation model of information processing associated with posner, Strike, Hewson and Gertzoy's (1982) conceptual change model. A critical difference between the two lies in the degree of imposition of conceptual change on students (cultural assimilation). An example is the replacement of indigenous reasons for recurrent infant mortality in a home by a scientific reason such as a sickle cell anemia. If a student who holds the "Abiku" or "Ogbanje" conception comes in contact with the sickle cell phenomenon in a biology class, the letter is very likely be a discarding of the unscientific preconception for the more plausible

and intelligible scientific concept. The student does not necessarily have to discard his African or traditional world view for the scientific. This promotes meaningful learning in that if it occurs often in students cognition, it will eventually, lead to a change in the world view.

4. Simultaneous Collateral Learning: This fits between parallel and dependent collateral learning on the spectrum described above. A unique situation can occur in which learning a concept in one domain of knowledge or culture can facilitate the learning of a similar or related concept in another milieu. It does not happen often, but when it does, it is usually coincidental. For instance, suppose a Nigerian student is studying photosynthesis in biology class and come across terms such as chlorophyll, denaturing and chloroplast. Initially he/she may likely have problems comprehending these conceptions. But supposed that after encountering the concept in school, he/she finds something that makes the school science vivid while helping the mother in the kitchen, the initial conflicting concepts are either reinforced or extinguished. In Nigeria, people often bleach green vegetables before adding them to soup or any food. During this preparation the vegetables are left for some minutes to soak in boiling water, and the vegetables lose some of the green coloration (chlorophyll). When people drain the water, all they see is green colour. In that situation, a student might simultaneously learn more about the school concepts of chlorophyll, denaturing and chloroplast while learning to prepare soup with green vegetables at home. In these two settings (school and home), learning about arise spontaneously and simultaneously. By reflecting on the two settings and their concomitant concepts (for example green blanched water and chlorophyll), a student may easily cross the cultural border between home and school science. The two sets of schemata established in long-term

memory by simultaneous collateral learning, may over time further compartmentalized, learning or interact and be resolved in some ways, resulting in either dependent or secured collateral learning depending on the manner in which the conflict is resolved. Therefore, meaningful learning often results in parallel collateral learning. In this study analogy and collateral strategies was use for teaching evolution concepts to determine their effectiveness.

2.6.2 Advantages of Collateral Strategy for Science Learning

Collateral as a teaching strategy has the following advantages to learning of science concepts. The advantages are as follows:-

- It helps resolving problem of conflict between culture and science,
- It helps students cope with science learning without doing violence to their culture beliefs and experiences.
- -It helps all students acquire scientific knowledge, skills, attitudes, interest and ways of thinking without violating cultural believes.
- It foster the understanding or cognitive achievement of science concepts among students in schools.
- Cognitive conflicts resulting from a traditional worldview and that science lead to learning of biology meaningfully. Also Ogonnaya (2011) outlined the following advantages of collateral teaching strategy.
- It helps to produce functional students who could effectively exploit their environment by observing the relationship between the sciences they learn.
- It makes border crossings explicit for students, it facilitate these border crossings.
- It promotes discourse so that students, not just the teacher, are talking science, Substantiate and build on the legitimacy of students personally and culturally constructed ways of knowledge.

Shull (2013) suggested some advantages of collateral learning as a teaching strategy that improves learning and increases content taught without significant loss of class time,

- It helps students having better understanding of concept.
- -They were better able to take remedial action to resolve conflicts.
- -Students in the science classroom will construct scientific concepts side by side.
- -The strategy is active and experimental

2.7 Gender and Academic Performance in Science

Gender is one of the factors interfering with performance and studies on it have been unresolved in their conclusions (Nussbaum, 2000). Some researchers found that male students have a higher performance than female students (Novak and Mosunda, 1991; Danmole, 1998; Usman, 2000; Arbogast, 1997) reported that boys performed significantly better than girls in SSCE physic examination. Jegede and Inyang (1990) worked on gender differences and academic achievement in integrated science in junior secondary school. They confirmed that males performed better than females. They affirmed that males demonstrated significantly more positive attitudes towards science than females. Schibbeci (1984) also noted that female exhibit more positive attitudes towards biology and males physics. Other studies of Mari, 1994; Shuaibu and Mari, 1997 confirmed the superiority of female students' performance over male students. Owuamannam and Babatunde (2007) noted that the girls tend to go for courses that do not require more energy and brain tasking such as home making while boys looked for jobs in management, engineering, banking and other brain tasking professions. Yet other researchers found no significant difference between male and female performance (Price, 1993; Bello, 1996; Nussbaum, 2000; Bichi, 2002; Danmole and Adebayo, 2004; Udousoro, 2011) studied the effects of gender and mathematics ability on academic

performance of students in chemistry. The sample size comprised one hundred (100) SS I chemistry students in two secondary schools Uyo metropolis. The instruments used were the Chemistry Achievement Test (CAT) and the Mathematics Ability Test (MAT) Independent t-test statistic tool was used to analyse the data collected. The result of the test indicated that gender does not have any significant effect on the academic performance of students in chemistry. It was also observed that students with high mathematic ability performed significantly better than those with low mathematics ability in chemistry. Danmole and Femi-Adeoye (2004); Okonna, Ushie and Okworo (2014) carried out studies on effect of gender on academic performance of maritime trainees in Nigeria taught with web-based resources. They carried out a pretest and posttest non-equivalent control group design was employed using a total of forty maritime trainees, twenty participants each in the experimental and control groups, from the maritime industry in Nigeria. The findings showed that no significant difference exists between the academic performance of male and female maritime security trainees. Abdulraheem (2012) worked on gender differences and students' academic achievement and retention in junior secondary schools in Ekiti state. A total of 240 junior secondary school class II students selected from 6 schools, 3 boys only and 3girls only in Ekiti state Simple random sampling was used to select 40 students from each single-sex school. The instrument used for the study was the social studies achievement test (SSAT) designed by researcher. SSAT contained the bio-data of the respondents in section A while section B consisted of 40 multiple-choice items designed to find the level of achievement and retention in social studies. The data were analyzed using ANOVA statistical analyses. The findings indicated that there is no significant differences between the achievements mean scores of male and female students in the experimental and control groups. There is no significant difference between the retention mean score of male and female students in the

experimental and control. Hence, this study looks at the impact of gender on unscientific preconception and academic performance in evolution concepts among NCE III biology students.

2.8 Overview of Similar Studies

Several studies were carried out on the use of analogy in the teaching and learning of science. The reason why analogies work as teaching tools is the fact that they are familiar to the students. So anything that relates to students' live will be immediately familiar.

Harrison (2002) used analogy to teach chemistry teachers with 16 years experience participated in this case study. The Grade-12 chemistry lessons studied were reaction rates, reversible reaction and equilibrium. Before each lesson, the teacher was interviewed about his intentions while after each lesson; the teacher's post-lesson interview and interviews with a number of the students who received the analogical instruction. Students taught were between aged 8 and 10 science students. The data were interpreted from constructivist perspective with attention given to credibility, dependability and confirm ability. The interviews mostly focused on the use of analogies for explaining relevant chemistry concepts. The lessons and interviews were audio taped and transcribed and the transcripts were analyses individually by both authors using investigator triangulation (Jamestick, 1994), the analyses were compared and discussed until consensus was established concerning the in-class interactions and the teachers' analogical explanations. The result shows that the teacher presented seven analogies to his students and the analysis reveals that the teacher appeared to be aware of the relevant correspondences, but was not aware of the differences, especially the absence of his intended attention to the limitations of specific analogies, and the absence of his intended check of students understanding of links between an analogy and its target. The teacher

was experienced in telling analogical stories. From this study there is need to pay attention to specific aspects of teaching with analogies in the context of pre-service and in-service teacher education. The study findings demonstrated that students understanding of difficult science concepts did appear to be enhanced by the use of the analogy in the lesson. This study is relevant to the present study because it enhanced students understanding of difficult science concepts which is the focus of this study and serve as a guide to teachers' preparation.

Antal (2004) carried out a research on improving analogical reasoning in biology teaching. The experiment was carried out in 7 primary schools in 16 classes 7 experimental, 9 control with students aged 14 in, and Szeged, Hungary. The students level of thinking, level of subject knowledge, and attitude with experimental/control pretest, posttest experimental design. Antal opined that sample can be considered representative because of previous experiments in and around Szeged, which measured students' performance on knowledge and abilities tests. These earlier experiments results did not differ to a great extent from the national average. This way Szeged and its immediate surroundings characterize the teaching practice and pedagogical culture in Hungary; it is a so-called cultural unit. In the sample there were 405 14-year-old students (185 experimental, 220 control) boys and girls were approximately equal in number in the survey. The instrument used was questionnaire test consisting of three sub-tests: 1) number analogies, 2) verbal analogies, and 3) number series. The results indicated the importance of the following for educators to make students aware of the characteristics of the applied thinking strategies, and operations of thinking (metacognition). The finding of the study showed that students' performance knowledge and abilities were improved after using analogical instruction in biology. This study was relevant to this study because

analogical reasoning is put into consideration how analogy are used to improved performance and thinking abilities of the learners.

Culree (2005) worked on implementation of 5E inquiry incorporated with analogy learning approach to enhance conceptual understanding of earth science for grade II students. The study adopts pre-conceptual test and post-conceptual test experimental control group design. Population and sample for the study was Forty-four (44) grades II students were the target group. She taught an earth science lesson on the structure of the earth. The researcher baked layered cup-cakes for her students and explained that the cupcakes were analogy of the earth, with the four layers corresponding to the crust, mantle, outer core, and inner core of the earth using straws, the students took "core examples from the cupcakes, examined the samples and compared them to representations of the earth in their textbooks. Students taught using analogy had better understanding of the concept and their performance was improved. This study serve as guide to development of analogy in classroom learning.

Conti (2005) taught a biology lesson on natural selection and "survival of the fittest" at SS II secondary school level. He took his children outside to an area of green where earlier he had scattered on equal number of green, yellow and red uncooked noodles. He explained that the noodles represented different coloured grasshoppers and that the students were hungry birds who preyed on the grasshoppers. The students caught as many grasshoppers as they could in the next five minutes and returned to the classroom, where a tally revealed that fewer green grasshoppers were caught than yellow, and fewer yellow than red. Joe then asked his students to hypothesis how a trait such as coloration could increase or decrease the probability that species would survive in a green environment. Students were able to give better explanations of what they saw. Students performed significantly well because of the analogy used in explaining the concept taught

having a pretest10.3, while having a posttest 28.7 mean scores which signifies positive effects of analogy as a teaching strategy. This type of study is required at NCE more especially to correct preconceptions and improve performance among the learners.

Wheeler (2005) taught a physical science lesson on optics. She and her students built a simple, working camera and she used this camera to explain optic principles. Wheeler, and then explained, that the camera was analogous to the human eye and, using a physical model of the eye, she compared its features to those of the camera. Finally, she taught optic principle common to both the camera and the eye. This study serves as a guide in terms of mapping and identifying the relevant features of analogy and target concept.

Harrison and Treagust (2006) reported that most analogies are teacher generated but in conducive circumstances, students can generate effective analogies. A grade 9 teacher called sally was investigating electric circuits. In short time, she realized her students thought that current is used up in the series circuit found in a flashlight. To explain current conservation she used continuous train analogy. The train (representing the current) is clearly conserved while the passengers (representing energy) move from station 1 (energy in the battery) to station 2 (energy converted to heat and light). She realized that her version of the analogy taught the students that current changes speed (and intermittently stops) as the train loaded and alighted passengers fell apart in her class. She realized that an alternative conception would result if she maintained the continuous train analogy. She stopped the analogy and explained to her student what was going wrong with the analogy and reverted to a classical explanation of the difference between current and energy. Analogy guides the students to have better understanding of the concepts even if the analogy breaks down. This study gives insight to the study that

analogy can breaks down and that the teacher should use explanation to finished the teaching.

Guerra-Remos (2011) carried out two empirical studies on the use of analogies in primary classrooms in Mexico. String circuit analogy was used for aged 8-9 while making a cake analogy was used for teaching photosynthesis for aged 10-11. The researcher presented analogy using verbal description and by means of a physical representation. The instrument used for data collection was questionnaires, interviews, and written text. The outcome of both studies was scrutinized to assess the effectiveness of analogy as tools for meaning making. Students' populations were 12 for aged 8-9 and 10 for aged 10-11.

The findings of the study reviewed that analogy can play an important role in promoting students understanding and in developing meaningful explanations of scientific ideas. This study is relevant to this study because analogy improved students understanding and makes science learning more meaningful.

Owolabi (2002) worked on the use of analogy as vehicle for achieving effective physics delivery among selected senior secondary schools in Lagos. The study will adopt a pretest, posttest experimental/control group design. The sample of 112 senior secondary school two physics students drawn from two randomly selected secondary schools in Lagos. The instrument used for data collection was adopted from Owaseye (2000). The Achievement test was to find out specific information regarding the concepts of mirror and lenses which many students often confuse or use interchangeably. The result shows that the experimental group performed significantly better and retained more of the concepts than the control group after post- posttest. It shows that there is statistically significant difference between the mean scores of experimental and control groups. This is an indication that there is significant influence of analogy on students' performance in

physics. Owolabi's study is relevant to the present study because he used analogy to improved students understanding of concepts of mirror and lenses which confuse or used interchangeably. The finding of these study are of relevance to the present study in that it guided the researcher to select problems and also use the strategy in teaching concepts of evolution to NCE III Biology Students.

Hoputaife & Nworgu, (2002) worked on analysis of restructuring alternative conceptions of physics students using analogy and a five step conceptual change instructional model on senior secondary school students. The study adopts a pretest posttest experimental control group design. The sample for the study consisted of 186 SS I Students from four selected secondary schools in Enugu State. Out of the four secondary schools, two schools were assigned to the five step conceptual change instructional models group while the remaining two schools were assigned to the analogy group. The two groups were taught simple electric circuit. The instrument used for data collection was Physics Achievement Test (PAT) developed by the researcher. T-test statistical analysis was used to test the stated hypothesis, and the result was 93.5 percent for the students that had alternative conceptions on electric circuit before treatment while only 6.5 percent of the students had scientific conceptions before instruction took place. After treatment 92 percent of the students who possessed alternative conceptions before treatment shifted to scientific views after formal instructions took place that is effects of analogy and while those taught using five steps conceptual change instructional models achievement did not differ significantly.

The finding confirms that students develop ways of interpreting the world around them and also the finding of this agrees with Nworgu (1996) that students bring to the school learning ideas expectations and beliefs concerning natural phenomena which they have developed prior to their school learning. The study finding confirms to Nworgu

(1997) views that constructivist based methods like those used for this study result in a conceptual shift or change Nworgu's study was relevant to the present study in that analogy adopted as constructivist learning approach was used which is the focus of this study.

Sani (2006) made a study on effect of analogy on conceptual understanding chemical equilibrium in chemistry among SS II Students in Minna, Niger State. The study used Eighty (80) SS II Senior Secondary School Students for data collection. Purposive sample was used because all chemistry students in selected schools were used. Average aged of students was 14 to 16 years old. The study adopts a pretest, posttest experimental control group design. The instruments used for posttest were two forms of multiple-choice chemistry tests which were used for data collection, t-test statistical analysis was used to test the stated hypothesis. The result obtained from the data analysis indicated that scores of experimental and control groups before the treatment were 23.3 for experimental group and 24.9 for control group. This indicated that there is no statistically significant difference between the mean score of experimental group and the mean score of the control group at the 0.05 significant level. Thus the two groups were equivalent before the treatment. The result of the posttest mean scores of the experimental group was 56.7 and that of the control group was 31.3. This indicates that there is statistically significant difference between the mean scores of the experimental and control groups at the 0.05 level ($P \leq 0.05$). Thus the null hypothesis was rejected. The experimental group taught with analogy performed significantly better than the control group. Thus, the null hypothesis was rejected. The significant difference observed could be attributed to the effect of the analogy strategy which had increased conceptual understanding of chemical equilibrium and consequently higher performance. Sani (2006) study used students at

senior secondary school level for the teaching of chemistry the present study however used NCE students and were taught evolution concept.

Ijioma and Onwukwe (2011) reported that the use of analogy as teaching strategy is a sure way of helping teachers and students to overcome difficulties associated with teaching and learning difficult in science concept. The study took place in Imo state, Nigeria. They carried out two empirical studies on senior secondary class 1-3(SS3) chemistry students increased firm to 36.9 to 77.2% over a period of three years. Average aged of class 16 years. They used culturally based analogies of TWA model adapted from Onwukwe and Onwukwe (2010) as an abridged lesson plan. The findings showed that the students that were exposed to the play performed significantly higher than those that were not exposed to the play culturally based analogies generated from one source. It has also been evident that the usefulness of analogy for students may depend on several factors as the difficulty of science concepts. This study is relevant because it ensure the role of analogy in simplifying difficult science concepts.

Olorukooba, Lawal and Jiya (2012) made a study on effects of the use of analogy teaching strategy in Evolution concepts among NCE Biology Students Niger State Minna. The study adopts a pretest, posttest post-posttest experimental control group designed. A total of 280 NCE III Students were used for both experimental and control group. The instrument used for the study was Evolution Achievement Test (EAT). EAT was made up of a 40 items multiple-choice questions which were used for data collection the instrument has reliability coefficient of 0.80. Two groups were involved the two groups were pretested at the beginning of the study using EAT. After treatment the experimental and control group were posttest and after two weeks post-posttest to determine the students retention level t-test statistically analysis was used to test the stated hypothesis, the result shows that the experimental score 26.17 while control group score 13.01 at

P≤0.05 level this indicate that the experimental group performed significantly better than the control group taught using lecture method. The analogy teaching strategy was found to significantly improve students' performance and retention. Students learn better when taught using analogy. This study confirms the potentials of analogy in improving students' performance therefore serve a guide to this study.

Ayanda, Abimbola and Ahmed (2012) studied on the effects of teacher's use of analogies on the achievement of senior school biology students in Oro, Kwara State, Nigeria. The study adopts pretest, posttest experimental control group design. Total population of 119 Students were assigned into two groups, experimental and control. Purposive sampling technique was used. The instrument was Biology Achievement Test (BAT) with reliability coefficient of 0.73 was used. The two groups were pretested before treatment to determine their abilities level, after treatment the students were also exposed to posttest, the scores obtained are used for data analysis using t-test statistically. The result shows that there is a significant difference in their achievement, the mean scores of experimental group is 17.08 higher than the mean scores of control group is 15.32. The findings from the study show that there is a significant difference in the achievement of the experimental group exposed to analogies than the control group exposed to lecture method. The finding of this study is relevant to the present study because the study was carried out on biology concepts which may different but may be applicable.

Muhammed (2013) carried out study on teaching some chemical equilibrium concepts among NCE Chemistry students in the colleges of education in Kaduna state. A total of 278 NCE II students were purposefully selected from the two colleges of education in the state, comprising 179 males and 90 females. The experimental and control groups. A pretest posttest quasi-experimental control group design was adopted. The experimental group was taught using analogy teaching strategy while the control

group was taught using lecture method. The validated instrument was chemical equilibrium achievement test (CEAT). The hypothesis was tested using t-test statistic at $p \leq 0.05$ alpha levels of significance. The experimental group taught with analogy teaching strategy has the mean score of 26.17 while control group has mean score of 13.01 at 0.001 significant level. The finding showed that the analogy teaching strategy is better at improving students' achievement in chemical equilibrium concepts than lecture method. This study is related because it has given an insight in to how analogy has improved students performance. In this study therefore, the impacts of analogy and collateral teaching strategies was use on unscientific preconception and academic achievement in evolution concepts among NCE III Biology Students in North Central Zone, Nigeria.

Haidar (1999) links his study of nature of science views among both pre-service and in-service teachers in united Arab-Emirate with the idea of teaching science from a constructivist view point instead of a traditionalist view point. A total of 545 were used for the study. According to Haidar, Collateral learning helps students understand that there is more than one way of understanding nature, and consequently they can use a suitable way without having abandoned their original beliefs. Therefore, if science is introduced from the constructivist perspective, students will have the opportunity to realize that science is only one way of knowing, that has proved to be helpful and will not feel a sense of violence. He recommended in one instance that pre-service science teachers be allowed the opportunity to constructivist format using a discuss framework. Thus, collateral learning in this case was recommended to help facilitate a constructivist approach to science.

According to McCoy (2002) a questionnaire form was used to differentiate among students based upon the world view universals or assumptions of classification,

relationship, and causality. The participants for the study were made up of six ninth grade students between the ages of 14-16 years who has not entered into an official high school biology course. The researcher held three interviews with each student and then all students were invited to a focus group interview. For McCoy, the major reason for the study is to describe the world views of each student in relationship to biological science before the participants attended a biology class. Kearneys model seemed to be chosen because of its analytical power within the scope of a qualitative study. The following two implications were made by McCoy after a thorough analysis was completed of the data and several assertions had been made: Implication One: World View causes students to hold implicit theories of the world that are based as much on personal feeling as on thinking.

Implication Two: World View causes students to separate what we call "scientific thinking" from their'' everyday thinking'' about living things. Because in secured collateral strategy students given scientific explanation different from their everyday thinking which most them used in their response to UPTE test.

Herbert (2004) investigated students from two secondary schools in Trinidad and Tobago and their responses to an evaluation after a series of units that were designed to teach accepted scientific idea and health issues by building cultural bridges. Qualitative evidence supported the idea that certain individuals' students experience parallel collateral learning. For example, one student used both her own traditional knowledge about the cause of the common cold and also a scientific approach to the same idea when the context demanded it.

Evidence of both dependent and secured collateral learning becomes apparent after a pre-intervention and post-intervention analysis. He discovered that secured collateral learning to the construction of more developed conventional science concepts.

Research finding by Sutherland (2005) showed that some students engage in acts of resistance to science learning by using avoidance strategies. Strategies that will assist students to do well in school science should be explored as a means of understanding students' engagement in science learning's Sutherland (2005) carried out a study on resiliency and collateral learning in science in some students of cree ancestry. The first interview was semi-structured in design, with questions that prompted students to discuss their family, peers, teacher and extracurricular activities. He used 20 students of cree ancestry; 13 female and 7 males with age 11-15 years, they were interviewed on two separate occasions on their family, peers, teacher and extracurricular activities. In addition, students were asked about their interest in science, their ideas about science and their teacher expectations in their science achievement. The second interview used critical incidents to elicit students' negotiated boundaries with science and their personal experience. Out of the 20 students interviewed there were 7 who could be identified as possible collateral learners. Each of the recorded interviews was transcribed to allow analysis of verbatim text. These students were capable of expressing a different between the science knowledge they learned in school and the knowledge that may be obtained through interaction with an elder. Students who did not identify any differences between western science and indigenous knowledge could be collateral learners because these students did not view any difference between the two knowledge systems. He went further to say that the more difficult task is to determine if the student has orientation of types of collateral learning like parallel or secured collateral learning's.

A secured collateral learner will most likely provide responses in the science classroom that include a rationalized conceptual understanding that may combine western science and indigenous knowledge. He found that students hold at least two sources of knowledge to explain some science concepts and therefore may adopt a collateral learning

strategy. One final conclusion put forth was that because secured collateral learning carries with it the idea of a combination between western science and indigenous knowledge, that form of knowledge would not be as accepted in science class. Thus Sutherland was able not only to use collateral learning as a lens for the data but also to interpret the theory's usefulness by the data themselves. In this study therefore analogy and collateral teaching strategies were used to see their effectiveness on unscientific preconception and academic achievements of biology students on evolution concepts at NCE level to see what the result are.

Other studies within science education are also related tangentially to the ideas of collateral learning, border crossing and the religion/science. The study of Colburn and Henriques (2006) helps explain these mechanisms that allow for integration or compartmentalization of differing concepts. The study dealt primarily with clergy members' views about religion, science, creationism and evolution. In the first part of the study, eight clergy members and one professor of religion were interviewed. According to Colburn and Henriques, individuals included three women and six men. The second part of the study used a 36-item survey of a large number of clergy representing a grouping of more mainstream Christian denominations similar to the interviewees. The information gathered from the interviews and survey showed that clergy believe religion and evolution to be basically agreeable and not incompatible, that creationism should be taught within science classroom that the Bible should not be understood as a scientific book and a literal document, and that most of the clergy believe that god does have apart in the evolution and creation of life (Colburn and Henriques, 2006).

The researchers discovered that all clergy interviewed and surveyed held to an independent or compartmentalized view of science and religion or a convergent or integrated view of science and religion. For example, no individual held to the ideas that

religions knowledge is more correct than scientific knowledge when a conflict occurs; this would demonstrate more of a literalist or fundamentalist view of scripture. This aspect of the study falls also inline somewhat with collateral learning in that the clergy themselves kept the topics separate as in parallel collateral learning or found integration points as in secured collateral learning. Thus, the research by Colburn and Henriques, (2006), Shipman, Brickhouse, Daugher and Letis, (2002) and Aikenhead and Jegede (1999) all use the idea that Thus, the research by Colburn and Henriques, (2006), Shipman, Brickhouse, Daugher and Letis, (2002) and Aikenhead and Jegede (1999) all use the idea that individuals create mechanisms to accommodate conflicting knowledge. These mechanisms, while somewhat different in all three research articles, still build upon the promise that, within the parameters of the science and religion conflict, certain individuals are using mechanisms to transition cognitively across cultural borders. It was not the main purpose for the study to designate individuals into differing categories of collateral learning but to understand more completely how and possibly why certain individuals tend to compartmentalize or integrate differing aspects of cultural knowledge. This study shows that collateral learning helps in mental resolution mechanism that an individual uses because of a possible cognitive conflict with science. This study is relevant because it guides on mental resolution of possible cognitive conflict with science and common sense intuition.

Shull (2013) investigated extended abstract blending collateral and concurrent learning. An effective methodology to teach professional skills (professional skill-ABET professional skills 3.d.g). The engineering topic is the development of pros and cons for effective solution selection. The students were given assignment to develop a well developed pros and cons list for one of several controversial topics such as Marcellus gas drilling on public land. He compared student learning of emotional hijacking using new

method of intended collateral learning and a traditional method where the topic was known to the students throughout the exercise. He found that students taught using intended collateral learning recorded significantly more events with most students recorded at least one event where emotions interfered with team function. He concluded that student taught with intended collateral learning were better able to take remedial action to resolve the issue than students who were taught with the traditional method. He says that the method is active and experiential in nature. This study is relevant to the present study in that the result has given some insight into the present study.

Ogonnaya (2011) revealed in his study that collateral teaching strategy is a multicultural approach that enables students to understand science concepts while maintaining their world views. Multicultural learning approach will produce functional students who could effectively exploit their environment by observing the relationship between the science they learn, their cultural environment and experiences. In this study therefore, analogy and collateral teaching strategies were used on unscientific preconceptions and academic performance in evolution concepts among NCE III Biology students in North Central, Nigeria.

2.9 Implication of Literature Reviewed for the Present Study

The review into many research studies in the area of unscientific preconceptions, students' performance, use of analogy and collateral teaching strategies on evolution concepts were carried out. Several learning difficulties experienced by students made them have different conceptions of evolution concepts that the teachers attempt to put across. In many of the studies reviewed like Haidar (1999), Ijioma and Onwukwe (2011), Ayanda, Also, Abimbola and Ahmed (2012), Shull (2013), Kampourakis (2014) among other researchers used analogy and collateral teaching strategies in correcting unscientific preconceptions and improve students' academic performance. The findings showed that

the strategies may help students build conceptual bridges between what they already know and what they are setting out to learn. Also the strategies may help students construct their own knowledge, a process that is encouraged in the standards and consistent with the constructivist view of learning. Although the use of traditional method of teaching was revealed to be of little help for learners to change or alter harboured unscientific preconceptions. This has resulted into poor academic performance among NCE III biology students. To ensure meaningful learning that is to overcome unscientific preconceptions and improved academic performance among learners, several specific instructional strategies that are suitable to bring readiness to the problem have been found in the literature. Such instructional strategies that are gradually gaining research attention of recent are student-centred strategies which include analogy and collateral strategies. From the literature cited, most of the studies carried out on analogy and collateral teaching strategies were at primary and secondary level. Studies at NCE more especially in unscientific preconceptions and also in comparing analogy and collateral teaching strategies in evolution are relatively new. Therefore the research used analogy and collateral teaching strategies at NCE level to determine which one is more effective.

From literature cited, it was observed that studies centered on unscientific preconceptions more especially in evolution concepts were more prevalent at the secondary school level and scare at the tertiary level such as in colleges of education. Therefore this study deem to fill in this gap by investigating the use of analogy and collateral teaching strategies of Glynn (2007) and Fakudze (2004) to teach some aspects of evolution concepts to NCE III Biology students, in order to address the unscientific preconceptions brought into the class and to investigate if the academic performance of the students will be enhanced.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The purpose of the study was to investigate the impact of collateral and analogy teaching strategies on unscientific preconception and academic performance in evolution concepts among Nigeria Certificate in Education biology students in north central zone. In this chapter, the research design and procedure for data collection, as well as the instruments that were used for data collection are described. The procedure for data analysis is also highlighted. The chapter is presented under the following subheadings:

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Technique

3.5 Selection of Evolution Concepts taught

3.6 Instrumentation

3.6.1 Unscientific Preconception Test on Evolution (UPTE)

3.6.2 Evolution Performance Test (EPT)

3.6.3 Validity of the Instruments

3.7 Pilot Testing of Instruments

3.7.1 Reliability of the Instruments

3.7.2 Item Analysis of EPT

3.8 Administration of Treatment

3.9 Data Collection Procedure

3.10 Procedure for Data Analysis

3.2 Research Design

The study had two parts: the first part was descriptive design in form of survey method to identify unscientific preconceptions students hold about evolution concepts in biology. The finding of the first part was used to develop and design the research instrument for the second part of the study. The survey was a pencil and paper method used to identify the unscientific preconceptions students had about the concepts of evolution, (Kikas, 2004). The second part of the study adopted pretest, posttest quasi experimental control groups design as recommended by Kerlinger (1973). Three groups were involved, the experimental group1 (E1), experimental group 2 (E2) and the control group. The three groups were pretested using Evolution Performance Test (EPT) before the commencement of the treatments in order to determine the equivalence of the three groups in their ability level. The experiment group (E_1) was taught evolution concepts using Analogy teaching strategy, Experimental Group (E_2) was taught evolution concepts using collateral teaching strategy, while the control group was taught evolution concepts using lecture method. After treatment EPT and UPTE were administered to the subjects of the three groups as posttest to determine the effectiveness or otherwise of the three strategies employed in the teaching of the concepts. The same tests were administered as pretest, posttest. The design of the study is presented in Figure 3.1

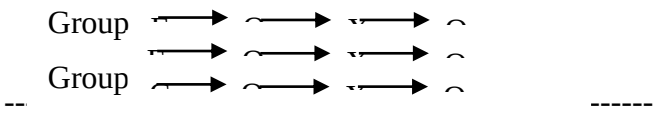


Fig. 3.1: Research Design
Adopted from Kerlinger (1973)

X_1: Analogy Teaching Strategy

X_2: Collateral Teaching Strategy

X_0: Lecture Method

O_1: Pretest

O_2: Posttest

E_1: Experimental Group I

E_2: Experimental Group II

C: Control Group

This design has the following advantages: (Kerlinger, 1973 & Sambo, 2012)

The scores from the pretest were used;

1. to ensure equality of the three groups academically at the start of the experiment.
2. for the calculation of individual as well as group mean posttest scores in order to determine the superiority of one teaching strategy relative to others.
3. to give an indication of the concepts attainment ability gained by students following instruction.
4. to test the assumption that any differences in the performance of the groups could only be attributed to the treatment given, since the treatment administered was the only difference between the three groups.

3.3 Population of the Study

The population of this study comprised all the NCE III Students of the Department of Biology in Colleges of Education in North Central Zone, Nigeria. There were 12 colleges of education in the zone. The total number of students in the population was 1211 comprising 683 males and 528 females distributed among the 12 Colleges of Education in North Central Zone as shown in Table 3.1. These students were regarded as suitable for the study since they were NCE III biology students studying evolution course according to NCCE minimum standard 2012 revised. Their age range was between 18 and 22 years. The colleges of education in the population were categorized as follows;

1. State government –owned colleges of education.

2. Federal government-owned colleges of education.

For the purpose of this study, only the state government –owned colleges of education were used. The population of the study is presented in Table 3.1

Table 3.1: Population of the Study

S/N	Colleges	Male	Female	Total
1	COE Minna	90	60	150
2	COE Ilorin	25	15	40
3	FCE Panshin	30	30	60
4	FCE Okene	22	33	55
5	COEKastina Ala	126	90	216
6	COE Akwanga	77	50	127
7	FCE Kontagora	30	17	47
8	COE Oju	143	130	273
9	FCE Lafiyagi	48	16	64
10	COE Gindiri	20	25	45
11	COE Oro	24	46	70
12	COE Zuba	48	16	64
Total		**683**	**528**	**1211**

Source: - Examination offices of the Colleges of Education in North Central, Zone (2015)

There are Eight (8) State Colleges of Education in the study area and all are co-educational schools. The colleges were accredited by the National Commission for Colleges of Education (NCCE) and they are supervised by this body to monitor quality output of these colleges. The colleges are similar in terms of manpower, student population, quality of staff and their qualifications.

3.4 Sample and Sampling Procedure

From the population, there are eight (8) State Colleges of Education from north central zone, Nigeria. Due to the nature of the study, two categories of samples were selected. The first category of the sampled students was those required for identification of unscientific preconceptions among students. All the NCE III biology students from the Eight (8) state colleges of education in the north central zone were given Unscientific Preconception Test on Evolution concepts (UPTE), to identify unscientific

preconceptions held by the students about evolution concepts, the scripts were marked and scored. A total of 981 students comprising 550 males and 431 females were used for the identification of unscientific preconception. ANOVA was employed on scores from the eight (8) colleges in the population and Scheffe's test was used to bring out those colleges with higher unscientific preconception i.e not significantly different in their abilities see Appendix H. Table 3.2 is the distribution of the college types and the number of students in each of the colleges.

Table 3.2: Schools Sampled for Pilot Study

S/N	Colleges	Male	Female	Total
1	COE Minna	90	60	150
2	COE Ilorin	25	15	40
3	COE Katsina Ala	126	90	216
4	COE Oju	143	130	273
5	COE Zuba	48	16	64
6	COE Gindiri	20	25	45
7	COE Oro	24	46	66
8	COE Akwanga	77	50	127
	Total	**550**	**431**	**981**

Those colleges with the highest unscientific preconceptions results were selected from those eight (8) colleges. The colleges are as follows: College of Education Kastina-Ala, College of Education Akwanga, Kwara State College of Education Ilorin, Niger State College of Education, Minna and College of Education, Oju. These five colleges of education were pretested using Evolution Performance Test (EPT) before the commencement of the treatment in order to determine their equivalence in ability level. The scores obtained from the pretest, were subjected to Analyses of Variance (ANOVA) and Scheffe's test. Three of those colleges were found not to differ significantly in their abilities and the three were college of education Akwanga, college of education, Kastina-Ala and college of education Ilorin. To categorize the three (3) colleges into Experimental group 1 (E1), Experimental group 2 (E2) and the control group, simple random sampling

involving balloting was used. The details of the sample selected are presented in Table 3.3**.**

Table 3.3: Sample of the Study

Groups	Schools	Male	Female	Total
Exptal 1	COE Kastina-Ala	126	90	216
Exptal 2	COE Ilorin	25	15	40
Control	COE Akwanga	77	50	127
	Total	228	155	383

Source: Examination offices of colleges of education Kastina Ala, Ilorin and Akwanga (2015)

Total number of subjects that were used for the study was 383 students comprising of 228 males and 155 females. This sample size is viable for the study based on central limit theorem which for experimental control of this nature (Tuckman, 1975, Wallen & Franklrn, 2000).

3.5 Selection of Evolution Concepts Taught

Topics taught were from evolution course in biology (Bio 325) of the NCCE Minimum Standard (2012) revised version. The contents were as follows:

1 Adaptive Radiation.

2 Darwin's theory of natural selection, competition, variation and survival of the fittest.

3 Mutational changes as causes of evolution.

4 concepts of evolution

5 Fossil and human evolution.

6 Origin of life

These topics were selected for the following reasons

a to maintain continuity and objectives of the NCCE Minimum Standard for the NCE students.

b the topics constituted the areas students perceived difficult and have unscientific preconceived ideas about the concepts as observed by Bishop and Anderson (1990), Jensen and Finley (1996), Bernado and Clores (2007) and Kampourakis (2014).

C the topics lend themselves to the use of analogy and collateral instructions which were used for the present study.

3.6 Instrumentation

The instruments used for data collection were:

1. Unscientific Preconception Test on Evolution (UPTE) which was used to collect data on students' unscientific preconceptions and was also used for posttest. See Appendix A
2. Evolution Performance Test (EPT) which was used for pretest and posttest. See Appendix B

3.6.1 Unscientific Preconception Test on Evolution (UPTE)

The test was designed to identify the unscientific preconceptions students held about the concept of evolution. A total of Fifteen (15) test-items were used by the researcher. Adopted questions from text books written by Solomon, Berg and Martin, (2005) were set before the students to ask questions on their knowledge of concepts of evolution. The answers written out by the students were marked, scored and analyzed to determine their initial conception of the concepts of evolution. The non-scientific statements formed the unscientific preconceptions. These unscientific preconceptions were then used as distractors in the construction of the Evolution Performance Test (EPT). The test items initially comprising of twenty items along with the marking scheme

were validated. The validation was carried out by two chief lecturers and one principal lecturer from biology department Niger State College of Education, Minna and senior lecturers from Science Education Department ABU Zaria. They validated the instrument for accuracy, clarity and level of phrasing of the test items. The final test items comprising fifteen questions as suggested by the validators which led to the dropping of five questions and reframing of six questions.

3.6.2 Evolution Performance Test (EPT)

Evolution Performance Test (EPT) was constructed based on the findings from the Unscientific Preconception Test on Evolution (UPTE), which was first administered to NCE III biology students from Eight (8) State Colleges of Education in the study area. The unscientific preconceived ideas were then used as distractors in the construction of the EPT test items. Sixty questions with the marking scheme were developed but after validation about ten questions were dropped; only fifty were later retained and used data collection. See Appendix C.

EPT test items was made up of forty-four multiple-choice questions with four options, the correct option with three incorrect options and six fill-in-the blank space items. The test items covered all the units that were taught by the researcher on evolution concept. The EPT test items were constructed to determine the students' unscientific preconceptions had shifted and improved their academic performance in evolution concepts after the teaching. To ensure equal distribution of the test items over the units taught, a table of specification based on Bloom's cognitive taxonomy was prepared as shown in Tables 3.4.

Table 3.4: Table of Specification for EPT based on Bloom's Cognitive Taxanomy

S/N	*Topic*	*Kno 30%*	*Comp 18%*	*App 10%*	*Ana 16%*	*Syn 10%*	*Eval 16%*	*Total Items*
1	Origin of life	03	03	00	01	01	02	10
2	Darwins theory of natural selection, competition, variation &Survival of fittest	02	03	02	01	01	03	11
3	Mutation changes as causes of evolution	05	01	00	03	00	01	10
4	Adaptive Radiation	02	01	02	01	02	02	10
5	Fossils &Human Evolution	03	01	01	02	02	00	09
	Total Items	15	09	05	08	05	08	50

3.6.3 Validation of the Instrument

The UPTE and EPT with the marking scheme were validated by two chief lecturers and one principal lecturer from department of Biology Niger State College of Education, Minna, and two senior lecturers from Department of Science Education Ahmadu Bello University Zaria. The validators' qualifications were masters' degree and Ph.D in Science Education. They were to:

i. check whether test items conform to the objectives of the study.

ii. evaluate the test items whether they are clearly stated and appropriate in terms of the reading difficulty level of the students understanding.

iii. check the structure of test items with cognitive levels.

iv. check if the language use for the test items are in line with the students' ability level.

v. check the possible errors in the proposed answers.

Their suggestions led to the reframing and elimination or dropping of some test items.

3.7 Pilot Testing

NCE III Biology Students from College of Education Ankpa in Kogi state were used for pilot-testing of the instrument. This school was part of the population but not one of those used for the main study. The subjects were NCE III Biology students studying evolution course in biology. The data collected from the pilot study was used to determine the characteristics of the test items which included their facility and discrimination indices and the reliability coefficient. A total of fifty four (54) students made up of 29 males and 25 females participated in the pilot study. The pilot study was also used to determine the duration of test administration.

3.7.1 Reliability of the Instruments

The scores obtained from the pilot study were used to determine the reliability coefficient of the EPT. The study employed test retest method on the scores obtained from the Pilot study Two weeks after the first administration of EPT; it was re-administered to the students again as proposed by (Tuckman, 1975 and Sambo, 2008).

Pearson Product Moment Correlation Coefficient Statistics (PPMCC) was used to determine the reliability Coefficient of both UPTE and EPT. The reliability coefficient of the instruments was found to be 0.69 and 0.76. This showed that the instrument is reliable and was used for this study.

3.7.2 Item Analysis of EPT

Item analysis was carried out on the scores obtained from the pilot study to determine the facility and the difficulty indices of the items in EPT

The facility index (FI) of a test according to wood (1990) is the percentage of the students that got an item right. It is determined by using the formula:

$$\text{FI} \qquad \frac{R}{T}$$

Where R number of correct responses

T total number of students

Inyang (1988) and Usman (2008) recommended values within the range of 0.30 to 0.70 for good test item values in assessing achievement. This was used in selecting the final items of the EPT. For the present study 0.30 to 0.70 was chosen for the study. Appendix J.

The discrimination (difficulty) index indicates the discriminating power of each of the test items. It is the ability to sort or separate between high and low ranking students in the whole test. The Calculation was done using scores of the top twenty seven percent (27%) and bottom twenty seven percent (27%) of the total respondents. This was calculated using the formula given by (Furst in Olorukooba, 2001).

$$DI \quad \frac{Ru - RI}{\frac{1}{2} N}$$

Where d discrimination index

Ru number among upper 27% of respondents

RI number among lower 27% of respondents

N total number of respondents

The discrimination index which ranges between 0.30 and 0.70 was regarded as moderately positive and was accepted for the present study. This was used in selecting the final items of the EPT.

3.8 Administration of Treatment

Before the treatment a pretest was administered to both experimental group1 (E1), experimental group2 (E2) and control group (c). The experimental groups E1 was taught evolution concepts using Analogy teaching strategy, experimental group 2 (E2) was taught evolution concepts using Collateral teaching strategy while the control group was taught evolution concepts using lecture method by the researcher. Lesson plan was

prepared to teach study subjects based on the topic selected for the period of six weeks, two hours per period.

3.8.1 Analogy Teaching Strategy

The treatment administered to the study students involves teaching of concepts in Evolution using Analogy teaching strategy. The subjects were taught concepts of Evolution for the period of six (6) weeks consisting of 2 hours per week. Experimental group1 (E_1) was taught using Analogy teaching strategy (TWA) Model (Glynn, 2007). In this model, ideas from a familiar concept (the analogue) were transferred to an unfamiliar one (the target). If the analogy and the target shared some similarity in their features, an analogy was drawn between them. The process of comparing the features is called mapping.

Teaching–With-Analogy (TWA) Glynn (2007) model consists of six steps that the teacher carries out when drawing an analogy.

Step1. Introduce the Target Concept

Step2. Review the Analogy Concept.

Step3. Identify the Relevant Features of Target and Analogy

Step4. Map the Similarities

Step5. Indicate where the Analogy Breaks Down

Step6. Draw Conclusions

In adopting TWA model for this study, all the six steps were followed accordingly.

Step1. Introduce the Target Concept to be Learned

This step involved a brief introduction to a full explanation depending on how the analogy was utilized. If the analogy is to be used as an advance organizer, then the target concept would be introduced after the analogy. The analogy may also be used for reviewing the concept(s) in which case, the target concepts is fully taught at this stage.

Step 2. Cue the Student's Memory to the Analogous Situation

This step involves the introduction of the analogy and determines the student level of familiarity through questioning and/or discussion. If student understanding is low, the analogy is modified or the process is aborted. The teacher should ensure that there is at least one obvious similarity for the students between the analogy and the target.

Step 3. Identify the Features of the Analog that are Relevant

This step involves explaining the analogy to the students at a level that is appropriate to their understanding and which will accurately identify the features of the analogy that was used to build concepts in the next stage.

Step 4. Map the Similarities between the Analogy and the Target Concepts

Item by item, the analogy features are linked with the target concepts. There may be a one-to-one correspondence from analogy to target, two or more analogy features may converge on a single target concept or a single analogy attribute may develop two or more target concepts.

Step 5. Identify Where the Analogy Breaks Down

During the mapping exercise, the students may suggest inappropriate links. Other invalid transfers that the teacher may be aware of can now be combined with the student's alternative conceptions for discussion at this point. These conceptions should be discussed so that the student can distinguish the valid from the invalid. This step can be integrated into the discussion at any appropriate point.

Step 6. Drawing Conclusions about the Target Concept

As in all teaching, a succinct summary of what has been learned about the target concept from the analogy should be stated to facilitate student learning.

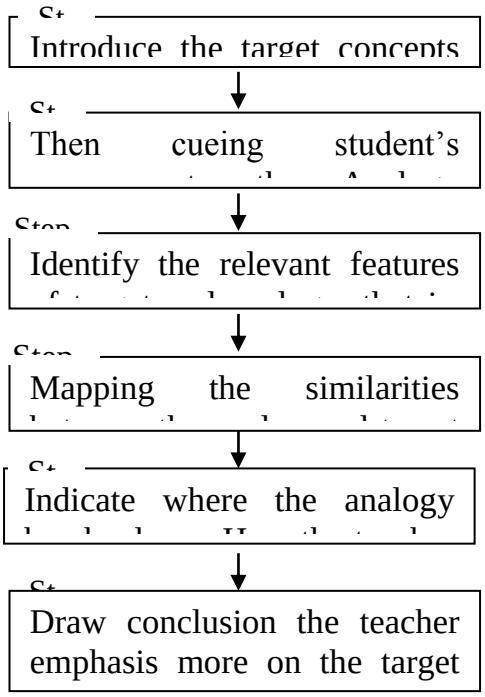


Figure. 3.2: Flowchart of Teaching- With- Analogy (TWA).
Source: Adapted from Glynn (2007)

3.8.2 Collateral Teaching Strategy

The second treatment administered to the study students involved teaching of concepts of evolution using Collateral teaching strategy (Fakudze, 2004). The subjects were taught concepts of Evolution for six (6) weeks consisting of 2 hours per week. Experimental group (E2) was taught using Collateral teaching strategy model (Fakudze, 2004)

Collateral Teaching Strategy

The model was divided into three main parts. The sensory register (SR), the working memory (WM) and the collateral learning that are joined by arrows. The model was used to describe how a scientific concept presented in a science classroom is learned or rejected by a student.

The Learning Process in Terms of the CTS. Scientific concept presented in a science classroom receptors and sensory register. Students Sensory Register (SR) through receptors, the context of the scientific phenomenon being presented activates his/her schemata. The student will pay attention and start to perceive the scientific concepts being presented by attaching meaning to the information received from his receptors by using prior knowledge and experience. For instance, we have cases of male circumcision that our traditional beliefs cannot explain why males are circumcised in our society. In contrast, in science classroom reasons why males are circumcised are explained. The resultant world view schema will then be transferred to the working memory. The diagonal line across the working memory box shows the divide between traditional and scientific worldviews.

Learning within the Working Memory (WM) when the perceived worldview schema from the sensory register enters the working memory (WM), it lies contiguously with two or more other worldviews (traditional and/or commonsense – intuitive knowledge) that have been retrieved from his/her LTM via the feedback loop. The student's indigenous beliefs as well as his/her common sense-intuitive knowledge are contrasted with the scientific concept encountered by the science classroom and given a tentative status. The concepts now lie contiguously and information is then processed by recalling, relating, collaborating the new with the old knowledge. The information received or the condition evoked by a given experience in the working memory to trigger

off the assemblage of certain appropriate elements (e.g. neurotransmitters) in each macro thoughts or schema capable of responding to the changed mental state. The success of this integrative and transformative cognitive process is what Ogunniyi (2000) calls contiguity learning.

Border Crossing and Transition between WM and Collateral learning, the border crossing theory is used in the transition between the Working Memory and Collateral learning. The arrows between the WM and Collateral learning illustrate the various types of border crossings that occur when information is transferred from the WM into Collateral learning. According to Fakudze (2002), the level of success of the integrative and transformative cognitive process determines the type of border crossing that take place in the transition between the WM and Collateral learning.

i. Managed border crossing would occur when the scientific world-view schema is dominant

ii. Impossible border crossing would occur when the traditional world-view schema is dominant.

iii. Hazardous border crossing occur when the worldview schemata have gained more or less equal supremacy or where the commonsense-intuitive schema is dominant.

iv. collateral Learning

The collateral learning theory is used once the information passes from WM some permanent storing begins on the type of border crossing (Aikenhead, 1996) that took place. The storage takes place in the form of collateral learning. The different types of collateral learning are represented in four sections.

iv Parallel collateral learning

v Secured collateral learning

vi Dependent collateral learning

vii No collateral learning

Step.1. Sensory Register (SR)

Introduction of the concept to be learnt through materials like pictures, diagrams, and questions related to the topic in the society were asked.

Step. 2. Working Memory (WM)

Presentation of the target concept is done .

Ideas gathered from the society are brought into science classroom and are related to the science concepts taught.

Step. 3. Border Crossing and Transition between working memory and Collateral learning.

Questions are raised by the researcher based on topic taught. From the answers given by the student, the types of border crossing that has taken place in the students, is identified by the researcher.

Step. 4. Collateral learning

From the information passed from WM to the collateral learning, there is permanent storing of what students have learned depending on the type of border crossing. The

Storage takes place in the form of collateral learning.

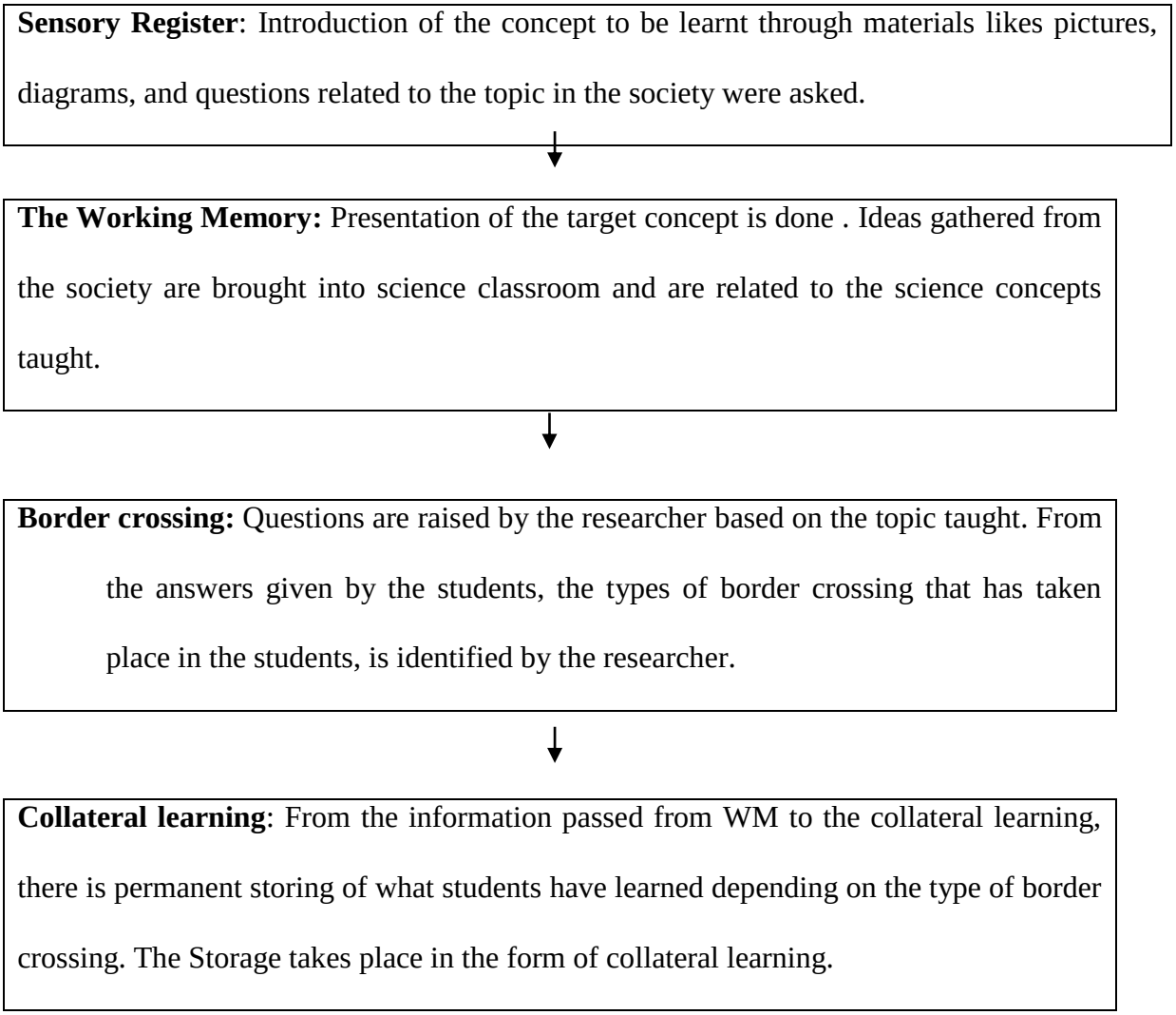


Figure 3.3: Flowchart of CTSM
Source: Adapted from Fakduze, 2004

3.8.3 Control Group

The control group was taught the same concepts by the researcher using lecture method. Two hours per week for the period of six (6) weeks was used. The pretest was administered to the subjects before the commencement of the teaching. The lesson was presented by defining the term or concept then followed by the explanation and important points were written on the chalkboard. The subjects were referred to relevant Biology text books for more information. Written assignment was given to the subjects after each lesson as demand by the lesson note.

3.9 Data Collection Procedure

The procedure for administration of the research instrument and data collection was described as follows.

Treatment to the Experimental Group

The teaching of the Concepts was done by the researcher. The pretest was administered to the subjects before the commencement of the teaching. Teaching lasted for 6 weeks, two hours per week based on lesson note. The experimental group E_1 was taught using Analogy Teaching Strategy (ATS) Model Glynn (2007) and the experimental group E_2 was taught using Collateral Teaching Strategy (CTS) Model Fakudze (2004). After teaching the experimental group1 (E1), experimental group2 (E2) and control group posttest was administered using EPT and UPTE to the three groups. The response of the subjects to UPTE and EPT was scored using the marking scheme see Appendix B and D. Each correct response was scored one point with maximum scores of 50 marks and 3 points for correct response with maximum of 45 marks. The subject scores was collected for the three groups and subdivided into male and female scores to test for gender effect.

3.10 Procedure for Data Analysis

The scores that were obtained from EPT and UPTE were used for testing stated research questions and hypotheses 1-4. The data collected were subjected to statistical analysis at $p \leq 0.05$ level of significance. Descriptive statistics was used to answer research questions and ANOVA statistics was used to test the hypotheses on unscientific preconceptions and academic performance. The following research questions were answered in this study:-

1. What are the common unscientific preconceptions NCE III biology students hold on evolution concepts?

2. What is the difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method?
3. What is the difference in the mean scores in evolution performance test among NCE III biology students taught using analogy, collateral teaching strategies and those taught using lecture method.
4. What is the difference in the unscientific preconceptions score in evolution concepts between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture Method?
5. What is the difference in the mean scores in evolution performance test between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method?

Null Hypotheses

The following null hypotheses were tested in the course of this study at $p<0.05$ level

$H0_1$. There is no significant difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using collateral, analogy teaching strategies and lecture Method?

$H0_{2.}$: There is no significant difference in the mean scores in evolution performance test among NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method.

$H0_3$: There is no significant difference in the unscientific preconception mean scores in evolution concept between male and female students taught using collateral, analogy teaching strategies and those taught using lecture method.

$H0_4$: There is no significant difference in the mean scores in evolution performance test between male and female NCE III biology students taught using collateral, analogy teaching strategies and those taught using lecture method.

All the four null hypotheses stated were analyzed using ANOVA this is for the purpose of determining significant difference (if any) between the Experimental group1 (E1), Experimental group2 (E2), control group and gender on unscientific preconceptions and academic performance. Significant level of $p \leq 0.05$ was used to retain or reject the hypotheses stated.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

The study investigated the Impact of Collateral and Analogy teaching Strategies on Preconception and Academic Performance in Evolution Concepts among NCE Students of North Central, Nigeria. The data collected were analyzed using the Statistical Package for Social Science (SPSS) 19th Edition, and the level of significance adopted for rejecting or retaining the stated hypothesis was 0.05.

The chapter was discussed under the following subheadings:

4.2 Data Presentation and Analysis

4.3 Summary of Findings

4.4 Discussion of the Findings

Two instruments used for data collection were:

i. Unscientific Preconception Evolution Test Concepts (UPTE) was used to measure the

ii. subjects' unscientific preconceptions in the survey and posttest for experimental group E1, experimental group E2 and control group.

iii. Evolution Performance Test (EPT) was used to measure the subjects' performance in the pretest and posttest for experimental group E1, experimental group E2 and control group.

The data obtained in the course of the study were:

i. Unscientific preconception scores from the posttest for experimental group E1, experimental group E2 and control group.

ii. Performance scores from the posttest for experimental group E1, experimental group E2 and control group.

4.2 Answering Research Questions and Testing Null Hypotheses

Research Question One: What are the common unscientific preconceptions NCE III biology students hold on evolution concepts?

To answer research question one the scores collected were analyzed using descriptive statistics

The common unscientific preconceptions held by NCE III biology students in evolution concepts are as follows:

Table 4.01: Frequency and Percentage of Unscientific Preconception Types found on Students' scripts

S/N	Unscientific Preconceptions-type	Frequency	Percentage
1.	Unscientific preconceived notions	245	24.97
2.	Non-scientific beliefs	586	59.73
3.	Conceptual misunderstanding	35	3.57
4.	Factual preconceptions	51	5.50
5.	Vernacular preconceptions	64	6.52
Total		981	100.00

From the result in Table 4.01 the most frequent group of unscientific preconceptions held by NCE III biology students is Non-scientific beliefs with 586(59.73%) followed by Unscientific preconceived notions with 245(24.97%). The third high percentage unscientific preconceptions held by NCE III students was vernacular preconceptions with 64(6.52%) followed by Factual preconceptions with 51(5.20%) while Conceptual misunderstanding was the least with 35(3.36%).

Research Question Two: What is the difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using collateral, analogy teaching and lecture method?

To answer research question two the scores collected were analyzed using descriptive statistics in form of mean scores as shown in Table 4.02.

Table 4.02: Pretest-Posttest Mean Scores from Unscientific preconception test on Evolution for E1, E2 and Control Groups

Group	N	Mean Before	Mean After	Mean difference
Analogy	216	8.13	23.84	15.71
Collateral	40	7.94	23.10	15.16
Lecture	127	6.92	7.61	0.69

Result on Table 4.02 showed that there was difference in the pretest and posttest of subjects before and after. Before treatment, subjects committed a number of mistakes which made their mean scores to be low but after treatment the subjects committed less mistakes and their mean scores increased showing that the treatments had positive impact on their unscientific preconceptions. Experimental groups (Analogy, Collateral) had mean score gain of 15.71 and 15.16 respectively, while the control group gained only 0.69. From the mean scores, the experimental groups outperformed the control group on evolution concepts by overcoming their unscientific preconceptions at NCE level.

Table 4.03: Means and Standard Deviations of Posttest Scores form Unscientific Preconceptions for E1, E2 and Control Groups

Groups	N	$\overline{X}$	SD	MD
E1	216	23.84		
			7.97	0.74
E2	40	23.10		
E1	216	23.84		
			7.96	16.23
C	127	7.61		
E2	40	23.10		
			3.88	15.49
C	127	7.61		

Table 4.03 shows that the mean scores for unscientific preconceptions in evolution were 23.10, 23.85 and 7.61 when taught using collateral, analogy and lecture method respectively. The mean difference in analogy and collateral was 0.74, analogy and lecture

method was 16.23 while collateral and lecture method was 15.49 respectively. The mean score for analogy were the highest while that of lecture method was the lowest. Therefore differences existed in the unscientific preconceptions scores in evolution concepts for experimental E1 taught using analogy teaching strategy, experimental E2 taught using collateral teaching strategy and the control group taught using lecture method. This means that analogy strategy was better than collateral strategy at helping students to overcome their unscientific preconceptions in evolution concepts and thus improved their performance than lecture method. To find out how significant the differences were the mean scores were subjected to ANOVA statistics.

4.2.1 Comparison of the Mean Scores of Unscientific Preconceptions Test on Evolution for E1, E2 and Control Groups

Null Hypothesis

There is no significant difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using collateral, analogy and lecture Method?

In order to test null hypothesis, the posttest scores of unscientific preconceptions of the students in the experimental group E1, E2 and control groups were subjected to ANOVA statistics at $p \leq 0.05$. The result of the analysis is presented in Table 4.04

Table 4.04: Summary of ANOVA Statistics for Posttest Mean Scores for E1, E2 and Control Groups

	Sum of Squares	Df	Mean Square	F	P	R
Between Groups	22077.78	2	11038.89	232.98	.001	S
Within Groups	18004.56	380	47.38			
Total	40082.34	382				

*Significant at $p \leq 0.05$

The result in Table 4.04 shows that the p-value obtained is 0.001, at p≤ 0.05. Since the p value obtained is less than p≤0.05 level of significance, this indicates that there is significant difference in the unscientific preconceptions means scores in evolution concepts among NCE III biology students taught using collateral, analogy and lecture methods. The null hypothesis which states that there is no significant difference in the unscientific preconceptions scores on evolution concepts is therefore rejected. To find out where the significant difference lies, the result was subjected to Scheffe's test as showed in Table 4.05.

Table 4.05: Scheffe's test for Mean Scores Multiple Comparisons among E1, E2 and Control Groups

Groups	Groups	Mean	M D	SE	P	R
Collateral strategy	Analogy	23.84	-.742	1.18	.822	NS
	Lecture	7.60	15.49	1.25	.001	S
Analogy Strategy	Collateral	23.10	.742	1.18	.822	NS
	Lecture	7.60	16.23*	.769	.001	S
Lecture Method	Collateral	23.10	-15.49*	1.25	.001	S
	Analogy	23.84	-16.23*	.769	. 001	S

* Significant at p ≤0.05 level.

Table 4.05 shows that a p value of 0.82 was observed in collateral and analogy teaching strategies which was greater than 0.05 significant level. This shows that there was no significant difference in the collateral and analogy teaching strategies. But p-value of 0.001 was observed between collateral and lecture method, and analogy and lecture method which was lower than the 0.05 significant level. This indicates that students taught using collateral strategy and those taught using analogy strategy performed significantly higher than those taught using lecture method. Hence the null hypothesis was rejected. Analogy and collateral teaching strategies had the potentials of helping students overcome their unscientific preconceptions in evolution but analogy strategy was better than lecture method as presented in Table 4.05.

Research Question Three: What is the difference in the mean scores in evolution performance test among NCE III biology students taught using analogy, collateral teaching strategies and lecture method.

The scores collected was used to answer research question two, and were analyzed using descriptive statistics in form of mean scores and standard deviation as shown in Table 4.06.

Table 4.06: Pretest-Posttest Mean Scores of Evolution Performance Test for E1, E2 and Control Groups

Group	N	Mean Before	Mean After	Mean Difference
Analogy	216	8.13	24.78	16.65
Collateral	40	7.94	20.52	12.58
Lecture	127	6.92	9.13	2.21

Result on Table 4.06 showed that there was difference in pretest and posttest of the subjects, before treatment subjects were given EPT test where most of them had low mean scores but after treatment the subjects were given EPT test where the subjects gain more mean scores, experimental groups analogy and collateral teaching strategies had mean scores gain of 16.65, 12.58 having the highest respectively, while the control group gained only 2.21. From their mean scores, the experimental groups gained better in their performance, thus these suggest that analogy and collateral teaching strategies have positive effect on students' performance, at NCE level.

Table 4.07: Means and Standard Deviation of Posttest Performance Scores for the E1, E2 and Control Groups

Groups	N	$\overline{X}$	SD	Mean Difference
E1	216	24.78		
			4.96	4.26
E2	40	20.52		
E1	216	24.78		
			4.59	15.65
C	127	9.13		
E2	40	20.52		
			3.01	11.39
C	127	9.13		

Table 4.07 shows that the calculated academic performance means scores in evolution concepts by students taught using collateral, analogy and lecture methods were 20.52, 24.78 and 9.12 respectively; with analogy scoring the highest and lecture method scored the lowest. The mean difference in analogy and collateral was 4.26; in analogy and lecture was 15.65 while in collateral and lecture was 11.39 respectively. To find out how significant the difference in the groups was, the mean scores were subjected to ANOVA statistics.

4.2.2 Comparison of Mean Performance Test Scores for E1, E2 and Control groups

Null Hypothesis: There is no significant difference in the mean scores in evolution performance test among NCE III biology students taught using collateral, Analogy teaching strategies and lecture method.

To test this hypothesis, the posttest performance means scores of the students in the experimental group E1, E2 and control groups were analyzed using ANOVA statistics.

Table 4.08: Summary of ANOVA for the Posttest Mean Performance Scores for E1, E2 and Control Groups

	Summary of Squares	Df	Mean Square	F	P	R
Between Groups	19689.08	2	9844.54			
Within Groups	6642.73	380	17.48	563.16	.001	S
Total	26331.81	382				

Significant at $p \leq 0.05$

Tables 4.08 show that the p-value obtained was 0.001 at $p \leq 0.05$. The p-value of 0.001 obtained is less than $p \leq 0.05$ level of significance indicating that there is significant difference in the academic performance mean scores of NCE III biology students taught using collateral, analogy teaching strategies and lecture method. The null hypothesis which states that there is no significant difference is rejected. To find out which group shows the significant difference, Scheffe's test was used as shown in Table 4.09.

Table 4.09: Summary of Scheffes test for Means Performance Scores of Multiple Comparisons between E1, E2 and Control Groups

Methods	Groups	N	$\overline{X}$	MD	SE	P	R
Collateral Strategy	Analogy	216	24.78	-4.25*	.71969	.001	S
	Lecture	127	9.13	11.39*	.75807	.001	S
Analogy Strategy	Collateral	40	20.52	4.26*	.71969	.001	S
	Lecture	127	9.13	15.65*	.46752	.001	S
Lecture	Collateral	40	20.52	-11.39*	.75807	.001	S
	Analogy	216	24.78	-15.65*	.46752	.001	S

* Significant at 0.05 level.

Table 4.09 shows that the p values for collateral, analogy and lecture method were 0.001 which is less than the alpha value of 0.05 level of significance was obtained. This is an indication that significant differences exists in the academic performance mean scores of students taught using analogy teaching strategy, collateral teaching strategy and lecture method, in favour of students taught using analogy strategy. The academic performance mean scores of the students were 24.78 for analogy strategy; 20.52 for collateral teaching strategy and 9.13 for lecture method. The null hypothesis is therefore rejected.

Research Question Four: what is the difference in the unscientific preconceptions mean scores in evolution concepts between male and female NCE III biology students after being taught using collateral, analogy teaching strategies and lecture method.

The scores collected were used to answer research question three, and were analyzed using descriptive statistics in form of mean scores and standard deviation as shown in Table 4.10

Table 4.10: Pretest-posttest Mean Scores for Unscientific Preconceptions Test for Male and Female in E1, E2 and Control Groups

Group	N	Sex	Mean Pretest	Mean Posttest	MD
Analogy	126	M	7.66	23.58	15.92
	90	F	6.03	23.99	17.96
Collateral	25	M	8.18	23.04	14.86
	15	F	6.87	23.20	16.33
Lecture	77	M	6.78	8.12	1.64
	50	F	5.45	6.82	1.37

Table 4.10 shows that there was difference in pretest and posttest mean scores of male and female students in their unscientific preconceptions test. Before treatment the male and female subjects were given UPTE test in which they had low mean scores because they made many mistakes. After treatment they were given the same test and they made fewer. Hence the subjects had higher mean scores. This indicates that male and female students gained more mean scores after treatment with the mean difference of 15.92 and 17. 96 for analogy group, 14.86 and 16.33 for collateral group while lecture group gain lower 1.64 and 1.37 respectively. These suggest that treatment had positive effect on male and female students in their unscientific preconceptions in evolution concepts at NCE level.

Table 4.11: Gender-Related Difference in the Mean Scores on unscientific Preconceptions between Male and Female in E1, E2 and Control Groups

Group	Sex	N	$\overline{X}$	SD	MD
E1	M	126	23.58	8.37	
					0.41
	F	90	23.99	7.66	
E2	M	25	23.04	8.05	
					0.16
	F	15	23.20	8.11	
C	M	77	8.12	3.75	
					1.30
	F	50	6.82	3.99	

Table 4.11 shows that the mean scores of male and female students in the collateral teaching strategy group were 23.04 and 23.20 respectively with the mean difference of 0.41, for analogy teaching strategy group were 23.57 and 23.98 with the mean difference of 0.16 and for lecture method group were 8.11 and 6.82 with the mean difference of 1.30 respectively. To find out how significant these differences were, ANOVA test was used to analyze the data.

4.2.3 Test for Gender-Related Difference in the Mean Scores on Unscientific Preconceptions between Male and Female in E1, E2 and Control Groups

Null Hypothesis: .There is no significant difference in the unscientific preconceptions scores in evolution concepts between male and female NCE III biology students taught using collateral, analogy teaching strategies and lecture method.

To test this null hypothesis three, the unscientific preconceptions mean scores of male and female students were subjected to ANOVA test. The result is shown in Table 4.12.

Table 4.12: Summary of ANOVA for Posttest Mean Scores on Unscientific Preconceptions between Male and Female Students in E1, E2 and Control Groups

	Sum of Squares	Df	Mean Square	F	P	R
Between Groups	21860.13	2	10930.06	226.29	0.55	NS
Within Groups	18354.41	380	48.30			
Total	40214.54	382				

*Significant level at 0.05

Table 4.12 shows that there is no significant differences in the unscientific preconceptions' mean scores on evolution concepts held by male and female NCE III biology students taught using collateral, analogy teaching strategies and lecture method. The calculated p value of 0.55 was higher than P≤0.05 level of significance. This shows that sex does not significantly influence the unscientific preconceptions scores on evolution. The null hypothesis which stated that there is no significant difference in the unscientific preconceptions scores on evolution concepts held by male and female NCE III biology students taught using collateral, analogy teaching strategies and lecture method, is therefore accepted and retained. The treatments were gender friendly. To find the source of significant difference, post hoc test was conducted; the result is presented in Table 4.13.

Table 4.13: Result of Scheffes test for posttest unscientific Scores of Multiple Comparisons between Male and Female in E1, E2 and Control Groups

Methods	Gender	N	$\overline{X}$	MD	SE	P	R
Collateral Strategy	M	25	23.04	0.16	1.19	.86	NS
	F	15	23.20				
Analogy Strategy	M	126	23.58	0.41	1.19	.86	NS
	F	90	23.99				
Lecture	M	77	8.12	1.3	.77	.10	NS
	F	50	6.82				

*Significant level of p≤0.05

Result in Table 4.13 shows that no significant difference exist in male and female in the control groups with the p-value of .10 which is greater than the p-value of 0.05, also there was no significant difference between male and female in the analogy and collateral strategies groups with p-value of .86 which is greater than the p-value of 0.05 as indicated. This shows that sex does not significantly influence the unscientific preconceptions in evolution concepts taught using analogy, collateral strategies and lecture method.

Research Question Five: What is the difference in the mean scores in evolution performance test between male and female NCE III biology students taught using collateral, analogy teaching strategies and lecture method?

The scores collected were used to answer research question five, and analyzed using descriptive statistics in form of mean scores and standard deviation as shown in Table 4.14

Table 4.14: Pretest-Posttest Mean Scores of Evolution Performance Test of Male and Female Students for E1, E2 and Control Groups

Group	N	Sex	Mean Pretest	Mean Posttest	MD
Analogy	126	M	7.66	25.50	17.84
	90	F	6.03	23.70	17.67
Collateral	25	M	8.18	21.36	13.18
	15	F	6.87	19.13	12.26
Lecture	77	M	6.78	8.93	2.15
	50	F	5.45	9.36	3.91

The result in Table 4.14 showed that there was difference in male and female students pretest and posttest mean scores among NCE III biology students. Before treatment male and female subjects were given EPT test. Their mean scores were low, but after treatment when given EPT test their mean scores increased. This showed that the treatments had effect on their performance. The male and female students in experimental groups gained more. The mean difference in male and female in analogy group was 17.84 and 17.67; collateral group was 13.18 and 12.26 while lecture was 2.15

and 3.91 respectively. The difference in the mean scores could be attributed to exposure of male and female subjects to treatment which had positive effects on their performance.

Table 4.15: Gender-Related Difference in the Mean Performance Scores between Male and Female in E1, E2 and Control Groups

Group	Sex	N	$\overline{X}$	SD	MD
E1	M	126	25.50	4.82	
					1.80
	F	90	23.70	4.06	
E2	M	25	21.36	5.60	
					2.23
	F	15	19.13	3.37	
C	M	77	8.93	2.94	
					-0.43
	F	50	9.36	3.10	

Table 4.15 shows that the mean scores of collateral strategy were 21.36 and 19.13 for male and female students with the mean difference of 2.23, mean scores for analogy strategy were 25.50 and 23.70 for male and female students with the mean difference of 1.80 and mean scores of lecture method were 8.93 and 9.36 for male and female students with the mean difference of 0.43 respectively. To find out how significant these differences are, ANOVA statistics was used to analysed the data.

Null Hypothesis: There is no significant difference in the mean scores in evolution performance test between male and female NCE III biology students taught using collateral, analogy teaching strategies and lecture method.

To test this hypothesis, the posttest means scores of the male and female students were subjected to ANOVA statistical analysis. The results are shown in Table 4.16.

Table 4.16: Summary of ANOVA for Posttest Mean Performance Scores of Male and Female Students in E1, E2 and Control Groups

	Sum of Squares	Df	Mean Square	F	P	R
Between Groups	19681.59	2	9840.79	562.87	.001	S
Within Groups	6643.64	380	17.48			
Total	26325.23	382				

* Significant at p≤ 0.05 level.

In Table 4.16, the result shows that p value of 0.001 obtained is less than p≤ 0.05 level of significance. Result showed that there is a significant difference in the academic performance in evolution concepts among male and female NCE III biology students taught using collateral, analogy teaching strategies and lecture method. The null hypothesis which states that there is no significant difference in the academic performances in evolution concepts among male and female NCE III biology students is therefore rejected. To indicate the group that shows significant difference, Scheffes test was used; as showed in Table 4.17

Table 4.17: Result of Scheffes test for Performance Scores of Multiple Comparisons between Male and Female Students in E1, E2 and Control Groups

Methods	Gender	N	$\overline{X}$	MD	SE	P	R
Collateral Strategy	M	25	21.36	2.23	.72	.001	S
	F	15	19.13		.76		
Analogy Strategy	M	126	25.50	1.8	.72	.001	S
	F	90	23.70		.47		
Lecture	M	77	8.93	0.43	.76	.001	S
	F	50	9.36		.47		

Significant at p≤ .05 level

In Table 4.1 7 p values observed for collateral, analogy and lecture method for male and female were 0.001 which is less than p≤0.05 level of significance. The result indicates that there is significant difference in male and female students in the academic

performance in evolution concepts taught using collateral, analogy strategies and lecture method. It also shows that male and female students taught using analogy strategy performed significantly better than those taught using collateral strategy. This shows that male students performed significantly better than female students when taught using analogy and collateral strategies while in lecture method the female students' performance is better than the male students. Therefore the null hypothesis is rejected as presented in Table: 4.17.

4.3 Summary of Major Findings

Based on the results of data analyzed, the summary of findings is as follows.

1. Five types of unscientific preconceptions were indentified among NCE III biology students in North Central Zone of Nigeria.
2. There was no significant difference in the unscientific preconceptions among NCE III biology students when taught using collateral, analogy teaching strategies but significant difference existed between the students taught using collateral and lecture in favour of collateral and also between students taught using analogy and lecture method in favour of analogy teaching strategy.
3. Students taught using analogy teaching strategy performed significantly better than students taught using collateral teaching strategy and students taught using lecture method. Also students taught using collateral teaching strategy significantly performed better than those taught using lecture method.
4. Male and female students did not differ significantly in their unscientific preconceptions when taught using analogy teaching strategy, collateral teaching strategy and lecture method.
5. The male students significantly performed better than the female students when taught using collateral and analogy teaching strategies

4.4 Discussion of the Results

The objectives of this study were to identify unscientific preconceptions and find out the impact of collateral and analogy strategies on performance in evolution concepts among Nigeria Certificate in Education biology students. The study also aimed at finding out whether the unscientific preconceptions could be overcome using collateral and analogy strategies of Fakudze (2004) and Glynn (2007).

Research question one was stated to identify what are the common unscientific preconceptions NCE III biology students hold in evolution concepts. Unscientific Preconception Test on Evolution (UPTE) was used to identify their preconceptions. The findings of the study showed that five types of unscientific preconceptions were held by NCE III biology students in evolution concepts. The frequencies of the unscientific preconceptions found in the scripts of students were indication of the number of unscientific preconceptions held about the concepts. The unscientific preconceptions identified include:

1. unscientific preconception notions,
2. non-scientific beliefs,
3. conceptual misunderstanding,
4. factual preconceptions and
5. vernacular preconceptions.

This is in agreement with the findings of NRC (1997) in Kwen (2005) and Bernardo and Clores (2007) Burke (2012) and Kampourakis (2014) who asserted that learners harbor unscientific preconceptions, and that such unscientific preconceptions affects learning and are resistant to change. In fact, Brown and Clement (1987) also confirmed that unscientific preconceptions are detrimental to learning as they constitute major block to students' understanding.

Results in Tables 4.02, 4.03, show that there is difference in the posttest and pretest unscientific preconceptions mean scores. The difference in improvement indicated that treatment reduced the mistakes committed by students in the experimental groups than control group. Tables 4.04 and 4.05 shows that there is significant difference in the posttest mean scores for experimental group E1, E2 and control group. The experimental group E1and E2 achieved significantly better than the control group in the posttest mean scores. The significant difference in favour of experimental group E1and E2 suggest a greater effectiveness of the analogy teaching strategy and collateral teaching strategy used to teach the experimental groups than lecture method used to teach the control group.

The analogy teaching strategy has helped in shifting the subjects' unscientific preconceptions thus influencing their performance positively because something familiar was used to explain unfamiliar science concepts, also the strategies allowed new materials, especially abstract concepts, to be more easily assimilated with the students' prior knowledge, enabling them to develop a more scientific understanding of the concept. Also because the students were able to interact with one another within the group after the story was told and some pictures should help them to understand science concepts better in collateral strategy class. This means that students who have being exposed to analogy and collateral teaching strategies have gain more mean scores and having the mean difference of 15.71 and 15.16 respectively. Analogy group having the highest scores signifies its effectiveness over collateral strategy while lecture method having the lowest. The findings agrees with that of Jiya (2011) who reported positive effect of analogy teaching strategy on academic performance when students prior knowledge was put into consideration by the introduction of something familiar.

Orgill and Bodner (2004) who clearly stated that analogy can play a very vital role in promoting conceptual change by helping students overcome existing unscientific

preconceptions because something familiar was used to explained unfamiliar difficult science concept. They also agreed that analogy can help students recognize errors in their conceptions they currently hold, reject those conceptions, and adopt new conceptions that are in line with those accepted by the scientific community. The findings is in line with the finding of Shull (2013) who reported that collateral strategy helps students to have better understanding of concept through its remedial action to resolve conflicts. Also Shull (2013) reviewed the following advantages of collateral teaching strategy as strategy that foster the understanding of cognitive achievement of science concepts among students helps them overcome their unscientific preconceptions to acquire scientific knowledge and ways of thinking without violating cultural believes.

Tables 4.06, 4.07, show that there is difference in the mean scores of pretest and posttest performance of the students in the experimental groups than control group. The difference was attributed to positive effect of treatment by enhancing academic performance of students in experimental groups. Tables 4.08 and 4.09 shows that the experimental group E1 (analogy) performed significantly better than experimental group E2 (collateral) in the posttest mean scores. The significant difference in favour of the experimental group E1 suggest a greater effectiveness of the analogy teaching strategy over the collateral teaching strategy. The improvement in students performance might have been induced by the fact that the subject were able to have appropriate level of understanding of the concept by identifying corresponding features between analogy and the target concept as well as mapping out similarities between the analogy and the target concept by each student in the class, better understanding was achieved through recognition of the features.

The findings agrees with the findings of Sani (2006) who independently reported that students taught using analogy teaching strategy performed significantly better than

those taught using lecture method this is because the students' concept of learning was enhanced by the spontaneous introduction of familiar experiences. Thiele and Treagust (1994) agreed that analogies can make new material interesting to students, particularly when the analogy relates new information to the students' real world experiences. The finding is in line with that of Ayanda, Abimbola and Ahmed (2012) who all separately reported that the analogy teaching strategy is better at improving students' performance in biology than lecture method.

Aubusson, Treagust and Harrison (2009) also reviewed in their study the following advantages of the use of analogy teaching strategy in science teaching that it provides visualization of the abstract ideas by pointing to similarities in the real world, facilitates understanding of abstract concepts, arouse students' interest that may have motivation function, they are valuable tools in conceptual change learning, encourage the teacher to take students prior knowledge into consideration and also can reveal unscientific preconception in previously taught topics.

According to Haidar (1999) collateral teaching strategy also helps students understanding that there is more than one way of understanding nature, and consequently they can use a suitable way without having abandoned their original beliefs. Therefore, if science is introduced from the constructivist perspective, students will have the opportunity to realize that science is only one way of knowing, that has proved to be helpful and will not feel a sense of violence.

Tables 4.10, 4.11, show that there is difference between male and female pretest and posttest mean scores which show that treatment was effective in addressing or correcting students' unscientific preconceptions in evolution concepts, that has positively increase their mean unscientific preconceptions scores. Tables 4.12 and 4.13 shows that there is no significant difference in the unscientific preconceptions of male and female

students taught using collateral, analogy teaching strategies and lecture method. It was observed that male and female students do not differ significantly in their unscientific preconceptions. Thus the null hypothesis is therefore accepted and retained. The subjects were able to have equal level of understanding of the concepts learned because of using familiar experiences and ideas which acts as a motivating influence in studying unfamiliar concepts.

The results of this study is in agreement with the findings of Nussbaum (2000), Bichi (2002), Danmole and Adebayo (2004), Udousoro (2011) that gender does not have any significant effect on the unscientific preconceptions scores of students in science subjects. The finding is also in line with the findings of Danmole and Femi-Adeoye (2004). Abdu-raheem (2012), Okonna, Ushie and Okworo (2014) who reported that no significant difference existed between the academic performance of male and female maritime security trainees. The findings of no significant difference in performance of male and female taught using analogy, collateral teaching strategies and lecture method is also supported by the findings of Oyedokun (1998), Lakpini (2006) and Lawal (2009). Yet other researchers found significant difference between male and females. Diver (1980) reported higher performance for girls in mathematics and physical science than boys.

Results in Tables 4.14, 4.15, show that there is difference in the performance mean scores of pretest and posttest of students as result of treatment administration that has significantly improved their mean performance sores. Tables 4.16 and 4.17 the research question five was answered by testing the corresponding hypothesis. Hypothesis which states that there is no significant difference in the mean scores of male and female students taught evolution concepts using collateral, analogy and lecture method. The results showed that there is a significant difference in male and female students taught

using collateral, analogy teaching strategies and those taught using lecture method. The null hypothesis is therefore rejected. It was observed that male students performed significantly better than the female students when taught using analogy and collateral strategies, this might be due to change in mode of instructions that is from teacher-centre to students-centre thus male and female in analogy group performed significantly better than those in collateral group while female performed better than male when taught using lecture method.

The finding is supported by Arbogast (1997), Usman (2000), Jiya (2011) who reported that boys performed significantly better than girls in SSCE physics examination, biology among others. Olorukooba, Lawal and Jiya (2012) also revealed that there is a significant difference in the performance of male and female students in favour of the male students at NCE level when taught using analogy teaching strategy. Jegede and Inyang (1990) worked on gender differences and academic achievement in integrated science in junior secondary schools. They confirmed that males performed better than females. They affirmed that males demonstrated significantly more positive performance towards science than females, but disagree with the findings of Schibbeci (1984) who noted that female exhibit more positive performance towards biology and males towards physics.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter the summary of the findings from the study are presented, also the conclusion and recommendation are highlighted in the following subheading.

5.2 Summary

5.3 Summary of Findings

5.4 Conclusion

5.5 Contribution to Knowledge

5.6 Recommendations

5.7 Limitation of the Study

5.8 Suggestions for Further Studies

5.2 Summary

This study was carried out to find out the impacts of collateral and analogy teaching strategies on unscientific preconception and performance in evolution concepts among Nigeria Certificate in Education biology students, North Central Nigeria. An adapted analogy teaching strategy of Glynn (2007) and collateral teaching strategy of Fakudze (2004) were used to correct unscientific preconceptions that the NCE students held about evolution concepts. Also the lecture method was used as control; the study had five objectives, five research questions and four hypotheses. Related literature was reviewed which provided the basis for the existing information about the problem of the study.

The study was in two parts: the first part of the study was a survey to identify unscientific preconceptions that the students harbor about the concepts of evolution. 981 NCE III students offering biology drawn from eight State Government owned Colleges of

Education from the north central zone of Nigeria were used for survey. The second part of the study involved using the analogy teaching strategy to teach experimental group E1; using collateral teaching strategy to teach experimental group E2; they harboured on the concepts of evolution and lecture method to teach the control group. A total of 383 students were used for the data collection for the second part of the study.

The concepts selected for the study were the origin of life, mutational changes as causes of evolution, adaptive radiation, fossils and human evolution. Five research questions and four null hypotheses were stated and tested. Unscientific Preconception Test on Evolution (UPTE) used was made up of fifteen (15) short answer structure questions used to identify unscientific preconceptions NCE III biology students' habour about evolution concept. Based on the identified unscientific preconceived ideas Evolution Performance Test (EPT) was developed which was made up of 40 multiple and 10 filling in the blank questions. Before treatment three groups were pretested using Evolution Performance Test (EPT) to determine the equivalence of the three groups in their ability level. The three groups were taught evolution concepts for the period of six weeks, experimental group E1 was taught using analogy teaching strategy, experimental group E2 was taught using collateral teaching strategy while the control group was taught using lecture method. After treatment both Evolution Performance Test (EPT) and Unscientific Preconception Test on Evolution (UPTE) were administered. The data collected from the unscientific preconception test on evolution and evolution performance test were analyzed using descriptive statistics, ANOVA statistics to answer the stated research questions and test the null hypotheses. The results and discussions were reported in chapter four. This study suggested the need for further research in this direction for more collaboration.

5.3 Summary of Findings

The summary of the findings from the results are as follows:

1. Five types of unscientific preconceptions were identified among NCE III biology students in north central Nigeria.
2. There was no significant difference in the unscientific preconceptions among students when taught using collateral, analogy teaching strategies but significant difference existed between the students taught using collateral and lecture in favour of collateral and also between students taught using analogy and lecture method in favour of analogy teaching strategy.
3. Students taught using analogy teaching strategy performed significantly better than students taught using collateral teaching strategy and students taught using lecture method. Also students taught using collateral teaching strategy significantly performed better than those taught using lecture method.
4. Male and female students did not differ significantly in their unscientific preconceptions when taught using analogy teaching strategy, collateral teaching strategy and lecture method.
5. The male students significantly performed better than the female students when taught using collateral and analogy teaching strategies.

5.4 Conclusion

Based on the findings from the study, the following conclusions were drawn:

Students held unscientific preconceptions about evolution concepts in biology at NCE level, and these unscientific preconceptions were shifted when taught evolution concepts using analogy and collateral teaching strategies as revealed in this study.

The analogy teaching strategy has the potentials of enhancing NCE III students performance when taught evolution concepts in biology better than collateral and lecture method.

Male students taught using analogy and collateral teaching strategies performed higher in evolution concepts at NCE level than female students, while female students performed higher when taught using lecture method. Male and female NCE III biology students' unscientific preconceptions were not gender base. The collateral and analogy teaching strategies have potentials of improving students' performance in evolution concepts and overcome their unscientific preconceptions because prior knowledge was used and familiar ideas were also used to link what the teacher wanted the students to learn and what the students already knew to explained difficult concepts among others.

5.5 Contributions to Knowledge

The study has contributed to knowledge in the following ways.

1. The Unscientific Preconception Test on Evolution (UPTE) instrument developed could be used by other researchers for the purpose of identifying students' unscientific preconception in evolution concept associated with learning difficulties at NCE level.
2. The Evolution Performance Test (EPT) instrument developed using Blooms cognitive taxonomy by the researcher for the aim of improving students performance in evolution could be adopted by other researchers for similar study
3. The package of collateral teaching strategy adopted and modified for helping students shift unscientific preconceptions in evolution concepts to enhance performance for the study can also be used by other researchers at even secondary schools and other institutions.

4. The package of analogy teaching strategy adopted for the study by using familiar thing in order to help students understand abstract nature of evolution concept can also be used by other researchers at NCE level and Secondary schools among others.
5. Using analogy and collateral teaching strategies to remediate unscientific preconceptions in evolution concepts at NCE level has contributed to existing body of knowledge.
6. Using analogy and collateral teaching strategies to overcome students unscientific preconceptions in order to improved performance in evolution concepts at the tertiary level such as in colleges of education has contributed to existing body of knowledge.

5.6 Recommendations

Based on the findings from this study the following recommendations are made:

1. The management of Colleges of Education in Nigeria, NCCE and Universities should encouraged the teachers of biology to use Analogy and collateral teaching strategies in teaching as it helps to shift unscientific preconceptions students' harbor, since it creates a suitable foundation for subsequent meaningful learning. Academic performance is also enhanced in students in concept taught compared to using lecture method.
2. College managements, STAN, MAN should organized seminars, workshops and conferences for training and re-training of biology teachers on the use of analogy and collateral teaching strategies for teaching.
3. Book writers, publishers should give examples of how to use analogy and collateral in simplifying some difficult biology concept in biology textbooks in order to enhance better understanding and easier access.

4. Professional bodies like UNICEF, NCCE among others should encouraged Science teachers to identify students' unscientific preconceptions and use effective strategies to correct them, and also improve students' performance in evolution concepts.
5. It is recommended that teacher-trainers like the Colleges of Education, Polytechnics and Universities should incorporate analogy and collateral strategies into their methodology curricular at all levels. This will ensure the development of its knowledge in the teachers on training.
6. Curriculum developers, Federal Ministry of Education and also state Ministry of Education should incorporate Analogy and collateral teaching strategies into teachers' education curriculum and be taught as other teaching methods being taught since they are relatively new techniques with many stages for their successful implementation.

5.7 Limitations of the Study

1. The study was restricted to State Government owned Colleges of Education in North Central Zone of Nigeria. The Federal Colleges of Education were not used because they have different settings in equipment and manpower. These could bring about difference which can affect the generalization to be made from the findings of present study.
2. Only evolution concept was used among other biology concepts. Other concepts may have their peculiarities which may be different from that of evolution. The possible difference could limit the generaliability of the present findings from the study.
3. The large experimental classes were possible because students are matured.

5.8 Suggestions for Further Studies

1. The present study used subjects at NCE level only. It is suggested that similar studies be replicated at Universities, Polytechnics and other Colleges of Education in other zones both State and Federal in order to obtain a more comprehensive and generalisable outcome on the study topic.
2. It is suggested that similar study should be conducted on other concepts of biology at NCE level so as to have an outcome for better and wider generalization.
3. Present study was restricted to NCE III biology students only; it is therefore suggested for further studies on other science subjects at different levels and different concepts so as to obtain a wider base for generalization and contribution to knowledge on impact of collateral and analogy teaching strategies on unscientific preconceptions and performance in evolution concepts.
4. The results obtained in this research are for biology, the method can therefore be tried in other disciplines such as chemistry, physics and mathematics among others at NCE level.

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APPENDIX A

Unscientific Preconception Test on Evolution (UPTE) For NCE III Biology Students

Questions on adaptive radiation, fossils, human evolution, mutational changes as causes of evolution, Darwin's theory of natural selection, competition, variation, survival of the fittest, origin of life and geological timetable.

Introduction

You are to answer all the questions on the attached plain sheets. Answer each question carefully and express yourself as freely as you can. The questions are set to find out the much you know about the concepts.

Thank you very much for your anticipated cooperation.

Section: A Biodata of Respondent

1. Name of school----------

2. Sex: Male----------Female----------

Section: B. Items on Evolution Concepts

Questions: Answer all questions on the sheets provided. You can express yourself as freely as you can.

1. What do biologists consider as the meaning of mutation?

2. Chromosomal mutations are of different types, mention them and explain any one of them?

3. What is evolution?

4. Explain the relationship between Homo habilis, Homo sapiens and Homo erectus?

5. What is the importance of fossil on theory of evolution?

6. Describe the origin of life?

7. How did Charles Darwin explained the process of evolution?

8. Discuss how environment select for itself favourable traits using the theory of natural selection?

9. Justify how vestigial structures have been used to explain evolution?

10. Briefly explain what you understood by survival of the fittest?

11. What are the implications of geographical isolation on animals?

12. Discuss Lamarks theory of evolution based on the use and disuse of body organ/ parts?

13. Discuss the term geological timetable?

14. Compare and contrast intra-specific competition and inter-specific competition?

15. What do the terms Paleozoic, Mesozoic and Cenozoic mean

APPENDIX B

Marking scheme [Unscientific Preconception Test on Evolution (UPTE)]

1. Mutation is a sudden and unpredictable change in the structure of the genetic materials in the gene.
2. There are four(4) types of chromosomal mutation
   i. Deletion
   ii. Inversion
   iii. Translocation
   iv. Duplication

   Translocation is a form of chromosomal mutation in which a portion of a chromosome breaks off from the chromosome and then attacks itself to another chromosome.
3. Evolution means the change in the characteristics of a population of species over several generations, with the resultant formation of a new species.

   From the definition,
   i. That evolution implies that species do change;
   ii. That all organism presently on earth have evolved over a long period of time from some others which existed in the past;
   iii. That new species which evolve from previously existing ones are more advanced or better equipped than the older ones- the original species, hence their ability to adapt to the changing environment on the planet earth.
4. i) Homo habilis: is believed to have lived about 1.3 million years ago, they lived in caves but also built shelter for themselves, they used fire. He is about 1.2 metres in height, his foot similar to that of modern man. He had an effective power grip and he was good at handling objects. He was not capable of any precision grip such as handling a pen or a pencil. They were more representative of the true basic stock of man.

   ii. Homo sapiens: is the first thinking man, with a well developed brain, well built body, effective hands, bipedal stance and speech. The earliest recognizable modern man is swanscombe man. He was advanced than any of its predecessors. He not only used stone implements, he actually practiced art, he hunted, and practice herding and he also domesticated some animals which were formerly his prey. He produced his

food from plants and animals around him. He developed crafts such as pottery. He lived in communities, engaged in labour specialization.

5. (i)Fossils are remains of plants and animals or impressions of plant and animal structures that were once buried in sedimentary rocks. –it allows biologists to reconstruct the history of life on earth.
   (ii) Provides some of the strongest evidence that species have evolved over time.
   (iii) It reveals how environments have changed over time.
   (iv) It shows how major new groups of organisms arose from previously existing organisms.
6. Origin of life is meant the mechanism or process through which living things originate on the planet earth. This can also be interpreted to mean how the first organisms get into this world.
7. Darwin and his process of evolution
   - There is over production of individuals by any species of organism
   - Struggle for existence occurs among these individuals.
   - Variation usually exist among the individuals of a species, some of these variations are favourable.
   - -Survival of the fittest occurs among the individuals of a species.
   - The favourable characteristics possessed by individuals are inherited.
   - The new forms are produced which favourable characteristics which adapt them for survival and are have thus naturally selected as new species.
8. Theory natural selection is the process by which biological organisms with favorable traits survive and reproduce more successfully than organisms that do not possess such traits, and, conversely, organisms with deleterious traits survive and reproduce less successfully than organisms lacking such deleterious traits. This selection process is in response to forces in the natural world
9. Vestigial structures used to explain evolution. These are certain structures found in the bodies of living organisms in poorly developed forms, are known to be well developed in their ancestors. In some groups of organisms, some of these structures which are poorly developed in a number of organisms are well developed in some of their living relatives. Such structures in these poor states of development are called Vestigial Organs. The explanation for the presence of such organs in living organisms is that they were useful in the ancestors and some of

the living relatives that have them. However, they are still retained in the organisms carrying them to indicate that they too have them, even if they do not use them. For example, the modern day horse has a number of unused bones in their feet. In their ancestors, such bones are well developed and were used to support the toes. Man- a tailless primate, has tail bones at the end of the spinal column. The gorillas and monkeys which are the closest living relatives of man, all carry tails all of which have these tail bones of the same number as man has, even though those of man are fused to form the coccyx. Tails in these relatives of man are organs for balancing when climbing trees. Man does not need a tail, since he is not arboreal in habitat. Man also carries the appendix as a vestigial structure.

10. Survival of the fittest is described as all favourable variation that enhance the ability of individuals to struggle effectively for survival or existence in an environment, enable such individuals to survive and reproduce. This implies that only those individuals that posse desirable variations within their environment are fittest and only these survive in the competition within their environment.
11. Implication of geographic isolation is that it could prevent individuals of the population to meet physically.
    - They are essentially disconnected genetically.
    - there is little or no gene flow between or among them.
    - it can result in to new species
    - it can lead to speciation.
12. Lamarks theory of evolution on use and disuse In this theory, Lamark postulated that the organs possessed by living organisms remain active, develop and enlarge and are retained by them as long as they are constantly used. However, if such organs are not used, they weaken, become smaller and may eventually disappear.
13. Geological timetable is a table showing the Eras, Epochs and the approximate years in the past during which the different organisms presently on earth and those that once existed but are now extinct, might have evolved.
14. Competition is a concept that is used to describe the relationship between organisms that are making demand for certain material needs that are in short supply in their environment. This relationship which is often described as a negative relationship can be between individuals of the same species (a type known as intraspecies competition), or between individuals of different species (a type known as interspecific competition). The materials which can bring about

competition include the following food materials, oxygen, space, and reproductive mates. Competition can in extreme instances, lead to death of all or any or some of the individuals involved in the competition. It can also lead in less extreme instances to poor growth, reduced production of offspring and migration in the case of animals.

15. The Paleozoic Era is the era that comes after the Proterozoic Era. The term Paleozoic means Ancient Life. This is a reflection of the ancient type of life the era contained as dominant life. The rocks of this era contain a large number of fossils. They are unlik-the rocks of the Palezoic Era, not so changed by the processes of mountain formation. The Paleozoic Era lasted for about 300 million years, starting from 500 million years ago to 200 million years ago. The Era embraces 6 major epochs also termed periods.

The Mesozoic Era came after the Paleozoic Era. The rocks of this era too, contained a large number of fossils. This era lasted for about 140 million years, starting from 200 million years ago to 60 million years ago. The era is also referred to as the age of Reptiles. The Mesozoic Era is composed of 3 major epochs. These together with their duration

The Cenozoic Era came after Mesozoic Era. Its own rocks too contain a large number of fossils. The era lasted for about 60 million years ago to the present time. The Era covers 6 epochs.

APPENDIX C

Evolution Performance Test (EPT)

Instruction: Answer all questions

Time: 1 Hour

1. Points out source of all new alleles

A) Gene flow

B) Natural selection

C) Mutation

D) Genetic drift

2. Which of the following is not true of natural selection?

A) Natural selection gets to preserve favorable traits and eliminate a favorable trait

B) The offspring of individuals those are better adapted to the environment

C) Natural selection directs the course of evolution by preserving the traits acquired during an individual lifetime

D) Natural selection acts on a population's genetic variability, which arises through mutation

3. Describe what Scientist collectively call humans and their immediate ancestors

A) Mammals

B) Primates

C) Anthropoids

D) Hominids

4. Some scientist now thinks that fossils identified as Homo erectus represent which two species?

A) H.ergaster and H.erectus

B) H.habilis and H.erectus

C) H.heidelbergensi and H.ergaster

D) H.neanderthalenis and H.erectus

5. Archaic Homo sapiens appeared about_____ years ago

A) 5 million

B) 800,000

C) 230,000

D) 100,000

6. Organise the following hominids in chronolological order of appearance, beginning with the earliest: H.habilis, H.sapiens, H.neanderthalenis, and H.erectus.

A) H.habilis, H.erectus, H.sapiens, H.neanderthalenis

B) H.erectus, H.habilis, H.sapiens, H.neanderthalenis

C) H.erectus, H.habilis, H.neanderthalenis, H.sapiens

D) H.habilis, H.erectus, H.neanderthalenis, H.sapiens

7. Intrepret process of reproductive isolating mechanism in which two closely related species live in the same geographic area but reproduce at different times

A) Temporal isolation

B) behavioral isolation

C) mechanical isolation

D) gametic isolation

8. Interspecific hybrids, if they survive, are

A) always sterile

B) always fertile

C) usually sterile

D) usually fertile.

9. Write the first step leading to allopathic speciation

A) hybrid inviability

B) hybrid breakdown

C) adaptive radiation

D) geographic isolation .

10. Predict the evolutionary process associated with allopolyploidy?

A) gradualism

B) algometric growth

C) sympatric speciation

D) mass extinction.

11. Point out the largest unit within which gene flow can occur

A) species

B) subspecies

C) population

D) individual organism.

12. Adaptive radiation is common following a period of mass extinction, justify why

A) the survivors of a mass extinction are remarkably well adapted to their environment

B) the unchanging environment following a mass extinction drives the evolutionary process

C) many adaptive zones are empty

D) many ecological niches are filled.

13. The Hawaiian silver swords are an excellent example of which evolutionary process?

A) allometry

B) preadaptation

C) micro evolution

D) adaptive radiation.

14. Identify the electromagnetic waves that cause mutation ----------

15. Gives name of abnormal exchange of genetic material between two homologous pair of chromosomes ----------

16. The removal of a functional part of chromosome is called----------

17. Modification of gene sequence on the chromosome through artificial method and the transfer of the genetic material from one organism to another are called ----------

18. Rearrangement of genes on the chromosome is called ----------

19. Artificial modification of gene sequence is used in the field of _____

20. Categorize the process by which adaptive features that are transmissible from generations to generation results in the emergence of new species _____

A. Revolution

B. Evolution

C. Ecology

D. Devolution

21. Discuss ways students can apply the knowledge of evolution in the society.

A. students can build evolution schools in the society as exemplified by some prominent evolutionist such as Charles Darwin

B. Student can interact with other societal members as shown by an eminent evolutionist (Lamarck)

C. Student can promote interspecies relationship in the society as promoted by eminent evolutionists of 18^{th} and 19^{th} centuries

D. Student can emulate the hard works of some eminent evolutionist such as Lamarck and Darwin in their daily academic life

22. Produces the best example of Natural selection phenomenon

A. Peppered moth (Biston betularia)

B. Peppered moth (Biston betularia)

C. Salted moth (Biston betularia)

D. Black moth (Manchester species)

23. Represents one of the most recognised orthodox fathers of evolution

A. Charles Darwin

B. Aristotle

C. Lamarck

D. Bill klington

24. Produces one evolutionary evidence from fossils

A. Direct evidence for evolution

B. Unconfirmed evidence for evolution

C. Indirect evidence for evolution

D. Incomplete evidence for evolution

25. Observed genetic recombination as expressed by successive generations is because the new species which evolve from the previously existing ones are more

A. sensitive to environmental changes and challenges on earth

B. adapted and equipped in curding environmental challenges on planet earth.

C. brilliant in decision taking on environmental changes

D. beautiful than the previous existing ones

26._____implies longtime reproductive separation of naturally selected individuals of a give species

A. isolation phenomenon

B. males and females separation

C. reproduction phenomenon

D. evolution phenomenon

27. Rearrange the following evolutionary trend in vertebrate in an ascending order as evidenced by fossil study?

A. amphibians▸ fishes ▸ reptiles ▸birds ▸mammals

B.fishes ▸amphibians ▸birds ▸reptiles ▸mammals

C.fishes ► amphibians ► mammals ► reptiles ► birds

D. fishes ► amphibians ► reptiles ► birds ► mammals

28. Paleontology is the study of

A. parents

B. fossils

C. refuse

D. pollio

29. Shows peppered moths dark colour assist the insects.

A. escape

B. camouflage

C. prey

D. pretend

30. Recognizes appendix as one of the_____ in man

A. digestive organ

B. adaptive organ

C. annex organ

D. vestigial organ

31. Theory of use and disuse was postulated by

A. Jean-Baptiste de Lamarck

B. James-Baptiste de Lamarck

C. Charles Darwin

D. Jean-Baptiste demarck

32. Examples of courtship

A. maturity behavior

B. love expression

C. behavioural adaptation

D. territorial behavior

33. Interprets the structural similarity present in different groups of organisms which have similarity of embryonic origin and development

A. homozygous structures

B. homologous structures

C. heterologous structures

D. analogous structures

34. Apprises homologous structure that leads to_____ and analogous structures that leads to_____ evolution

A) Invergent and invergent

B) Convergent and divergent

C) Convergent and divergent

D) Divergent and convergent

35. Plan ways in an ecosystem that could lead to food crisis

A) Intraspecies and inter species competition

B) intra-species and inter communal dispute

C) Hunger and diseases

D) Intra species and extra species competition

36. Evaluate the process through which living things originate on the planet earth as expressed by evolutionist

A) Mechanism of evolution

B) Evolution of life

C) History of life

D) Origin of life

37. Rearrange in a descending order the evolutionary trend in plant kingdom

A) Spermatophytes ► pteridophytes ► bryophytes ► algae

B) Bryophytes ► algae ► pteridophytes ► spermatophytes

C) Algae ► bryophytes ► pteridophytes ► spermatophytes

D) Spermatophytes ► bryophytes ► algae ► pteridophytes

38. Predicts where organic evolution can takes place

A) Living things

B) sand

C) rocks

D) exploitation

39. Fossils found in sedimentary rocks can be dated using

A) Carbon dating method

B) nitrogen dating method

C) calcium dating method

D) bitumen dating method

40. Indentify the followings energy, the absence of oxygen, chemical building blocks, and time as the requirements for

A) Chemical evolution

B) Biological evolution

C) Cambrian explosion

D) The mass extinction episode at the end of the cretaceous period

41 Justify evolutionary conversions of reptilian scales into feathers

A) Allometric

B) Paedomorphosis

C) Preadaption

D) Hybrid breakdown

42 Defends evolutions that concerns history of life

A) Prokaryotes

B) Eukaryotes

C) Photosynthesizers

D) Plants and animals

43 The consensus among scientist is that the first cells were

A) Aerobic autotrophic prokaryotes

B) Anaerobic autotrophic prokaryotes

C) Aerobic heterotrophic prokaryotes

D) Anaerobic heterotrophic prokaryotes

44 Creates fossil record that offers direct evidence for common descent

A) See that the types of fossils change over time

B) Sometimes find common ancestors

C) Trace the ancestry of a particular group

D) All of these are correct

45 Allopatric but not sympatric speciation requires

A) Reproductive isolation

B) Geographic isolation

C) Prior hybridization

D) Spontaneous differences in males and females

46. Indentifies which of these is incorrectly matched

A) H.erectus----made tools

B) Neanderthal-----good hunter

C) H.habilis-----controlled fire

D) Cro-magnon----good artist

47. Ediacaran fossils

A) Are the oldest fossils of early vascular plants

B) Are the oldest known fossils of multicellular animals

C) Come from the burgess shale in british Columbia

D) Contain remains of large salamander-like organism

48. Mass extinctions

A) Are always caused by asteroid impacts

B) Are periods of time in which many species go extinct worldwide

C) Have little lasting effect on the history of life

D) Affect only terrestrial organisms.

49. Supports the history of life that

A) Biodiversity has remained constant for about 400 million years

B) Extinctions have little effect on biodiversity

C) Macroevolution is greatly influenced by mass extinction and adaptive radiations

D) Macroevolution can be understood solely in terms of the evolution of populations.

50. Which of the following evolutionary mechanisms acts to slow down or prevent the evolution of reproductive isolation?

A) Natural selection
B) Gene flow
C) Mutation
D) Genetic drift

APPENDIX D

Evolution Performance Test (EPT) Marking Scheme

S/N	Answer	S/N	Answer	S/N	Answer
1	c	21	d	41	c
2	c	22	a	42	a
3	d	23	a	43	d
4	b	24	c	44	d
5	b	25	b	45	b
6	d	26	a	46	d
7	a	27	d	47	b
8	c	28	b	48	b
9	d	29	b	49	c
10	c	30	d	50	b
11	a	31	a	1x 50= 50 marks	
12	c	32	c		
13	d	33	b		
14	X-ray/gama ray	34	d		
15	Translocation	35	a		
16	Deletion	36	d		
17	Genetic engineering	37	a		
18	Chromosomal mutation	38	a		
19	Agriculture/mechine	39	a		
20	b	40	a		

APPENDIX: E

Experimental Group One (Analogy Teaching Strategy)

Lesson 1

School: College of Education, Kastina-Ala

Level: 300

Course: Bio: 325

Credit unit: 2

Topic: Mutation, types of mutation and causes and their effects

Duration: 2hours

Instructional materials: plastic blocks, students, hanger, clothes

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

1. define what is mutation,
2. state at least three types of mutation and explain them, and
3. outline causes of mutation and their effects.

Entry behavior: Students are familiar with different kinds of Down syndrome in their communities and calendar,

Introduction: Students were asked the following questions:

1. What is the physical abnormality they might have observed in people?

2. What do you think are the causes of these abnormalities?

Presentation: The teacher presents the lesson to the students using analogy teaching strategy as follows.

1. Introduce the Target Concept to be Learnt

Mutation is a sudden and unpredictable change in the structure of the genetic materials or the gene. Mutation is from the latin word mutare, meaning to change.

Main characteristics of mutation

(i) Gene mutations vary in their frequency

They however rarely occur. It is claimed that a gene mutates only about once in one million cell generations or even more than this.

(ii) Mutations are often reversible

This implies that a gene may mutate to an allele and the allele can itself mutate back to the original form of gene.

(iii) A gene can mutate to different alleles on different occasions.

(iv) Mutations are rarely of any advantage to the organisms in which they occur only very few are of any advantage.

(v) Mutations that are advantageous are inheritable.

(vi) The rate of mutation can be increased by certain agents known as mutagenic agents. Examples of these agents are lionizing radiations and certain chemicals.

Step II: Classifications of mutations

Mutations can be classified into different forms, using different bases. Using bases, mutations can be grouped into two: These are gene mutation and chromosomal mutation.

Gene mutation also known as point mutation

Gene mutation occurs in the genetic material involves a change in the chemical constitution of the gene. This by implication involves a particular region of the genetic material. Gene mutation cannot be viewed under the microscope. Different forms of gene mutations are known. These include the following substitution, insertion, deletion and inversion.

*Substitution is a form of gene mutation in which an incorrect nucleotide is substituted for a correct one. A commonly cited example of this is the gene mutation which causes sickle cell anemia.

*Insertion is a form of gene mutation in which an extra material is brought into the genetic chemical material.

*Deletion is a form of gene mutation involving the leaving out of a portion of the genetic chemical material.

*Inversion is a form of gene mutation. It is a wrong placement of a portion of the genetic chemical material.

Step III: Chromosomal mutation: This is also known as chromosomal aberration.

Chromosomal mutation is a form of change occurring in the genes structure of chromosomes. Chromosomal mutations can be viewed under the microscope. Different forms of chromosomal mutations are known, these include deletion, inversion, translocation and duplication.

Deletion is a form of chromosome mutation involving a loss of a portion of a chromosome. Most forms of deletion usually result in death in the affected organism. However, it is generally known that the effect of the deletion depends on the amount and nature of the genetics material lost.

Inversion is a form of chromosomal aberration involving the breaking of a portion of a chromosome which then attaches itself to the chromosome in a wrong way round, such that the sequence of genes on the affected chromosomes become reserved.

Translocation is a form of chromosomal mutation in which a portion of a chromosome breaks off from the chromosome and then attaches itself to another chromosome.

Duplication is a form of chromosomal mutation in which a section of the chromosome replicates such that a set of genes in the replicated chromosome become repeated.

Based on the site of mutation. Mutation can be broadly grouped into two. There are germinal mutations and somatic mutations.

i. Germinal mutations are mutations affecting the gamete cells. Such mutations can as such be perpetuated through sexual reproduction.

ii. Somatic mutations are mutations occurring in the body cells and as such cannot be perpetuated through sexual reproduction. They can however be propagated asexually.

Step IV: Effect of the mutation: mutation effect can be grouped into three (3) types. These are those with minor effects, those with drastic effects and those that are lethal.

1. Mutations with minor effects are mutations that have effects which are not very significant on the affected organisms.

2. Mutations with drastic effects are mutations whose effects on the affected organisms are major, through the affected organisms do not die as a result of such mutations.

3. Mutations that are lethal are mutations which result in outright death in the affected organisms.

Step 2. Cue students to the analogy situations.

Students have come across people with different types of deformity. They wonder what have actually gone wrong or may be the cause.

Step 3. Identify the features of the analogy that are relevant.

The analogy involved building a structure using plastic blocks to represent proteins. Students were given eight (8) lego blocks and asked to stacks of two. They were told that four stacks of two were sufficient for the wild-type phenotypes. Students were then asked to break down the blocks, remove four of them, illustrating a deletion at on allele.

Students were asked to re-stack the blocks in sets of two. Again, produced the same block illustrating that at times 50% production is insufficient for maintenance of retinal attachment.

Another Analogy involved creating a structural tangle (sickle cell rods) using an object with a different known function (a clothes hanger). Students were shown a hanger and asked the function (to hang up clothes). Equal numbers of plastic hangers (wild type proteins) and wire hangers (Hbs proteins) were placed in a sack and shaken to stimulate low oxygen tension. This generated a tangle of hangers, assuming, the polymerization of the hemoglobin rods that generate the in flexible, sickle shaped red blood cell.

Step 4. Map the similarities between the analogy and the target.

Target	Analogy
Gene that code for protein	Plastic blocks
The amount of protein required is so great that the normal phenotype is only generated when both alleles produce functional product.	Students were given eight lego blocks and asked to stack them in sets of two. Four stacks of two were sufficient for the wild type normal phenotype.
When one mutant protein in a protein complex initiates the cell quality control and destroy the entire protein complex	Students were asked to break down the blocks, remove four of them, illustrating a deletion at on allele
Due to structural defect resulting from insufficient production of protein during development bring about gene mutation that causes syndrome.	Students to re-stack the blocks in sets of two but were unable because of four blocks they have removed making it insufficient for normal phenotype this result in down syndrome.

Step 5. Identify where the analogy breakdown.

- In the target mutation are often reversible but in analogy the break blocks were unable to restack are not reversible.

- In the target mutation are grouped into two but in the analogy the blocks are not grouped.

- In the target characteristics of mutation are discussed while in the analogy these are not discussed.

- In the target effects of mutation are discussed while in the analogy effects of mutation are not discussed.

- In the target the agents that brings about mutations are discuss while in analogy agents mutations are not discussed.

Step 6. Summarise, drawing conclusions about the target concept

Mutation is of great importance as a major process in the mechanism of evolution. It is particularly important as the process which initiates evolution in a species. This is because it is the product of mutation that other processes in the mechanism of evolution build upon, so important is mutation that without it taking place in a species of organism, no evolution can occur in that organism to form a new species.

Evaluation: The teacher evaluates her lesson by asking the students the following questions. i) What is mutation

ii) State at least three types of mutation and explain them

The Experimental Group One

Lesson 2

Analogy Teaching Strategy

School: College of Education, Kastina-Ala

Level: 300

Course: **Bio: 325**

Credit Unit: 2

Topic: Darwin Theory of Natural selection, competition, variation and survival of the fittest

Duration: 2hours

Instructional Materials: Uncooked noodles of different colours i.e. green, yellow and red and the students.

Behavioural Objectives: By the end of the lesson, the students should be able to explain the followings::

(i)Natural selection (ii) Competition (iii) Variation (v) Survival of the fittest

Entry Behaviour: Students are familiar with how people struggle for food, and compete for best result award in schools; see how some people are stronger than each other in terms of strength and other abilities, see variations in colour & shapes of other animals including human being around them.

Introduction

Students were asked the following questions:

1. Mention some animals you have had of from the story told by grandparents

2. Do you think all those animals still exist?

Presentation: The teacher presents the lesson to the student using Analogy teaching strategy as follows

Step 1. Introducing the Target Concept to be Learned.

Charles Darwin travels around the world between 1831 and 1836, enabled him to collect a large number of evidence on the fact that there is modification of species by descent also referred to as organic evolution. This implies that species do change. They are not immutable. He came about this idea as a result of his visit to the mainland of South American and the Galapagos Islands which is 885 kilometres off the cost of Ecuador. On these Islands, he saw different animals such as lizards, giant tortoise and 13 different species of finches. Malthus (1766-1834) a political economist in his publication suggested that human population at that time was growing at an exponential rate 1,2,4,8,16 Z whereas food supply was not progression 1,2,3,4,56 Z. He then, inferred that as a result of this development there will eventually be starvation. Competition is a concept that is used to describe the relationship between organisms that are making demand for certain material needs that are in short supply in their environment. This relationship which is often described as a negative relationship can be between individuals of the same species (a type known as intraspecies competition), or between individuals of different species (a type known as interspecific competition). The materials which can bring about competition include the following food materials, oxygen, space, and reproductive mates. Competition can in extreme instances, lead to death of all or any or some of the individuals involved in the competition. It can also lead in less extreme instances to poor growth, reduced production of offspring and migration in the case of animals.

Step II: Darwin further concluded from Malthus publication that living things have to compete for material needs essential for life and that in such competition, only the "fittest" would survive, while others would die off. There are certain variations which make individuals of organisms to be better adapted in their environment, that is, they enhance the capacity of such individuals for struggling for survival, are desirable

variations in the evolution of a species. They also make them survive and reproduce within their environment. Variations can be brought about in organisms by a number of factors, among which are (i) mutation (ii) genetic recommendation (ii) environmental influences.

These variations may be noticeable in the features of the structure of organisms in which case they are morphological variation. Others may only be noticeable in the reactions of the organisms to certain situations. Such variations are described as physiological variations. In both types of variations because they are noticeable, are collectively described as phenotypic variations. Some other variations are not noticeable. They are concealed and are right inside the genes. These are described as genotypic variations.

Step III: Darwin felt further that certain advantageous variation helps some individuals with a species in nature to survive and reproduce in their environment. Such advantageous or useful variations would accumulate in such individuals which would over sometime be different from the original species from which they came. This would lead to evolution of a new species. This natural process of "weeding out" individuals with undesirable variations, is what Darwin referred to as Natural Selection, it was this Natural selection process that was in operation in the weeding out of the "light coloured" moths in Manchester in the case of the peppered moth. Over years of operation the natural selection process in an environment which is constantly changing, new forms of old forms of life will continue to emerge. These two issues influenced Darwin and they led him to his theory of evolution known as the theory of natural selection.

Step 2. Cue Students' Memory to the Analogy Situation

– Have you ever seen noodles before?

– How does it look like?

– Have you tasted it?

– Do you like it?

– Are they of different colours?

– Can you mention the colours?

Step 3. Identify the features of the analogy that are relevant.

Teacher will take the students outside to an area of green grasses (field) where earlier teacher will have scattered an equal number of green, yellow and red uncooked noodles. Teacher will explain to the students that the uncooked noodles represent different coloured grasshoppers and that the students would be hungry birds whose population has grow at exponential rate who will prey on the grasshoppers. The teacher will ask the students to go into the field to catch as many grasshoppers as they can in the next five minutes and returned to the classroom; teacher will then ask students to count the numbers of green, yellow and red grasshopper they have caught.

– In analogy, green grasses (field) is just like the environment in target

– In analogy, green, yellow, red uncooked noodles are just like different colours of grasshopper in the target.

– In analogy, 216 students are just like 150,000 birds in the target.

– In analogy, students collect noodles to eat is just like birds collect grasshoppers to eat.

– In analogy, fast students were able to pick plenty noodles just like birds that are strong were able to collect enough food materials.

– In analogy, students collect the colour noodles are just like natural selection.

Step 4. Map the similarities between the analogy and the target.

	Target	Analogy
1.	Environment	Field (green grasses).
2.	Material resources Grasshoppers	Noodles of different colours (green, yellow an red).
3.	Birds	Students.
4.	Competition	Picking of noodles by the students
5.	Variation in birds – Strength – Colour	Students are different individuals who vary from one another. Power of vision to see the object of different colours. Fastness.
6.	Natural selection	Colours of noodles/collection of noodles on the basis of colour and interest. Green noodles were preserved.

Step 5. Identify where the analog breaks down

– All the students survive none of them die while in the target the species that are not strong enough to compete for resources die off.

– Human population change from their original species into another while in analogy the student are still the same species.

– All the noodles that were unseen by the students were not picked because of selection in terms of colour and interest while in the target environment preserved the species to survive and reproduced

Step 6. Summarize, drawing conclusions about the target concept

The main ideas in his theory of evolution can be highlighted as follows:

– There is over population of individuals by any species of organism

– Struggle for existence occurs among these individuals

– Considerable variations usually exist among the individuals of a species, some of these variations are favourable.

– Survival of the fittest occurs among the individuals of a species because they were able to compete and survive.

– The favourable characteristics possessed by individuals are inherited

– The new forms are produced which favourable characteristics which adapt them for survival and are have thus naturally selected as new species.

Evaluation: The teacher evaluates her lesson by asking student questions based on the topic treated.

(i). what is natural selection?

(ii). Summarize competition, variation and survival of

The Experimental Group One

Lesson 3

Analogy Teaching Strategy

School: College of Education, Kastina-Ala

Level: 300

Course: Bio 325

Credit unit: 2

Topic: Adaptive Radiation of Birds

Duration: 2hours

Instructional Materials: A range of tools, a Petri dish, a large dish, and seed food sources.

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

1. define adaptive radiation,
2. explain the concept of adaptive zone,
3. compare the various beak shapes and methods of obtaining food, and
4. explain why finches have different types of beaks.

Entry behavior: Students are familiar with different birds with different shape of beaks in their environments, on pictures like calendar and textbooks.

Introduction: Students were asked the following questions. Why do birds have different beaks shapes? Does this account for the type of food they feed on?

Presentation: The teacher presents the lesson to the student using Analogy teaching strategy as follows

Step 1. Introduce the target concept to be learnt

Adaptive radiation is the evolutionary diversification of many related species from one or a few ancestral species in a relatively short period. The concept of adaptive zone was developed to help explain why adaptive radiations take place. Adaptive zones are new ecological opportunities that were not exploited by an ancestral organism. At the species level, an adaptive zone is essentially identical to one or more similar ecological niches. Hawalian honey creepers, a group of related birds found on the hawalian islands. When the honey creeper ancestors reached hawali, few other birds were present. The succeeding generations of honey creeper quickly diversified into many new species and, in the process, occupied the many available adaptive zones that on the mainland are occupied by finches, honey eaters, treecreepers, and woodpeckers. The diversity of their bills is a particularly good illustration of adaptive radiation. Some honey creepers bills are curved to extract nectar out of tubular flowers, whereas others are shorts and thick for ripping away bark in search of insects.

Step II: Hawaiian silverswords, 28 species of closely related plants found only on the Hawaiian island. When the silversword ancestor, a California plant related to daisies, reaches the Hawaiian Islands, many diversed environments, such as cool, arid mountains; exposed lava flows; dry woodlands; shady, moist forests; and wet bogs were present and more or less unoccupied. The succeeding generations of silverswords quickly diversified in structure and physiology, occupying the many adoptive zones available to them. The diversity in their leaves, which changed during the course of natural selection as different populations adapted to various levels of light and moisture is a particularly good illustration of adaptive radiation. Leaves of silverswords that are adapture to shady moist forests are large, for example, whereas those of silverswords living in arid areas are small. The leaves of silverswords living on exposed volcanic slopes are covered with dense silvery hairs that may reflect some of the intense ultraviolet radiation off the plant.

Step III: Adaptive radiation appears more common during periods of major environmental change, but it is difficult to determine if these changes actually induce adaptive radiation. Possibly major environmental changes actually induce adaptive radiation by increasing the extinction rate. Extinction produces empty adapative zones, which provides new

opportunities for species that remain. For example, they had existed as small nocturnal insectivores (insect eaters) for millions of years before undergoing adaptive radiation leading to the modern mammalian orders.

Step 2. Cue students to the Analogy situation.

Have you ever seen different types or range of spoon? Have you ever observe the shape and size critically.

Have you ever seen birds? Do you care to observe their beaks?

Step 3. Identify the features of the Analogy that are relevant.

-a petri dish is just like a finch crop

-a large dish containing seeds is just like a Galapagos island.

-the seed food sources are just like the island

-students that are assigned with tools are just like the birds' beak or finches' beak.

-a range of tools in which each tool is just like different finch beaks

Step 4. Map the similarities between the analogy and target concepts

Target	**Analogy**
Different finch beaks	A range of tools
A finch crop	A petri dish
A Galapagos island	A large dish containing seeds
The island	The seed food sources
Finch beak to pick up small seeds	Students assigned with tools to pick up seeds from the large dish

Step 5. **Identify where the analogy breakdown.**

-in the target different finch beaks are alive while in analogy the tools are not alive

-in the target a finch crop is not see neither is it like a dish while in analogy petri dish are used

-in the target a Galapagos insland is a little world within itself, satellite town attached to America while in analogy a large dish containing seed not a town.

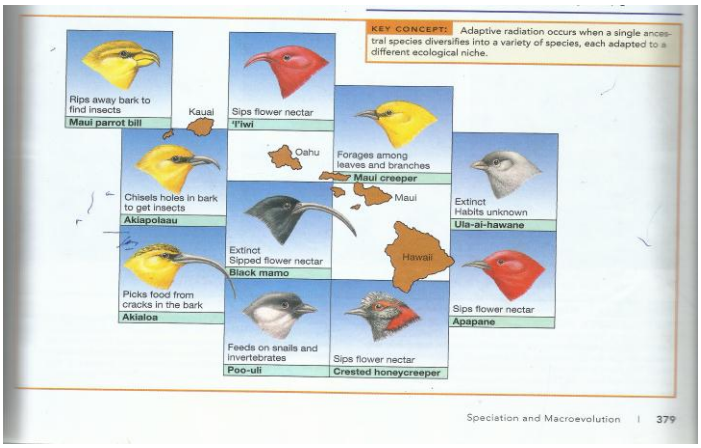
- in the target the island is a large free environment while in analogy seed food sources are collected and kept in a container.

-in the target different type of finch beak feed on different types of seed food sources while analogy students act like finches.

Step 6. Drawing conclusions about the target concept

The finches adapted to take advantages of the various food sources available on the island, which were being used by other species. Over the long term, the original finch species may have disappeared, but by diversitying, would stand a better chance of survival. All in all, the finches had adapted to their environment vial natural selection, which in turn, has allowed the species to survive in the longer term, the prime directive of any species.

Darwins Finches



Evaluation: The lesson will be evaluated as follows

1. Why do finches has different beak
2. Draw and explain different types of finches beak

The Experimental Group One

Lesson 4

Analogy Teaching Strategy

School: College of Education, Kastina-Ala

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Hypothesis on theories of Origin of Life

Duration: 2hours

Instructional Materials: Building blocks/bricks of different colours.

Behavioural Objectives: By the end of the lesson student should be able to:

(i). define the term origin of life,

(ii). write on the hypothesis that have been postulated to explain the origin of life, and

(iii). discuss biochemical evolution.

Entry Behaviour

Students had some knowledge about origin of life from their O' level, churches or mosques.

Introduction

Students were asked the following questions:

1. Where life does begins or starts

2. Is there any evidence to prove your answer?

Presentation: The teacher presents the lesson to the student using Analogy teaching strategy as follows:

Step 1. Introduce the target concept to be learned.

Origin of life is the process through which living things originate on the planet earth.

Hypothesis on theories of life

(a). Special creation

(b). Spontaneous generation

(c). Life from outer space

(d). Steady state

Theories of special creation

This is a theory which stated that all forms of life on earth have been created specially by a supreme being, commonly referred to as God. This Supreme Being is believed to have power over the universe. It is He who has through an order brought the earth into

existence and through the same order, created in a systematic manner, all living things on earth over a period of six days, with man being the last of His creations. This man is believed to have been given the authority or dominion over all other things created by God.

This is the origin of life that is most favoured by many Christians. The story is documented in the Bible in genesis Chapter 1. It is also on record that Dr. Light foot and Bishop, usher came up with an idea that God created the organisms in the world, all at once in the month of October in the year 4004BC.

Step II: Theory of Spontaneous generation

This theory of spontaneous generation is also known as the theory of Abiogenesis. It is a theory believed to have been proposed by Aristotle who is also described in some quarters as the founder of Biology. This theory explains the origin of all forms of life, as being due to a sudden change in non-living materials of the earth to living things. This change often described as a spontaneous change, is said to be due to certain natural forces, which are also described as "active principles" operating on these non-living materials.

Step III: Biochemical Evolution

It is today believed that life arose several millions of years ago from simple inorganic materials. It is also believed that life arose in water. It is believed that the environment in which life arose was a reducing one without oxygen, (i.e. anaerobic environment), but with gases such as nitrogen, ammonia, methane, carbondioxide and water vapour. From these simple inorganic materials, simple organic molecules such as amino acids were believed to have been synthesized in a reducing atmosphere with certain minerals serving as catalysts.

Later, these simple organic molecules formed bigger ones from which Deoxyribo Nucleic Acid (DNA) arose. These DNA molecules later transformed into simple forms of life which were heterotrophic in their nutrition, which later give rise to bigger forms of life, which were not only complex in form, but with some of them being capable of photosynthesizing. It is believed that it is from these simple organisms that all other organisms including other aquatic, amphibians and terrestrial organisms arose.

Step 2. Cue student's memory to the analogy situation.

What are we made of?

Let me show you what cells are like?

What are these little bricks and what can you do with them?

What is a gas?

Do you know that when two or more gases come together they form simple organic molecules?

Do you know that human body can be build with blocks?

Step 3. Identify the features of the analogy that are relevant.

You are made up of cells. In fact all animals and plants are made up of cells. The cells in you are live, just as you are. Every part of you is made up of cells, but we can't see them because cells are usually so small you need a magnifying glass of microscope to see them. Let me show you what cells are like. Teacher quickly gets a box of building bricks or blocks from the drawer. Teacher dramatically spills the unassembled bricks on the desk or table where all students can see them.

They are bricks! You can build things with them. Teacher quickly builds little person from the bricks and holds it above the head so that all students can see it.

Different colours of building blocks was used to represent different types of gases such as nitrogen-yellow colour of blocks, methane-blue colour of blocks, ammonia-green colour of blocks, carbondioxide-red colour of blocks and water vapour-black colour of blocks. When different colours of building blocks are joined together they form into a simple structure when more blocks are added to the simple structure then its formed into bigger structure then when more is added it form a complex structure at this stage building blocks can be build into human being, each colours representing the different cells of the human body.

Teacher will tell the students that the bricks in the analogy are like their cells in the target. Every part of animals is made up of cells in the target, just like bricks are built into every part of animal in the analogy. In the target the cells get put together to make bigger things is just like bricks get put together to make bigger things. In analogy building blocks of different colours are just like different gases in the target.

In analogy combine building blocks of different colours form a simple structure are just like simple organic molecules such as amino acids in the target.

In analogy when more building blocks are added to the simple structure a bigger structure is formed are just like simple organic molecules formed into bigger ones from which Deoxyribonuclei Acid (DNA) arose in the target.

In analogy when more building blocks are added to the bigger ones to complex structure is just like DNA molecules later transformed into simple forms of life in the target.

In analogy complex structure with addition of more building blocks can be build into human being is just like simple forms of life later gave rise to bigger forms of life as the target.

Step 4. Map the similarities between the analogy and the target

S/N	Target	Analogy
1.	Cells	Bricks/Blocks
2.	Every part of animal is made up of cells	Every parts of the human constructed model is made of bricks.
3.	Cells get put together to make bigger things	Bricks get put together to make bigger things
4.	Different gases such as nitrogen, methane, carbondioxide, ammonia and water vapour	Different colours of building blocks yellow, blue, green, red and black
5.	Combination of different gases form a simple organic molecules	Combination of different colours of building blocks form a simple structure
6.	Simple organic molecule formed bigger ones from which DNA arose.	When more building blocks are added to simple structure a bigger structure is formed.
7.	DNA molecules later transformed into simple forms of life	When more are added to bigger structure it forms a complex structure
8.	Simple forms of life later gave rise to bigger forms of life	Complex structure with addition of more building block can be built into human being.

Step 5. Identify where the analogy breaks down:

– In the target the cells that you are made of are much smaller than bricks in the analogy
– In the target our cells are alive while in the analogy the bricks are not alive.
– In the target the cells of animal or plants are tiny while in the analogy the bricks are big.
– In target life arose in water and that the environment in life arose was a reducing one without oxygen were discuss while in analogy they are not discussed.
– In target amino acids were believed to have been synthesized in a reducing atmosphere with certain minerals serving as catalysts are discussed while in analogy the bricks do not make chemical reaction.
– In target bigger forms of life are capable of photosynthesizing are discussed while in analogy they are not discussed.

– In target these simple organisms that all other organisms including other aquatic, amphibians and terrestrial organisms arose are discussed while in analogy they are discussed.

Step 6. Drawing conclusions about the target concept

In summary, the following trends can be listed on the origin of life:

(i). Life arose several million of years ago

(ii). Life arose from simple inorganic materials

(iii). Life arose most probably in water

(iv). Life arose in an anaerobic environment

(v). Simple materials from which life arose, transformed into simple organic molecules such as proteins and enzymes

(vi). These simple organic molecules later transformed into simple primitive forms of life

(vii). The simple primitive forms of life were as simple as the viruses and bacteria

(viii). They were heterotrophic in their nutrition

(ix). These organisms later gave rise to other aquatic, amphibians and terrestrial organisms.

(x). The newly evolved organisms were complex in structure, multicellular, some aerobic, some aquatic, some amphibians, others terrestrial

Evaluation: The lesson was evaluated as follows:

1. What is origin of life
2. Write briefly on any hypotheses that have been postulated to explain the origin of life.

The Experimental Group One

Lesson 5

Analogy Teaching Strategy

School: College of Education, Kastina-Ala

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Fossils and human evolution

Duration: 2hours

Instructional Materials: The developmental stages of human being from fertilization to the birth.

Behavioural Objectives: By the end of the lesson student should be able to:

1. explain the process of evolution of man, and
2. distinguish between
    i. Homo habilis
    ii. Homo erectus
    iii. Homo sapiens

Entry Behaviour: Student are familiar with different pictures of early man in biology textbooks, calendars and some are told stories about their great, great grandparents by their parents at home.

Introduction: Students were to ask the following questions:

1. From the pictures observed what you can say about the early man.
2. Have you see these kinds of people around.

Presentation: The teacher presents the lesson to the student using Analogy teaching strategy as follows:

Step 1. Introduce the target concept to be learnt

Fossils of ancestral relatives of the modern man homo sapiens have been gotten in different parts of the world at different times. Different names have also been given to these fossil specimens, whose features are well documented. It is from these documented pieces of information that the account below is being distilled. The teacher explains fossil specimens and outlined some of the important facts on the evolution of man to include the following:

1. The information on the evolution of man is gotten through fossil evidences assembled from different parts of the world notable among which were East Africa, Asia, China, Indonesia and Hungary.
2. Prominent among the evolutionists whose works provide useful information on the evolution of man, are LSB Leakey and his wife who worked in the Olduvai George locale of Tangayika in 1959 and Professor Raymond Dart whose work in Bechuanaland in South Africa in 1925, provided much information on the fossils of Australopithecus africanus.
3. Man is generally believed to have evolved from a lower primate stock.
4. Man is also in general, believed to have evolved from the primate stock which was found in sedimentary rocks of the Miocene and Pliocene epochs well over 20 million years ago.
5. The evolution of man involved biological changes involving the brain, the hands, muscular-skeletal system which brought about the bipedal stance, the jaws, the teeth, the height and overall size.
6. Besides the biological changes which the evolution of man went through, were the non-biological changes involving occupation, arts work, such as manufacture of stone implements, arts work, cultural evolution in areas such as use of fire and religious beliefs, involving mode of worship and ritual activities.
7. The main fossils that provide information on the evolutionary history of man are Dryopithecus africanus, and Australopithecus. Others include Homo habilis, Homo erectus and Homosapiens.

Step II**: History of the Fossil-Homo habilis**

There are three main species of the Genus Homo. These are Homo habilis, Homo erectus and Homosapiens (the modern man). Homo habilis arose from the Australopithecines and had lived about 1.3 million years ago. They were believed to have lived in caves but also built shelters for themselves. They were also said to have used fire. Homo habilis had a cranial capacity of about 680cc. He was about 1.2 metres in height. His foot was similar to that of modern man-Homosapiens. His foot was arched and it had a big toe and a short opposable thumb. Homo habilis most probably manufactured stone implements. He had an effective power grip and he was good at handling objects. He was not capable of any precision grip such as handling a pen or a pencil. Leakey was of the belief that Homo habilis was more representative of the true basic stock of man than Australopithecus.

Step III**: History of the Fossil-Homo erectus**

Fossils of Homo erectus have been found in Africa, Asia, China, Indonesia and Hungry in Europe. It is strongly believed that certain human fossils, have been given such names as pekin man, javaman and Heidelberg man, were most probably different samples of Homo erectus found in different geographical locations which expectedly are equipped with individual variations. Homo erectus was believed to have evolved from Homo habilis and too give rise to Homo sapiens-the modern man. Homo erectus had a cranial capacity which was between 775 and 1100cc. This range of skull size over laps that of the lower-range of modern man. The bones of the cranium were thick and had a medium stature. He had a low brain case with the sides tapering upwards. His limbs were like those of modem man. He walked on the two legs like modern man. His face was reduced and the chin was only slightly developed, dentition was similar though larger than that of modern man. Homo erectus was also like his predecessor, not capable of precision grip.

Biological changes of Homo erectus, this fossil man exhibited the following features of cultural evolution

– He was probably religious to some extent
– He buried his dead relations
– He carried out some rituals and probably collected skulls. Homo erectus lived close to sources of water such as banks of streams and shores of lakes. He also possibly occasionally lived in the cave.

Step IV: History of Homo sapiens is the first thinking man, with a well developed brain, well built body, effective hands and speech. He is believed to have evolved from Homo erectus. His far more advanced than any of its predecessors. He not only used stone implement, he actually practiced art. He hunted and at a later stage in his early life, he actually practiced herding and he also domesticated some animals which were formerly his prey. He produced his food from plants and animals around him. He developed crafts such as pottery for producing his domestic utensils. He lived in communities and was spread over many region of the earth and engaged in labour specialization. He therefore had members of the species as hunters, millers, weavers, tillers of soil and so on. The earliest recognizable modern man is swanscombe man who lived between 150,000 and 25,000 years ago in Germany and England.

Step 2. Cue students' memory to the Analogy situation.

Do you ever think how you were formed in your mothers' womb?

Have you ever seen where a baby is born?

How does it look like?

Step 3. Identify the features of the Analogy that are relevant.

Some important developmental events in the human embryo 24 hours after fertilization the embryo has divided to become a two-celled embryo. On the third day the embryo enters the uterus which is about fifth day of development. On about the seventh day of development the embryo begins the process of implantation. By 2 weeks 5days the notochord and neural plate are formed, tissue that will give rise to heart is differentiating blood cells are forming in yolk sac and chorion. At 3 weeks 5 days neural tube forming primordial eye and ear are visible, pharyngeal pouches forming liver bud differentiating, respiratory system and thyroid gland just beginning to develop, heart tubes fuse, bend, and begin to beat, blood vessels are laid down. By 4 weeks limb buds, appear, three primary divisions of brain forming. 2 months muscles differentiating embryo capable of movement, gonad distinguishable as testis, or ovary, bones begins to ossify, cerebral cortex, differentiating principal blood vessels assumes final positions.

At 3 months sex can be determined by external inspection, notochord degenerates, lymph glands develop while by 4 month face begins to look human, lobes of cerebrum differentiate, eyes, ears and nose look more normal. From 5-9 months a covering of downy hair covers the fetus, and then later is shed, neuron myelination begins tremendous growth of body. At the 266 days from conception the baby is then given birth to.

-In analogy from 24 hours after fertilization to 7 days of implantation is just like Dryopithecus in the target.

-In analogy from 2 weeks to 4 weeks of development is just like Australopithecus in the target.

-In analogy from 4 weeks to 2 months of development is just like Homo habilis in the target.

-In analogy from 2 months to 3 months of development is just like Homo erectus in the target.

-In analogy from 3 months to 4 months of development is just like Homosapiens in the target.

-In analogy from 5-9months of development is just like modern man in the target.

-In analogy by 9months the child is born is just like modification of part of the body of the modern man into present man in the target.

Step 4. Map the similarities between the Analogy and target concepts.

Target	Analogy
Dryopithecus	24 hours after fertilization to 7 days of implantation
Australopithecus	Embryo at 2weeks to 4 weeks
Homo habilis	Fetus at 4 weeks to 2 months
Homo erectus	Fetus at 2 months to 3 months
Homo sapiens	Fetus at 3 months to 4 months
Modern man	Development of baby from 5 months to 9 months
Modification of modern man to the present man	When the child is born

Step 5. Identify where the Analogy breaks down.

In target Dryopithecus look like ape in low skull and hairy jaw and has larger molar are discussed while they are not discuss in Analogy.

In target Australopithecus has smaller cranial than modern man live a hunting life are discussed while in the Analogy they are not discuss.

In target Homo habilis lived in caves, built shelters for themselves and use fire are discussed while in Analogy they are not discussed.

In target Homo habilis had an effective power grip, good at handling object, not capable of handling pen or pencil, he had a big toe and a short opposable thumb were all discussed while in Analogy they were not discussed.

In target Homo erectus were given names like Pekin man and Javaman, they were found in different geographical locations equipped with individual variations are discussed while in analogy they are not discussed.

In target Homosapiens hunted in his early life, actually practice herding and also domesticated some animals which were formerly his prey, developed crafts and produced his food from plants and animals around him were discussed while in Analogy they were not discussed.

Step 6. Drawing conclusions about the target concept

The two critical steps in the evolution of humans were the evolution of bipedalism (walking on two feet) and the enlargement of the brain. The earliest hominids and the

direct ancestors of humans belong to the genus Australopithecus. They appeared in Africa about 5 million years ago. They were small hominids, standing 3 to 4 feet tall and weighing from 50 to 100 pounds. The genus Australopithecus gave rise to humans belonging to the genus Homo. The first species of this genus Homo habilis, appeared in Africa about 2 million years ago. Now extinct, the people of this species are considered human because they exhibited intelligence for greater than their ancestors by making tools and clothing. The second species of Homo erectus, appeared in Africa approximately 1.6 million years ago. These people used fire, built shelters, fashioned sophisticated tools, and exhibited culture. Homo sapiens probably evolved from Homo erectus about 200,000 years ago. Homosapien is the first thinking man, with a well developed brain, well built body, effective hands and speech. He produced his food from plants and animals around him. He is engaged in labour specialization, he developed crafts and hunted.

Evaluation: The teacher evaluates her lesson by asking students questions based on what they are taught:

1. Give 3 important facts about evolution of man
2. Explain the following

i. Homo habilis

ii. Homo erectus iii. Homo sapiens

Appendix F

Experimental Group Two (Collateral Teaching Strategy)

Lesson 1

School: Kwara State College of Education, Ilorin

Level: 300:325

Credit unit: 2

Topic: Mutation, types and causes and their effects.

Duration: 2hours

Instructional materials: plastic blocks, students, hanger, clothes

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

1. define what is Mutation,
2. state at least three types of mutation and explain them, and
3. outline causes of mutation and their effects.

Entry behaviuor

Students are familiar with different kinds of people not looking normal, having extra fingers or non finger at all, having small head, unstable neck, abnormal legs, one part of the body jointed to other part and among others. Showing the students pictures of Down syndrome and sickle cell anemia individuals.

Introduction

Sensory Register

Students were asked the following questions:

1. What is the physical abnormality they might have observed in people?
2. What do you think are the causes of these abnormalities?

Presentation: The teacher presents the lesson to the students using CTS

Step I: Working Memory

Students were grouped and a leader was asked to read the story. In our culture when a pregnant women comes across an evil spirit, she is believe to give birth to an abnormal/evil child or whenever she enter a spiritual place where she is suppose not to enter or eat an animal forbidden by the family, she will give birth to a child that has problem with some part of his/her body deformed/Down syndrome or child that dies and come back to life or if a nursing mother visit a mountain on Friday to cut fire wood she

will see a lot of evil spirits children looking exactly like her child, this is done to deceive her, the evil spirit usually exchange peoples children and they will pick the one that is not theirs. In our communities, an abnormal child is always assumed as an action of evil spirits. Ideas of mutation are not known, but in science classroom students are told about mutation as a sudden change in variation of species.

Step II: From the story read discuss among your groups what mutation is? What are the main characteristics of this mutation? Mutation is a sudden and unpredictable change in the structure of the genetic materials or the gene. Mutation is from the Latin word mutare, meaning to change.

Main characteristics of mutation

i) Gene mutations vary in their frequency

They however rarely occur. It is claimed that a gene mutates only about once in one million cell generations or even more than this.

ii) Mutations are often reversible

This implies that a gene may mutate to an allele and the allele can itself mutate back to the original form of gene.

iii) A gene can mutate to different alleles on different occasions.

iv) Mutations are rarely of any advantage to the organisms in which they occur only very few are of any advantage.

v) Mutations that are advantageous are inheritable.

vi) The rate of mutation can be increased by certain agents known as mutagenic agents. Examples of these agents are lionizing radiations and certain chemicals.

Step III: Classifications of mutations

Mutations can be classified into different forms, using different basis. Using basis, mutations can be grouped into two these are gene mutation and chromosomal mutation.

Gene mutation also known as point mutation

Gene mutation occurs in the genetic material involves a change in the chemical constitution of the gene. This by implication involves a particular region of the genetic

material. Gene mutation cannot be viewed under the microscope. Different forms of gene mutations are known. These include the following substitution, insertion, deletion and in version.

*Substitution is a form of gene mutation in which an incorrect nucleotide is substituted for a correct one. A commonly cited example of this is the gene mutation which causes sickle cell anaemia.

*Insertion is a form of gene mutation in which an extra material is brought into the genetic chemical material.

*Deletion is a form of gene mutation involving the leaving out of a portion of the genetic chemical material.

*Inversion is a form of gene mutation. It is a wrong placement of a portion of the genetic chemical material.

Step IV: Chromosomal mutation: this is also known as chromosomal aberration. Chromosomal mutation is a form of change occurring in the genes structure of chromosomes. Chromosomal mutations can be viewed under the microscope. Different forms of chromosomal mutations are known, these include deletion, inversion, translocation and duplication.

Deletion is a form of chromosome mutation involving a loss of a portion of a chromosome. Most forms of deletion usually result in death in the affected organism. However, it is generally known that the effect of the deletion depends on the amount and nature of the genetics material lost.

Inversion is a form of chromosomal aberration involving the breaking of a portion of a chromosome which then attaches itself to the chromosome in a wrong way round, such that the sequence of genes on the affected chromosomes become reserved.

Translocation is a form of chromosomal mutation in which a portion of a chromosome breaks off from the chromosome and then attaches itself to another chromosome.

Duplication is a form of chromosomal mutation in which a section of the chromosome replicates such that a set of genes in the replicated chromosome become repeated.

Based on the site of mutation. Mutation can be broadly grouped into two. There are germinal mutations and somatic mutations.

i. Germinal mutations are mutations affecting the gamete cells. Such mutations can as such be perpetuated through sexual reproduction.

ii. Somatic mutations are mutations occurring in the body cells and as such cannot be perpetuated through sexual reproduction. They can however be propagated asexually.

Step V: Effect of the mutation: mutation effect can be grouped into three (3) types. These are those with minor effects, those with drastic effects and those that are lethal.

1. Mutations with minor effects are mutations that have effects which are not very significant on the affected organisms.

2. Mutations with drastic effects are mutations whose effects on the affected organisms are major, through the affected organisms do not die as a result of such mutations.

3. Mutations that are lethal are mutations which result in outright death in the affected organisms.

Summarise, mutation is of great importance as a major process in the mechanism is evolution. It is particularly important as the process which initiates evolution in a species. This is because it is the product of mutation that other processes in mechanism of evolution build upon, so important is mutation that without it taking place in a species of organism, no evolution can occur in that organism to form a new species

Evaluation: Boarder crossing and transition between working memory to collateral learning. From the answers students give to the following questions the teacher will be able to known the type of boarder crossing that has occur in the learner.

i) Explain what you understand by the word mutation
ii) What are the possible causes of mutation

Collateral learning: From the answer students give to the questions below the teacher will be able to deduce the type of collateral learning that has taken place in the learner.

The Experimental Group Two

Lesson 2

CTS

School: Kwara state College of Education, Ilorin

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Darwin theory of natural selection, competition, variation and survival of the fittest

Duration: 2hours

Instructional Materials: Uncooked noodles of different colours i.e. green, yellow and red and the students.

Behavioural Objectives: By the end of the lesson the students should be able to explain the following:

(i). natural selection,

(ii). Competition,

(iii). Variation, and

(v). survival of the fittest

Entry Behaviour: Students are familiar with how people struggle for food, and compete for best result award in schools; see how some people are stronger than others in terms of strength and other abilities, see variations in colour & shapes of other animals including human being around them.

Introduction

Sensory Register

Students were asked the following questions:

1. Mention some animals you have had of from the story told by grandparents,

2. Do you think all those animals still exist?

Presentation: The teacher presents her lesson to the student using CTS

Working Memory

Step I: Students were grouped and a leader was asked to read the story In our society some animals were formally found living very close to man, like lion, deaf, hipponteous, leopard, tiger, red lynx, cheetah, civet among others. Nowadays these animals are not found in our environment, because of vegetations that have been cleared, some of these

animals have no hidden places again. Human population or lack of enough food resources or hunting of these animals by human hunters for food or harshness of weather of the particular environment has made these animals fewer and unseen; some are used as raw materials for industrials and factories among others. Because of these reasons the mention animals are hardly found in our environment today but in science class we refer to these as survival of the fittest, natural selection that the environment select for itself and struggle for existence.

Step II: From the story read discuss among your groups. What do understand the natural selection? How this does effects the animals living within the environment? Is there any variation among them? Charles Darwin travels around the world between 1831 and 1836, enabled him to collect a large number of evidence on the fact that there is modification of species by descent also referred to as organic evolution. This implies that species do change. They are not immutable. He came about this idea as a result of his visit to the mainland of South American and the Galapagos Islands which is 885 kilometres off the cost of Ecuador. On these Islands, he saw different animals such as lizards, giant tortoise and 13 different species of finches. Malthus (1766-1834) a political economist in his publication suggested that human population at that time was growing at an exponential rate 1,2,4,8,16 Z whereas food supply was not progression 1,2,3,4,56 Z. He then, inferred that as a result of this development there will eventually be starvation. Competition is a concept that is used to describe the relationship between organisms that are making demand for certain material needs that are in short supply in their environment. This relationship which is often described as a negative relationship can be between individuals of the same species (a type known as intraspecies competition), or between individuals of different species (a type known as interspecific competition). The materials which can bring about competition include the following food materials, oxygen, space, and reproductive mates. Competition can in extreme instances, lead to death of all or any or some of the individuals involved in the competition. It can also lead in less extreme instances to poor growth, reduced production of offspring and migration in the case of animals.

Step III: Darwin further concluded from Malthus publication that living things have to compete for material needs essential for life and that in such competition, only the "fittest" would survive, while others would die off. There are certain variations which make individuals of organisms to be better adapted in their environment, that is, they enhance the capacity of such individuals for struggling for survival, are desirable

variations in the evolution of a species. They also make them survive and reproduce within their environment. Variations can be brought about in organisms by a number of factors, among which are (i) mutation (ii) genetic recommendation (ii) environmental influences.

Step IV: These variations may be noticeable in the features of the structure of organisms in which case they are morphological variation. Others may only be noticeable in the reactions of the organisms to certain situations. Such variations are described as physiological variations. In both types of variations because they are noticeable, are collectively described as phenotypic variations. Some other variations are not noticeable. They are concealed and are right inside the genes. These are described as genotypic variations. Darwin felt further that certain advantageous variation helps some individuals with a species in nature to survive and reproduce in their environment. Such advantageous or useful variations would accumulate in such individuals which would over sometime be different from the original species from which they came. This would lead to evolution of a new species. This natural process of "weeding out" individuals with undesirable variations, is what Darwin referred to as Natural Selection, it was this Natural selection process that was in operation in the weeding out of the "light coloured" moths in Manchester in the case of the peppered moth. Over years of operation the natural selection process in an environment which is constantly changing, new forms of old forms of life will continue to emerge. These two issues influenced Darwin and they led him to his theory of evolution known as the theory of natural selection.

Over years of operation the natural selection process in an environment which is constantly changing, new forms of old forms of life will continue to emerge.

Evaluation: Border crossing and transition from working memory to collateral learning. From the answers students give to the question below the teacher will be able to known the type of boarder crossing that has occur in the learner.

(i) What is natural selection and variation.

(ii) What are the evidences that it occurs?

Summary: The teacher summarises her lesson by given student notes to copy and reference book to read further.

Summarize, drawing conclusions about the target concept

The main ideas in his theory of evolution can be highlighted as follows:

– There is over population of individuals by any species of organism

– Struggle for existence occurs among these individuals

– Considerable variations usually exist among the individuals of a species; some of these variations are favourable.
– Survival of the fittest occurs among the individuals of a species
– The favourable characteristics possessed by individuals are inherited
– The new forms are produced which have favourable characteristics which adapt them for survival and are have thus naturally selected as new species.

Collateral learning : From the answer students will give to the question below the teacher will be able to deduce the type of collateral learning that has taken place in the learner.

i) Discuss term survival of the fittest

(ii). Summarize Darwin theory of natural selection, competition, and variation.

Experimental Group Two

CTS

Lesson 3

School: Kwara State College of Education, Ilorin

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Adaptative Radiation in Birds

Duration: 2hours

Instructional Materials: A range of tools, a Petri dish, a large dish, and seed food sources.

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

1. define adaptive radiation,
2. explain concept of adaptive zone,
3. compare the various beak shapes and methods of obtaining food, and
4. explain why finches have different types of beaks.

Entry behavior: Students are familiar with different birds with different shape of beaks in their environments, on pictures like calendar and textbooks.

Introduction: Sensory Register

Students were asked the following questions:

1. Why do birds have different beaks shapes?
2. Does this account for the type of food they feed on?

Presentation: The teacher presents the lesson to the student using CTS

Working Memory

StepI: Students were grouped and a leader was asked to read the story. In our environment we have been seeing a lot of different species of birds that look alike but having different beaks and feed on different kinds of food resources (grains) like rice, guinea corn, maize, millet, groundnut among others. This different beak helps them to source for enough food resources and to live within the environment. That is what science refers to as adaptative radiation.

Step: II From the story read discuss among your groups. What is adaptive radiation? What the reasons for modification in their beaks? Adaptive radiation is the evolutionary

diversification of many related species from one or a few ancestral species in a relatively short period. The concept of adaptive zone was developed to help explain why adaptive radiations take place. Adaptive zones are new ecological opportunities that were not exploited by an ancestral organism. At the species level, an adaptive zone is essentially identical to one or more similar ecological niches.

Hawalian honey creepers, a group of related birds found on the hawalian islands. When the honey creeper ancestors reached hawali, few other birds were present. The succeeding generations of honey creeper quickly diversified into many new species and, in the process, occupied the many available adaptive zones that on the mainland are occupied by finches, honey eaters, treecreepers, and woodpeckers. The diversity of their bills is a particularly good illustration of adaptive radiation. Some honey creepers bills are curved to extract nectar out of tubular flowers, whereas others are shorts and thick for ripping away bark in search of insects.

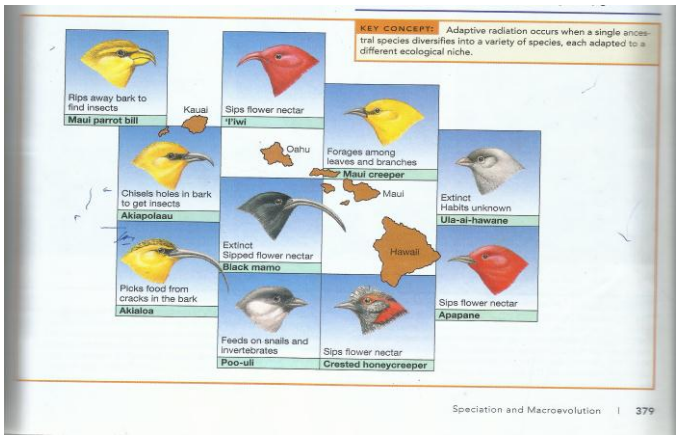
Step III: Hawaiian silverswords, 28 species of closely related plants found only on the Hawaiian island. When the silversword ancestor, a California plant related to daisies, reaches the Hawaiian islands, many diversed environments, such as cool, arid mountains; exposed lava flows; dry woodlands; shady, moist forests; and wet bogs were present and more or less unoccupied. The succeeding generations of silverswords quickly diversified in structure and physiology, occupying the many adoptive zones available to them. The diversity in their leaves, which changed during the course of natural selection as different populations adapted to various levels of light and moisture is a particularly good illustration of adaptive radiation. Leaves of silverswords that are adapture to shady moist forests are large, for example, whereas those of silverswords living in arid areas are small. The leaves of silverswords living on exposed volcanic slopes are covered with dense silvery hairs that may reflect some of the intense ultraviolet radiation off the plant.

Step IV: Adaptive radiation appears more common during periods of major environmental change, but it is difficult to determine if these changes actually induce adaptive radiation. Possibly major environmental changes actually induce adaptive radiation by increasing the extinction rate. Extinction produces empty adapative zones, which provides new opportunities for species that remain. For example, they had existed

as small nocturnal insectivores (insect eaters) for millions of years before undergoing adaptive radiation leading to the modern mammalian orders.

Summary: The finches adapted to take advantages of the various food sources available on the island, which were being used by other species. Over the long term, the original finch species may have disappeared, but by diversitying, would stand a better chance of survival. All in all, the finches had adapted to their environment vial natural selection, which in turn, has allowed the species to survive in the longer term, the prime directive of any species.

Darwins Finches



Evaluation: **Border crossing and transition between working memory to collateral learning.** From the answers students give to the following questions the teacher will be able to known the type of boarder crossing that has occur in the learner.

1. Allow students to ask question base what they have been taught
2. Why do finches has different beak

Collateral learning

From the answer students give to the questions below the teacher will be able to deduce the type of collateral learning that has taken place in the learner.

1 What is adaptive zone

2 Draw and explain different types of finches beak

Experimental Group Two

CTS

Lesson 4

School: Kwara State College of Education, Ilorin

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Hypothesis on theories of Origin of Life

Duration: 2hours

Instructional Materials: Building bricks/blocks of different colours

Behavioural Objectives: By the end of the lesson student should be able to:

(i). define the term origin of life,

(ii). write on the hypothesis that have been postulated to explain the origin of life, and

(iii). discuss Biochemical Evolution.

Entry Behaviour

Students had some knowledge about origin of life from their O' level, churches and mosques/religious beliefs

Introduction:

Sensory Register

Students were asked the following questions:

1. Where life does begins or starts

2. Is there any evidence to prove your answer?

Presentation: The teacher presents the lesson to the students using CTS

Working Memory

Step I: Students were grouped and a leader was asked to read the story. In most of the cultures in Nigeria, our believes about origin of life are based on religious believes either according to Bible or Quaran that human beings are created by God and that life does not come from any other place. Before, in our culture there are some idols that were assume to be gods, they were worshiped and sacrifices were made to them and that life were originated from them. Likewise in science life was assumed to have originated from inorganic materials, to something that has life like fish to reptiles to birds then to humans. Origin of life is the process through which living things originate on the planet earth.

Hypothesis and theories of life

(a). Special creation

(b). Spontaneous generation

(c). Life from outer space

(d). Steady state

(e). Biochemical evolution

Step II Theories of special creation

From the story read discuss among your groups. Does life really has an origin? How do prove your answer? This is a theory which states that all forms of life on earth have been created specially by a supreme being, commonly referred to as God. This Supreme Being is believed to have power over the universe. It is He who has through an order brought the earth into existence and through the same order, created in a systematic manner, all living things on earth over a period of six days, with man being the last of His creations. This man is believed to have been given the authority or dominion over all other things created by God.

This is the origin of life that is most favoured by many Christians. The story documented in the Bible in genesis Chapter 1. It is also on record that Dr. Light foot and Bishop, usher came up with an idea that God created the organisms in the world, all at once in the month of October in the year 4004BC.

Theory of Spontaneous generation

From the story read discuss among your groups. This theory of spontaneous generation is also known as the theory of Abiogenesis. It is a theory believed to have been proposed by Aristotle who is also described in some quarters as the founder of Biology. This theory explains the origin of all forms of life, as being due to a sudden change in non-living materials of the earth to living things. This change often described as a spontaneous change, is said to be due to certain natural forces, which are also described as "active principles" operating on these non-living materials.

Step III: Biochemical Evolution

It is today believed that life arose several millions of years ago from simple inorganic materials. It is also believed that life arose in water. It is believed that the environment in which life arose was a reducing one without oxygen, (i.e. anaerobic environment), but with gases such as nitrogen, ammonia, methane, carbondioxide and water vapour. From these simple inorganic materials, simple organic molecules such as amino acids were believed to have been synthesized in a reducing atmosphere with certain minerals serving as catalysts.

Later, these simple organic molecules formed bigger ones from which Deoxyribo Nucleic Acid (DNA) arose. These DNA molecules later transformed into simple forms of life which were heterotrophic in their nutrition, which later gave rise to bigger forms of life, which were not only complex in form, but with some of them being capable of photosynthesizing. It is believed that it is from these simple organisms that all other organisms including other aquatic, amphibians and terrestrial organisms arose.

Summary

In summary, the following trends can be listed on the origin of life:

(i). Life arose several million of years ago

(ii). Life arose from simple inorganic materials

(iii). Life arose most probably in water

(iv). Life arose in an anaerobic environment

(v). Simple materials from which life arose, transformed into simple organic molecules such as proteins and enzymes

(vi). these simple organic molecules later transformed into simple primitive forms of life

(vii). the simple primitive forms of life were as simple as the viruses and bacteria

(viii). They were heterotrophic in their nutrition

(ix). These organisms later gave rise to other aquatic, amphibians and terrestrial organisms.

(x). The newly evolved organisms were complex in structure, multicellular, some aerobic, some aquatic, some amphibians, others terrestrial.

Evaluation:

Border crossing and transition between working memory to collateral learning From the answers students give to the following questions the teacher will be able to known the type of boarder crossing that has occur in the learner

1. What is origin of life?
2. Explain briefly the Biochemical Evolution

Collateral learning. From the answer students give to the questions below the teacher will be able to deduce the type of collateral learning that has taken place in the learner.

1. Write briefly on the hypotheses that have been postulated to explain the origin of life.

Experimental Group Two

Lesson 5

CTS

School: Kwara State College of Education, Ilorin

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Fossils and human evolution

Duration: 2hours

Instructional Materials: The model of developmental stages of human being from fertilization to the birth.

Behavioural Objectives: By the end of the lesson student should be able to:

1. explain the process of evolution of man, and
2. discuss
    i. Homo habilis
    ii. Homo erectus
    iii. Homo sapiens

Entry Behaviour: Student are familiar with different pictures of early man in biology textbooks, calendars and some are told stories about their great, great grand parents by their parents at home.

Introduction:

Sensory Register: Students were to ask the following questions:

1. From the pictures observed what you can say about the early man.
2. Have you see these kinds of people around.

Presentation: The teacher presents her lesson to the students using CTS

Working Memory

Step I: Students were grouped and a leader was asked to read the story. In our society a dead person is assume to have come back to life whenever a new child is born into the family. Before a child is named, an oldest male in the family is often the decision maker and receive the name of the new child either through dream or vision by seeing the spirit of the dead man communicating with him. The oldest calls for a meeting to discuss with the rest members of the family his decision concerning the name of the child, elderly in the family are respected, and their authority is often unquestioned, therefore whatever he

says stand. As this child grew up he behaves in characters or looks exactly like the dead person he/she is named after. As such we believe that the dead person has come back to life, and always whenever the elderly person in the family sees the child they made some praises and incantations to please the idols those names the child bears. As the child grew there are modifications in the height, facial appearance, colour of skin, wisdom, knowledge, behavior towards opposite sex, mode of dressing, pattern of life, handling of materials or tools among others that are transfer from one generation to subsequent generation. As modifications continues new generation born are better than pass generation according to what fossil and human evolution talks about.

Step II: From the story read discuss among your groups. What evolution means from evidences of fossils. Fossils of ancestral relatives of the modern man homo sapiens have been gotten in different parts of the world at different times. Different names have also been given to these fossil specimens, whose features are well documented. It is from these documented pieces of information that the account below is being distilled. Some of the important facts on the evolution of man include the following:

1. The information on the evolution of man is gotten through fossil evidences assembled from different pasts of the world notable among which were East African, Asia, China, Indonesia and Hungary.
2. Prominent among the evolutionists whose works provide useful information on the evolution, of man, are LSB Leakey and his wife who worked in the Olduvai George locale of Tangayika in 1959 and Professor Raymond Dart whose work in Bechuanaland in South Africa in 1925, provided much information on the fossils of Australopithecus africanus.
3. Man is generally believed to have evolved from a lower primate stock.
4. Man is also in general, believed to have evolved from the primate stock which was found in sedimentary rocks of the Miocene and Pliocene epochs well over 20 million years ago.
5. The evolution of man involved biological changes involving the brain, the hands, muscular-skeletal system which brought about the bipedal stance, the jaws, the teeth, the height and overall size.
6. Besides the biological changes which the evolution of man went through, were the non-biological changes involving occupation, arts work, such as manufacture of stone implements, arts work, such as manufacture of stone implements, cultural

evolution in areas such as use of fire and religious beliefs, involving mode of worship and ritual activities.

7. The main fossils that provide information on the evolutionary history of man are Dryopithecus africanus, and Australopithecus. Others include Homo habilis, Homo erectus and Homosapiens.

Step II: The fossils are those of the skulls of Dryopithecus, Australopithecus, Homo habilis, Homo erectus and Homosapiens. Fossil evidence of Dryopithecus was found in East Africa. It was a primate which existed about 20 million years ago. Dryopithecus had both ape-like and human characteristics. The head which was more like that of an ape was with a low skull and hairy jaws. Its brain capacity which was estimated to be greater than that of any ape, was about 650cc. Dryopithecus has large molar and it is believed that this ape-like primitive lived on a diet of coarse vegetation.

Fossil evidence of Australopithecus was found in the tropical forest region of Gibraltar and Saudi Arabia. Australopithecus was claimed to have most of the features of man other than a big brain. It had smaller cranial capacity than that of modern man. This cranial capacity ranged from 300cc to 600cc. It was erect in his stance and his girdles were like those of man. He lives a hunting life. He was also carnivorous, with his dentition like that of modern man. This dentition was however more massive. Australopithecus is believed to have a direct link to the modern man Homosapiens. Australopithecus was of two types: these were Australopithecus robustus and Australopithecus africanus. Australopithecus rubustus was believed to be the male. He had powerful jaws and teeth. He also had heavy brow ridges and marked sagital crest. Australopithecus africanus was believed to be the female.

Step III: History of the Fossil-Homohabilis

There are three main species of the Genus Homo. These are Homo habilis, Homo erectus and Homosapiens- (the modern man). Homo habilis arose from the Australopithecines and had lived about 1.3 million years ago. They were believed to have lived in caves but also built shelters for themselves. They were also said to have used fire. Homo habilis had a cranial capacity of about 680cc. he was about 1.2 metres in height. His foot was similar to that of modern man-Homosapiens. His foot was arched and it had a big toe and a short opposable thumb. Homo habilis most probably manufactured stone implements. He had an effective power grip and he was good at handling objects. He was not capable of any precision grip such as handling a pen or a pencil. Leakey was of the

belief that Homo habilis was more representative of the true basic stock of man than Australopithecus.

Step IV: History of the Fossil-Homo erectus

Fossils of Homo erectus have been found in Africa, Asia, China, Indonesia and Hungry in Europe. It is strongly believed that certain human fossils, have been given such names as pekin man, javaman and Heidelberg man, were most probably different samples of Homo erectus found in different geographical locations which expectedly are equipped with individual variations. Homo erectus was believed to have evolved from Homo habilis and too give rise to Homsapiens-the modern man. Homoerectus had a cranial capacity which was between 775 and 1100cc. This range of skull size over laps that of the lower-range of modern man. The bones of the cranium were thick and had a medium stature. He had a low brain case with the sides tapering upwards. His limbs were like those of modem man. He walked on the two legs like modern man. His face was reduced and the chin was only slightly developed, dentition was similar, though larger than that of modern man. Homo erectus was also like his predecessor, not capable of precision grip.

Biological changes of Homo erectus, this fossil man exhibited the following features of cultural evolution

– He was probably religious to some extent
– He buried his dead relations
– He carried out some rituals and probably collected skulls. Homo erectus lived close to sources of water such as banks of streams and shores of lakes. He also possibly occasionally lived in the cave.

Step IV: History of Homosapiens is the first thinking man, with a well developed brain, well built body, effective hands and speech. He is believed to have evolved from Homo erectus. His far more advanced than any of its predecessors. He not only used stone implement, he actually practiced art. He hunted and at a later stage in his early life, he actually practiced herding and he also domesticated some animals which were formerly his prey. He produced his food from plants and animals around him. He developed crafts such as pottery for producing his domestic utensils. He lived in communities and was spread over many region of the earth and engaged in labour specialization. He therefore had members of the species as hunters, millers, weavers, tillers of soil and so on. The earliest recognizable modern man is swanscombe man who lived between 150,000 and 25,000 years ago in Germany and England.

Summary

The two critical steps in the evolution of humans were the evolution of bipedalism (walking on two feet) and the enlargement of the brain. The earliest hominids and the direct ancestors of humans belong to the genus Australopithecus. They appeared in African about 5 million years ago. They were small hominids, standing 3 to 4 feet tall and weighing from 50 t0 100 pounds. The genus Australopithecus gave rise to humans belonging to the genus Homo. The first species of this genus Homo habilis appeared in Africa about 2 million years ago. Now extinct, the people of this species are considered human because they exhibited intelligence for greater than their ancestors by making tools and clothing. The second species of Homo, Homo erectus, appeared in Africa approximately 1.6 million years ago. These people used fire, built shelters, fashioned sophisticated tools, and exhibited culture. Homo sapiens probably evolved from Homo erectus about 200,000 years ago. Homosapien is the first thinking man, with a well developed brain, well built body, effective hands and speech. He produced his food from plants and animals around him. He is engaged in labour specialization, he developed crafts and hunted.

Evaluation: Boarder crossing and transition between working memory to collateral learning. From the answers students give to the following questions the teacher will be able to known the type of boarder crossing that has occur in the learner.

1. Give 3 important facts about evolution of man
2. Write briefly on Homo sapiens

Collateral learning.

From the answer students give to the questions below the teacher will be able to deduce the type of collateral learning that has taken place in the learner.

Explain the following

i. Homo habilis
ii. Homo erectus

Appendix: G

The Control Group

Lesson 1

Lecture Method

School: College of education, Akwanga

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Mutation, types of mutation and causes and effects

Duration: 2hours

Instructional materials: plastic blocks, students, hanger, clothes

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

i) define what is mutation,

ii) state at least three types of mutation and explain them, and

iii) outline causes of mutation and their effects.

Entry behaviuor

Students are familiar with different kinds of people not looking normal, having extra fingers or non finger at all, having small head, unstable neck, abnormal legs, one part of the body jointed to other part and among others.

Introduction

Students were asked the following questions:

1. What is the physical abnormality they might have observed in people?
2. What do you think are the causes of these abnormalities?

Presentation: The teacher presents the lesson to the students in the following steps

Step I

Mutation is a sudden change in variation of species. Mutation is a sudden and unpredictable change in the structure of the genetic materials or the gene. Mutation is from the latin word mutare, meaning to change.

Main characteristics of mutation

i) Gene mutations vary in their frequency

They however rarely occur. It is claimed that a gene mutates only about once in one million cell generations or even more than this.

ii) Mutations are often reversible

This implies that a gene may mutate to an allele and the allele can itself mutate back to the original form of gene.

iii) A gene can mutate to different alleles on different occasions.

iv) Mutations are rarely of any advantage to the organisms in which they occur only very few are of any advantage.

v) Mutations that are advantageous are inheritable.

vi) The rate of mutation can be increased by certain agents known as mutagenic agents. Examples of these agents are lionizing radiations and certain chemicals.

Step II

Classifications of mutations

Mutations can be classified into different forms, using different basis. Using basis, mutations can be grouped into two these are gene mutation and chromosomal mutation.

Gene mutation also known as point mutation

Gene mutation occurs in the genetic material involves a change in the chemical constitution of the gene. This by implication involves a particular region of the genetic material. Gene mutation cannot be viewed under the microscope. Different forms of gene mutations are known. These include the following substitution, insertion, deletion and in version.

*Substitution is a form of gene mutation in which an incorrect nucleotide is substituted for a correct one. A commonly cited example of this is the gene mutation which causes sickle cell anaemia.

*Insertion is a form of gene mutation in which an extra material is brought into the genetic chemical material.

*Deletion is a form of gene mutation involving the leaving out of a portion of the genetic chemical material.

*Inversion is a form of gene mutation. It is a wrong placement of a portion of the genetic chemical material.

Step III

Chromosomal mutation: this is also known as chromosomal abernation.

Chromosomal mutation is a form of change occurring in the genes structure of chromosomes. Chromosomal mutations can be viewed under the microscope. Different

forms of chromosomal mutations are known, these include deletion, inversion, translocation and duplication.

Deletion is a form of chromosome mutation involving a loss of a portion of a chromosome. Most forms of deletion usually result in death in the affected organism. However, it is generally known that the effect of the deletion depends on the amount and nature of the genetics material lost.

Inversion is a form of chromosomal aberration involving the breaking of a portion of a chromosome which then attaches itself to the chromosome in a wrong way round, such that the sequence of genes on the affected chromosomes become reserved.

Translocation is a form of chromosomal mutation in which a portion of a chromosome breaks off from the chromosome and then attaches itself to another chromosome.

Duplication is a form of chromosomal mutation in which a section of the chromosome replicates such that a set of genes in the replicated chromosome become repeated.

Based on the site of mutation. Mutation can be broadly grouped into two. There are germinal mutations and somatic mutations.

i. Germinal mutations are mutations affecting the gamete cells. Such mutations can as such be perpetuated through sexual reproduction.

ii. Somatic mutations are mutations occurring in the body cells and as such cannot be perpetuated through sexual reproduction. They can however be propagated asexually.

Step IV

Effect of the mutation: mutation effect can be grouped into three (3) types. These are those with minor effects, those with drastic effects and those that are lethal.

i) Mutations with minor effects are mutations that have effects which are not very significant on the affected organisms.

ii) Mutations with drastic effects are mutations whose effects on the affected organisms are major, through the affected organisms do not die as a result of such mutations.

iii) Mutations that are lethal are mutations which result in outright death in the affected organisms.

Summary:

Mutation is of great importance as a major process in the mechanism is evolution. It is particularly important as the process which initiates evolution in a species. This is because it is the product of mutation that other processes in mechanism of evolution build upon, so important is mutation that without it taking place in a species of organism, no evolution can occur in that organism to form a new species.

Evaluation

The teacher evaluates her lesson by asking the students the following questions

i) what is mutation

ii) State at least three types of mutation and explain them

The Control Group

Lesson 2

Lecture Method

School: College of Education, Akwanga

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Darwin theory of natural selection, competition, variation and survival of the fittest

Duration: 2hours

Instructional Materials: Uncooked noodles of different colours i.e. green, yellow and red and the students.

Behavioural Objectives: By the end of the lesson student should be able to explain the following:

(i). natural selection,

(ii). Competition,

(iii). Variation, and

(v). survival of the fittest

Entry Behaviour: Students are familiar with how people struggle for food, how they compete for best result award in schools, see how some people are stronger than others in terms of strength and other abilities, see variations in colour & shapes of other animals including human being around them.

Introduction

Students were asked the following questions:

1. Mention some animals you have had of from the story told by grandparents,
2. Do you think all those animals still exist?.

Presentation: The teacher presents the lesson to the student as follows

Step I: Charles Darwin travels around the world between 1831 and 1836, enabled him to collect a large number of evidence on the fact that there is modification of species by descent also referred to as organic evolution. This implies that species do change. They are not immutable. He came about this idea as a result of his visit to the mainland of South American and the Galapagos Islands which is 885 kilometres off the cost of Ecuador. On these Islands, he saw different animals such as lizards, giant tortoise and 13 different species of finches. Malthus (1766-1834) a political economist in his publication suggested that human population at that time was growing at an exponential rate 1,2,4,8,16 Z whereas food supply was not progression 1,2,3,4,56 Z. He then, inferred that as a result of this development there will eventually be starvation. Competition is a concept that is used to describe the relationship between organisms that are making demand for certain material needs that are in short supply in their environment. This relationship which is often described as a negative relationship can be between individuals of the same species (a type known as intraspecies competition), or between individuals of different species (a type known as interspecific competition). The materials which can bring about competition include the following food materials, oxygen, space, and reproductive mates. Competition can in extreme instances, lead to death of all or any or some of the individuals involved in the competition. It can also lead in less extreme instances to poor growth, reduced production of offspring and migration in the case of animals.

Darwin further concluded from Malthus publication that living things have to compete for material needs essential for life and that in such competition, only the “fittest” would survive, while others would die off. There are certain variations which make individuals of organisms to be better adapted in their environment, that is, they enhance the capacity of such individuals for struggling for survival, are desirable variations in the evolution of a species. They also make them survive and reproduce within their environment. Variations can be brought about in organisms by a number of factors, among which are (i) mutation (ii) genetic recommendation (ii) environmental influences.

These variations may be noticeable in the features of the structure of organisms in which case they are morphological variation. Others may only be noticeable in the reactions of the organisms to certain situations. Such variations are described as physiological variations. In both types of variations because they are noticeable, are collectively described as phenotypic variations. Some other variations are not noticeable. They are concealed and are right inside the genes. These are described as genotypic variations. Darwin felt further that certain advantageous variation helps some individuals with a species in nature to survive and reproduce in their environment. Such advantageous or useful variations would accumulate in such individuals which would over sometime be different from the original species from which they came. This would lead to evolution of a new species. This natural process of "weeding out" individuals with undesirable variations, is what Darwin referred to as Natural Selection, it was this Natural selection process that was in operation in the weeding out of the "light coloured" moths in Manchester in the case of the peppered moth. Over years of operation the natural selection process in an environment which is constantly changing, new forms of old forms of life will continue to emerge. These two issues influenced Darwin and they led him to his theory of evolution known as the theory of natural selection.

Over years of operation the natural selection process in an environment which is constantly changing, new forms of old forms of life will continue to emerge.

Evaluation: The teacher evaluates her lesson by asking student questions based on the topic treated.

(i). What is natural selection?

(ii). Summarize Darwin theory of natural selection, competition, variation and survival of the fittest.

Summary: The teacher summarises her lesson by given student notes to copy and reference book to read further.

Summarize, drawing conclusions about the target concept

The main ideas in his theory of evolution can be highlighted as follows:

– There is over population of individuals by any species of organism
– Struggle for existence occurs among these individuals
– Considerable variations usually exist among the individuals of a species, some of these variations are favourable.
– Survival of the fittest occurs among the individuals of a species
– The favourable characteristics possessed by individuals are inherited

– The new forms are produced which have favourable characteristics which adapt them for survival and are have thus naturally selected as new species.

The Control Group

Lesson 3

Lecture Method

School: College of Education, Akwanga

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Adaptative Radiation in Birds

Duration: 2hours

Instructional Materials: A range of tools, a Petri dish, a large dish, and seed food sources.

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

1. define adaptive radiation,
2. explain concept of adaptive zone,
3. compare the various beak shapes and methods of obtaining food, and
4. explain why finches have different types of beaks.

Entry behavior: Students are familiar with different birds with different shape of beaks in their environments, on pictures like calendar and textbooks.

Introduction:

Adaption is one of the basic phenomena of biology, and is the process whereby an organism becomes better suited to its habitat. An adaptive trait is an aspect of the developmental pattern of the organism which enables or enhances the probability of that organism surviving and reproducing.

Presentation: the teacher presents the lesson to the student as follows

Step I: Adaptive radiation is the evolutionary diversification of many related species from one or a few ancestral species in a relatively short period. The concept of adaptive zone was developed to help explain why adaptive radiations take place. Adaptive zones are new ecological opportunities that were not exploited by an ancestral organism. At the species level, an adaptive zone is essentially identical to one or more similar ecological niches

Hawalian honey creepers, a group of related birds found on the hawalian islands. When the honey creeper ancestors reached hawali, few other birds were present. The succeeding generations of honey creeper quickly diversified into many new species and, in the

process, occupied the many available adaptive zones that on the mainland are occupied by finches, honey eaters, tree creepers, and woodpeckers. The diversity of their bills is a particularly good illustration of adaptive radiation. Some honey creepers bills are curved to extract nectar out of tubular flowers, whereas others are shorts and thick for ripping away bark in search of insects.

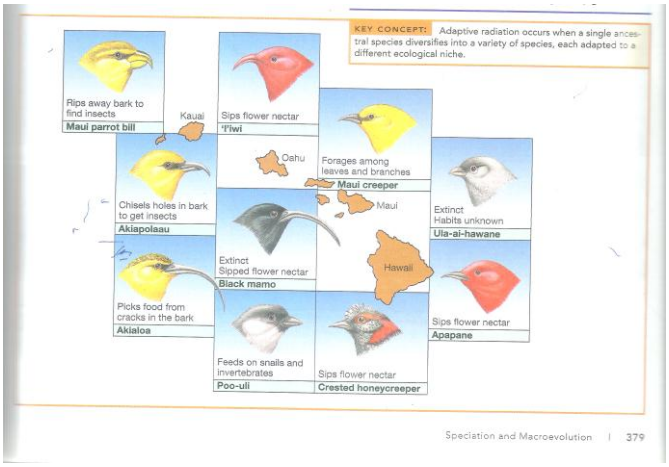
Step II: Hawaiian silverswords, 28 species of closely related plants found only on the Hawaiian island. When the silversword ancestor, a California plant related to daisies, reaches the Hawaiian Islands, many diverse environments, such as cool, arid mountains; exposed lava flows; dry woodlands; shady, moist forests; and wet bogs were present and more or less unoccupied. The succeeding generations of silverswords quickly diversified in structure and physiology, occupying the many adoptive zones available to them. The diversity in their leaves, which changed during the course of natural selection as different populations adapted to various levels of light and moisture is a particularly good illustration of adaptive radiation. Leaves of silverswords that are adapture to shady moist forests are large, for example, whereas those of silverswords living in arid areas are small. The leaves of silverswords living on exposed volcanic slopes are covered with dense silvery hairs that may reflect some of the intense ultraviolet radiation off the plant.

Step IV: Adaptive radiation appears more common during periods of major environmental change, but it is difficult to determine if these changes actually induce adaptive radiation. Possibly major environmental changes actually induce adaptive radiation by increasing the extinction rate. Extinction produces empty adaptive zones, which provides new opportunities for species that remain. For example, they had existed as small nocturnal insectivores (insect eaters) for millions of years before undergoing adaptive radiation leading to the modern mammalian orders.

Summary

The finches adapted to take advantages of the various food sources available on the island, which were being used by other species. Over the long term, the original finch species may have disappeared, but by diversifying, would stand a better chance of survival. All in all, the finches had adapted to their environment vial natural selection, which in turn, has allowed the species to survive in the longer term, the prime directive of any species.

Darwins Finches



Evaluation: The lesson will be evaluated as follows

1. Why do finches has different beak
2. Draw and explain different types of finches beak

The Control Group

Lesson 4

Lecture Method

School: College of education, Akwanga

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Origin of Life

Duration: 2hours

Instructional Materials: Building bricks/blocks of different colours

Behavioural Objectives: By the end of the lesson student should be able to:

(i). define the term origin of life,

(ii). write on the hypothesis that have been postulated to explain the origin of life, and

(iii). discuss Biochemical Evolution.

Entry Behaviour

Students had some knowledge about origin of life from their O' level, churches and mosques/religious beliefs

Introduction

The teacher introduces the lesson as follows: Life has a history. It began with the evolution of the first cells and continues even today. The fossil record provides information regarding the history and patterns of life's evolution.

Presentation: The teacher presents the lesson to the students as follows:

Step I: Definition: Origin of life is the process through which living things originate on the planet earth.

Hypothesis and theories of life

(a). Special creation

(b). Spontaneous generation

(c). Biochemical evolution

Theories of special creation

This is a theory which states that all forms of life on earth have been created specially by a supreme being, commonly referred to as God. This Supreme Being is believed to have power over the universe. It is He who has through an order brought the earth into existence and through the same order, created in a systematic manner, all living

things on earth over a period of six days, with man being the last of His creations. This man is believed to have been given the authority or dominion over all other things created by God.

This is the origin of life that is most favoured by many Christians. The story is documented in the Bible in genesis Chapter 1. It is also on record that Dr. Light foot and Bishop, usher came up with an idea that God created the organisms in the world, all at once in the month of October in the year 4004BC.

Step II: Theory of Spontaneous generation

This theory of spontaneous generation is also known as the theory of Abiogenesis. It is a theory believed to have been proposed by Aristotle who is also described in some quarters as the founder of Biology. This theory explains the origin of all forms of life, as being due to a sudden change in non-living materials of the earth to living things. This change often described as a spontaneous change, is said to be due to certain natural forces, which are also described as "active principles" operating on these non-living material.

Step IV: Biochemical Evolution

It is today believed that life arose several millions of years ago from simple inorganic materials. It is also believed that life arose in water. It is believed that the environment in which life arose was a reducing one without oxygen, (i.e. anaerobic environment), but with gases such as nitrogen, ammonia, methane, carbondioxide and water vapour. From these simple inorganic materials, simple organic molecules such as amino acids were believed to have been synthesized in a reducing atmosphere with certain minerals serving as catalysts.

Later, these simple organic molecules formed bigger ones from which Deoxyribo Nucleic Acid (DNA) arose. These DNA molecules later transformed into simple forms of life which were heterotrophic in their nutrition, which later gave rise to bigger forms of life, which were not only complex in form, but with some of them being capable of photosynthesizing. It is believed that it is from these simple organisms that all other organisms including other aquatic, amphibians and terrestrial organisms arose.

Summary

In summary, the following trends can be listed on the origin of life:

(i). Life arose several million of years ago

(ii). Life arose from simple inorganic materials

(iii). Life arose most probably in water

(iv). Life arose in an anaerobic environment

(v). Simple materials from which life arose, transformed into simple organic molecules such as proteins and enzymes

(vi). These simple organic molecules later transformed into simple primitive forms of life

(vii). The simple primitive forms of life were as simple as the viruses and bacteria

(viii). They were heterotrophic in their nutrition

(ix). These organisms later gave rise to other aquatic, amphibians and terrestrial organisms.

(x). The newly evolved organisms were complex in structure, multicellular, some aerobic, some aquatic, some amphibians, others terrestrial

Evaluation: The lesson was evaluated as follows:

1. What is origin of life?
2. Explain briefly the Biochemical Evolution

Assignment

Write briefly on the hypotheses that have been postulated to explain the origin of life.

Control Group

Lesson 5

Lecture Method

School: College of Education, Akwanga

Level: 300

Course: Bio 325

Credit Unit: 2

Topic: Fossils and human evolution

Duration: 2hours

Instructional Materials: The developmental stages of human being from fertilization to the birth.

Behavioural Objectives: By the end of the lesson student should be able to:

1. explain the process of evolution of man, and
2. discuss
    i. Homo habilis
    ii. Homo erectus
    iii. Homo sapiens

Entry Behaviour: Student are familiar with different pictures of early man in biology textbooks, calendars and some are told stories about their great, great grand parents by their parents at home.

Introduction: The teacher introduces the lesson that Biologists have over the years accepted that there is evolution of living things. They have also accepted that living organisms are related to one another by descent with the accompanying modifications. Through fossil records in particular, the evolutionary history of a number of organisms, has been properly documented.

Presentation: The teacher presents the lesson to the student as follows:

Step I: Fossils of ancestral relatives of the modern man homosapiens have been gotten in different parts of the world at different times. Different names have also been given to these fossil specimens, whose features are well documented. It is from these documented pieces of information that the account below is being distilled. Some of the important facts on the evolution of man include the following:

1. The information on the evolution of man is gotten through fossil evidences assembled from different pasts of the world notable among which were East African, Asia, China, Indonesia and Hungary.
2. Prominent among the evolutionists whose works provide useful information on the evolution, of man, are LSB Leakey and his wife who worked in the Olduvai George locale of Tangayika in 1959 and Professor Raymond Dart whose work in Bechuanaland in South Africa in 1925, provided much information on the fossils of Australopithecus africanus.
3. Man is generally believed to have evolved from a lower primate stock.
4. Man is also in general, believed to have evolved from the primate stock which was found in sedimentary rocks of the Miocene and Pliocene epochs well over 20 million years ago.
5. The evolution of man involved biological changes involving the brain, the hands, muscular-skeletal system which brought about the bipedal stance, the jaws, the teeth, the height and overall size.
6. Besides the biological changes which the evolution of man went through, were the non-biological changes involving occupation, arts work, such as manufacture of stone implements, arts work, such as manufacture of stone implements, cultural evolution in areas such as use of fire and religious beliefs, involving mode of worship and ritual activities.
7. The main fossils that provide information on the evolutionary history of man are Dryopithecus africanus, and Australopithecus. Others include Homo habilis, Homo erectus and Homosapiens.

Step II: History of the Fossil-Homohabilis

There are three main species of the Genus Homo. These are Homo habilis, Homo erectus and Homosapiens- (the modern man). Homo habilis arose from the Australopithecines and had lived about 1.3 million years ago. They were believed to have lived in caves but also built shelters for themselves. They were also said to have used fire. Homo habilis had a cranial capacity of about 680cc. he was about 1.2 metres in height. His foot was similar to that of modern man-Homosapiens. His foot was arched and it had a big toe and a short opposable thumb. Homo habilis most probably manufactured stone implements. He had an effective power grip and he was good at handling objects. He was not capable of any precision grip such as handling a pen or a pencil. Leakey was of the

belief that Homo habilis was more representative of the true basic stock of man than Australopithecus.

Step III: History of the Fossil-Homo erectus

Fossils of Homo erectus have been found in Africa, Asia, China, Indonesia and Hungry in Europe. It is strongly believed that certain human fossils, have been given such names as pekin man, javaman and Heidelberg man, were most probably different samples of Homo erectus found in different geographical locations which expectedly are equipped with individual variations. Homo erectus was believed to have evolved from Homo habilis and too give rise to Homsapiens-the modern man. Homoerectus had a cranial capacity which was between 775 and 1100cc. This range of skull size over laps that of the lower-range of modern man. The bones of the cranium were thick and had a medium stature. He had a low brain case with the sides tapering upwards. His limbs were like those of modem man. He walked on the two legs like modern man. His face was reduced and the chin was only slightly developed, dentition was similar, though larger than that of modern man. Homo erectus was also like his predecessor, not capable of precision grip.

Biological changes of Homo erectus, this fossil man exhibited the following features of cultural evolution

– He was probably religious to some extent
– He buried his dead relations
– He carried out some rituals and probably collected skulls. Homo erectus lived close to sources of water such as banks of streams and shores of lakes. He also possibly occasionally lived in the cave.

Step IV: History of Homosapiens is the first thinking man, with a well developed brain, well built body, effective hands and speech. He is believed to have evolved from Homo erectus. His far more advanced than any of its predecessors. He not only used stone implement, he actually practiced art. He hunted and at a later stage in his early life, he actually practiced herding and he also domesticated some animals which were formerly his prey. He produced his food from plants and animals around him. He developed crafts such as pottery for producing his domestic utensils. He lived in communities and was spread over many region of the earth and engaged in labour specialization. He therefore had members of the species as hunters, millers, weavers, tillers of soil and so on. The earliest recognizable modern man is swanscombe man who lived between 150,000 and 25,000 years ago in Germany and England.

Summary

The two critical steps in the evolution of humans were the evolution of bipedalism (walking on two feet) and the enlargement of the brain. The earliest hominids and the direct ancestors of humans belong to the genus Australopithecus. They appeared in African about 5 million years ago. They were small hominids, standing 3 to 4 feet tall and weighing from 50 t0 100 pounds. The genus Australopithecus gave rise to humans belonging to the genus Homo. The first species of this genus Homo habilis, appeared in Africa about 2 million years ago. Now extinct, the people of this species are considered human because they exhibited an intelligence for greater than their ancestors by making tools and clothing. The second species of Homo, Homo erectus, appeared in Africa approximately 1.6 million years ago. These people used fire, built shelters, fashioned sophisticated tools, and exhibited culture. Homo sapiens probably evolved from Homo erectus about 200,000 years ago. Homosapien is the first thinking man, with a well developed brain, well built body, effective hands and speech. He produced his food from plants and animals around him. He is engaged in labour specialization, he developed crafts and hunted.

Evaluation: The teacher evaluates her lesson by asking students questions based on what they are taught:

1. Give 3 important facts about evolution of man
2. Write briefly on Homo sapiens

Explain the following

i. Homo habilis

ii. Homo erectus

APPENDIX H

ANOVA Analysis of variance for unscientific preconception test of students in evolution concepts in the State colleges of education in North Central, Nigeria

ANOVA

	Sum of squares	Df	Mean square	F	Sig	Remark
Between Groups	740.042	2	105.720	10.136	.001	S
Within Groups	10148.486	973	10.430			
Total	10888.528	980				

Significant at $p < 0.05$

In order to determine the groups that show significant difference scheffes' LSD Test was conducted. The result is presented in Table below:

Scheff's

Colleges	N	1	2	3
COE ORO	66	5.5758		
COE ZUBA	64	6.6719	6.6719	
COE GINDIRI	45	6.7778	6.7778	
COE ILORIN	40		7.8750	7.8750
COE MINNA	150		7.9600	7.9600
COE AKWANGA	127		8.0000	8.0000
COE OJU	273		8.3773	8.3773
KASTINA-ALA	216			8.7870
Sig		.600	.137	.869

APPENDIX I

Analysis of variance (ANOVA) statistics for Pretest EAT was given in order to determine the level of significant among five colleges of education with higher unscientific preconception.

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig
Between Groups	399.742	4	99.936	4.208	.002
Within Groups	19020.983	801	23.747		
Total	19420.726	805			

Scheffe

Schools	N	Subset for alpha= 0.05	
		1	2
COE Akwanga	127	6.9291	
COE Ilorin	40	7.9377	
COE Kastina-Ala	216	8.1157	7.9377
COE Minna	150		8.1157
COE Oju	273		9.0467
Sig		.542	9.5500
			.222

APPENDIX J
Item Analysis of EPT Test items

S/N	(A) $F = \frac{R}{T}$	(B) $D = \frac{Ru - R_1}{\frac{1}{2}N}$
1	0.58*	0.58
2	0.60	0.42
3	0.45	0.48
4	0.38	0.60
5	0.67	0.39
6	0.70	0.47
7	0.86*	0.59
8	0.39	0.35
9	0.60	0.43
10	0.61*	0.51
11	0.43	0.33
12	0.64	0.59
13	0.45	0.46
14	0.77	0.58
15	0.83	0.33
16	0.34	0.65
17	0.62	0.41
18	0.70*	0.45
19	0.52	0.46
20	0.62	0.37
21	0.27	0.44
22	0.16*	0.47
23	0.47	0.55
24	0.40	0.56
25	0.70	0.64
26	0.51	0.71
27	0.60	0.59
28	0.77*	0.42
29	0.17*	0.50
30	0.30	0.70
31	0.40	0.65
32	0.35	0.41
33	0.40	0.45
34	0.58	0.46
35	0.50	0.58
36	0.70	0.42
37	0.65	0.48
38	0.17*	0.51
39	0.46	0.58
40	0.62	0.46

41	0.58	0.55
42	0.60	0.56
43	0.48	0.50
44	0.16*	0.48
45	0.52	0.49
46	0.60	0.55
47	0.55	0.58
48	0.34	0.35
49	0.40	0.50
50	0.48	0.46

F = Facility Index

D = Discriminatory Index

* = Items which were reconstructed

The types of unscientific preconceptions held by NCE III biology students in evolution concepts are as follows:

a. Unscientific Preconceived notions, these are popular notions rooted in everyday experience

that is what you come across or see around you.

b. Non scientific beliefs e.g. views learnt from religion, culture, mythical teaching among others.

c. Conceptual misunderstanding, which arises when learner is not well taught or misinterprets the concept taught, it resulted to unscientific preconceived beliefs.

d. Factual preconceptions, these are falsities learnt at early age and retained unchallenged into adulthood.

e. Vernacular preconceptions. These arise from use of words that mean one thing in everyday

life and another in a scientific context.

APPENDIX K

Students Unscientific Preconceptions from the Student Scripts

Under listed are the identified unscientific preconceptions that the students harbor on the concepts of evolution. These were collected from the written responses of the students to the unscientific preconception test on evolution (UPTE). These were used as distracters in the construction of the evolution performance test (EPT). They are as follow:.

- Mutation as the forces by which a part of body is not functioning.
- Homo habits this is the process by the gender of homous is being.
- The theory of fossil importance of evolution the are importance because they to understand what have folted before or to understand the teacher that as teaching us.
- The origin of life: this is the process by which the life of human was beginning by the time of the old fathers in the years 400BC.
- Using theory selection environment select it self as an place to live and do all the activities that are so post to do in environment.
- The geographical isolation they are implication on animal are they cannot move as they want.
- Matation is the death of living thing is a geographical area
- Types of chromosomal mutation
  - xx chromosomal mutation
  - xy chromosomal mutation
- Evolution means the evoluting of body organs of an animal
  The implication are:-
  - death rates
  - lack of foods
  - competition
  - temperature
  - pressure
- The term geological timetable is discuss as the use of stratigraphy.
- Intra specific competition is the process by which living organism of different species compete for their food.

i. mutation as the process by which living organisms that developed in different stage maturity.

ii. types of chromosomal mutation:-

- defective chromosomas
- genus chromosomas
- mutation chromosomas
- Evolution is the terms use in express how the world all living creature that lives in it was created or developed into existence.
- Life was come into existence when card use the mould man and he breath in his noise and that is where life begins.
- Vestigial structure explain evolution as the living organism that are live on the earth.
- The implication of geographic isolation of animals is base on the made of feeding, locomotion, reproduction and their adaptive habitants.
- Biologists consider us the meaning of mutation us the arrangement or movement of organism.
- evolution involves the living of organismal human from one specie to another.
- Life standard as far back ago before thing where created and put into the consider of human and living organism to produce and manufacture their foods and maintain themselves.
- Inter specific competition is just the struggle between organism of the same species in a given habitat.
- Intra-specific competition is the different species struggle for their survival in a given habitat.
- Evolution is the rotation of planet that exist on earth.
- Survival of the fitness is how normal people who have two eyes origin of life come in existence as a result of cells forming tissue, tissue organ and organ to system.

Geographical isolation on animals:-

i. Preservation of food for animal

ii. Avoidance of destruction

iii. Communicable disease

- The origin of life as the way people manage to survive and the way people chose to do with the cell bodies.

- Survival of the fittest is how organism try to survive in a habitat base on the co-operation and ability of been fast and good in any aspect.
- Charles Darwin as the father of taxonomy explain the process of evolution as the process by which the world evolves.

  i. mutation is the replication of DNA and these mistake can result to sickle cells.

  - genes chromosomes

  -Mutation means the process in which animals immune to adapted in an environment.

  Types of chromosomal mutation

  - insertion
  - substation
  - frame shift

- Evolution:- is the process by which different kinds of living organism are believed.
- Geological timetable is the tabular arrangement of geology.
- intra-specific competition and interspecific competition between the animals organisms.
- the biologist consider mutation as the process by which one part of the body is not functioning efficiently.
- mutation is a process which body or organ of a system is capable of what is to be done.
- evolution:- simply means changes in stages.
- the important of fossil of evolution is to known how an animal come about to be who he is.
- intra-specific refers to the competition outside the country inter-specific competition is the competition within the country.
- life was originated from how-sapiens.
- The origin of life specifically in organisms cannot just start, there must be a fertilization that occurs between the male and female sex cells which lead to the formation of a fetus in the female organism.
- The origin of man was as a result of Homo-sapies whereby a man use an old farm implement for farming man also eat fruits and drop for further germination. The origin of man stated in accent day when there was no availability of tractors for farming.
- The theory of lamarks evolution status that the body organ is made up of the eyes, nose, skin, tongue which are the sense organ in the body.

  mutation means the total number of ded. people per year.

- Evolution refers to the changes in environment it is the changes that comes pearly the harm marker the dry season and raining season which occurs years after years.
- Like being but the smallest units the atom which is said to be the smallest unit of life. Life begins in an atom inside the nucleus or an element which develop.
- The lamark theory of evolution base on use and disuse of body organs/parts is that an organ or parts can equally by moving its whole body or can equally move. Through the process of sight.
- The term Geology time table came from the two Greek term "Geo" means the earth and "logos" means to study this simply means that Geology timetable is the scale of preference prepared basically for the study of the earth.
- Raezoice:- is the functional structurally body of an organ.
- mecozoice:- is the functional internal body of an organ while
- cenocoice:- is the general functionally and poisons organ in the body.
- intra-specific and inter-specific is the internal and external consetition of adapting major areas of living.
- mutation-simply means to born or get bregenate to young ones.
- evolution simply means to express a view in a lesson plan at the end of lesson.

    a. Homosapiens- is a human being e.g man

    b. Homoesreslus – is a living organism e.g brids

    c. Homoesreslus – is a part of living or organism.

- It bringing from the eggs and later on the maggots and get brings and mature.
- Study different organism and known their life cycles
- Geological timetable:- is a process whereby a person controlling cattle on a piece of land.
- Evolution simply means is the type of competition in the population through generation.
- The origin of life describe as scientific problems by which yet solved in three stages.

    Types of chromosomal mutation:-

    - adaptation
    - reproduction
    - respiration
    - fertilization.

- Evolution is defined as life style of living organism.

- The importance of fossil on theory of evolution is that fossil is responsible for supporting of tissue in an living organism.
- The origin of life: these formulate in evolution to genetic which fertilization take place by means of reproduction were egg are fertilized to produce.
- Charles Darwin explain the theory of evolution as how inheritant of living organism of the same sex cell to were it originate.
- The structure of vestigial on evolution is that the individual of the same sex cell it has it own cell inform of circular form.
- The survival of the fittest are organism of the same structure or characteristic that surviving in a particular area or environment.
- mutation is the process by which the body it's own way of surviving.

  Types of chromosomal mutation:-

  - stomarch chromosomal mutation
  - enzymes chromosomal mutation
  - calcium chromosomal mutation
  - digestive chromosomal mutation
- evolution is the process by which common movement are been observed in a situation.
- the origin of life is by the result of the presence of heart beat and the presence of all the blood cells.
- Charles Darwins explained the process of evolution as the way by which human been get to change from place to place.
- Mutation is the relationship that exist in organism where one is benefit from the other without causing harm.
- Origin of life begins right from the cell with nucleus and order cell components.
- Lamarks theory states that body organ increase size due to cell enlargement.
- Intra-specific competition involves different species within the same species or environment.
- Geographical isolation on animals help the animal to live.

  Type of mutation

  - telophase
  - interphase
  - melophase
- Geographical timetable is the seasonal time.

- Charles explanation on evolution says each stage has different charge structures.
- Mutation is the existence of living organisms.
- Chromosomal mutation are of different types

  a. blood chromosomal

  b. skin chromosomal

  c. behaviour chromosomal
- Evolution simply means rotation
- Environment does not just exist it is part of man's ideal.
- Mutation means any alteration

  a. x chromosomal

  b. y chromosomal
- Geological timetable is an adaptation of one elaborated by les
- Intra competition takes place outside the body.
- Evolution is the process by which the underground elements moves to the surface of the earth.
- Survival of the fittest: is the process into which the living organism have the welfare.

  Types of mutation

  a. the liver

  b. tissue

  c. epithelia
- Geological timetable is a table showing the event that goes on in an environment.
- Paleozoic, Mesozoic and Cenozoic are simultaneous means or analysis that make up of living things.
- Live start as a result of fusion for male and female garment
- Favourable growth and development.
- Mutation biology consider if meaning as the change which occur as permanent.
- The origin of life started as result of evolution.

  Types of chromosomal mutation:-

  - Genetic mutation

  - Food mutation

  - Land mutation
- Geological time-table: is set as a guidance or direction to establish common activities.

- Mutation is where plants and animals posses to equal lives.
- Types of chromosomal mutation male and female.
- Evolution is +explained as the changes organism from the beginning to date.
- The origin of life:- Life comes into existence as a result of creation. God is the creator of every creature.
- The implication of geographical isolation or organism is:-

  a. the organism is either sick

  b. the organism is fit into the environment that it find itself.
- Paleozoic means geologic era.
- The reason for diversity of organism is as a result of different organism.
- Mutation duel to the science background of biologist they view and observe the mutation and know it can work as chromosomal mutation.

  Types of chromosomal mutation:-

  a. Biotic

  b. Abiotic

  c. Intuition
- The origin of life: the origin of life beings with creation of the heaven and earth when God created world.
- Charles Darwin explain the evolution by say, evolution of a period of an organism is undergone on heat period.
- Vestigial structure have been used to explain evolution base on structure looking and you discover that it is a structure of evolution.
- Evolution is the ability of an organism to exist from the formation of another organism or is the existence or formation of organism.

  Types of chromosomal mutation

  - Mutation of food

  - mutation of land

  - mutation of property
- Evolution is the process by which different kinds of living things or organisms developed to produce.
- Geological timetable: is the way and how geologist is.
- The origin of life is the scientific problem.
- Mutation is the process by which an organism is arranged in series of an organism period of both or pregnant.

- Evolution is the origin and the conception of human organism.
- The origin of life: The origin of life in an individual begins in the womb, when the male and female are together the man introduce the spermatophyte the (sperms) to the female ovum. Then the woman get pregnant. That is the zoites begins to form blood.
- Charles Darwin explained the process of evolution as use of hybrid and unhybrid experiments to determines the evolution.
- it gives an accountable of evolution.
- The following are implications of geographical isolation on animal it makes the other animals to be alone.
- The term geological timetable: it refers to the effective use of time, the duration of doing things.
- Patrozoic is the simply paratism misozoic.
- Evolution is the natural being of plants and animals heavenly bodies.
- The important of fossils on the theory of evolution includes.
  a. it gives nutrients to the soil.
  b. it improves the soil texture.
- Intra-specific competition refers to as to the competition that take place outside the environment.
  Intra-specific competition refers to as the competition that takes place within the environment.
- Mutation in biology can be seen as insufficient growth as a result of lack of nutriential materials.
- Evolution can be defined as the morphological changes.
- Origin of life: Life generally can not be pinpointed were and how it starts but according to records life started in a very simple way until this present complex stage.
- Mutation is the replication of DNA and these mistake lead to sickle cell anemia.
  Types of chromosomal mutation
  - Deletion chromosomal
  - DNA chromosomal
- Life find it origin from God that is when God created man he gave life to him.
- The term geological timetable is the table use by geographies.

- People believe that man was created by God and others says that man came into existence as a result of evolution.
- Mutation is the study of human behaviour.
- The origin of life: Life is originated from the organ that are combine to form life such as organ species.
- Charles Darwin discover that evolution is the processes by which organism can exist.
- Is a can of selection that done within the organism in the same environment which is favourable to them.
- Geological timetable: is the time taken to read a distance of a land.
- Mutation means a sudden change in the genes.
- Evolution is the process of finding out about the origin of man on the universe.
- Evolution theory to know where human beings were first found on the universe through the identification of human bones.
- It tells us of how man evoluted.
- The origin of life starts when the male and female organism come together when the male and the male release sperm it fertilized the egg in ovaries of the female.
- The implication of geographical isolation on animals are:
  a. It makes them difficult to adapt to new environment.
- Mutation is the process by which animals shade off their outer layer of their body.
- evolution is the process of change in the stage of a living organism for example man.
- It is because of the science to understand in such a that scientist.
- Evolution means organs that form in the body.
- Original life the mean the behaviour of human that is been environment or in the community.
- Survival fittest is when organism are in many species in environment order cannot grow up because of feeding that given to them
- Evolution is the process of through or by which man is considered to evolve from as propounded by Darwin.
- The origin of life: deenario, it is imperative to understand that life is beings of the spirit order relluting the nature of the one that created it so.
- Mutation is the restriction of generation trails.

- The origin of man can be travel through different ways first which is religion (Bible) and through views and research.
- Geological time-table is the adaptation one elaborated by the commission.
- The origin of life was the scientific problem which is not yet solved and it is attempted to solve in two stages and three hypothesis.

  Types of chromosomal mutation.

  - substitution
  - insertion
  - frame shift
- Evolution is the process by which different kinds of living organism are believed to have developed from early from during the history of the earth.
- The origin of life here have to do with a cell they meet together in hundreds or thousands they from what they called tissue.
- Vestigical structure gives very clear-explanation what evolution is taking about in vestigial structure it develop gradually as it happens in evolution.
- Geological time-table: It is the time-table by a specific purpose.
- Intra-specific competition involves only people or organisms within a geographical environment.
- Inter-specific competition is the competition which is composed of people or organism from another environment.
- Mutation means been resistant of something you need to do.

  Types of chromosomal mutation:

  a. male sex chromosomes

  b. female sex mutation chromosomal.
- The origin of life in genes chapter 1:30 says God creatures and sees that these creatures are good and he made Adam and sent air to his nostrils and Adam was alive.
- Charles Darwin explained the process of evolution as the change and development in the given society.
- Vestigial structure have been used to explain evolution because of the beauty of the environment.
- The survival of the fittest is the ability to do work.
- You are free to walk two legs.
- Free to make use of you five sense organs.

- You are not to remove one of your breast.
- Charles Darwin theories of natural and sexual selection apply to humans as they do to any other specie s recent edition of his most famous book an origin of species after feature a schematic of human evolution and the given in fact there is little mention of human evolution.
- Mutation can be defined as the mutationing of a part of the whole organism it is the situation whereby a particular element of a component is not functioning.

  Types of chromosomal mutation

  a. salivary gland

  b. eye focus problems

  c. short term memory
- Evolution is he gradual change that occur from one stage to the other.
- The origin of life is generally agree that all life today evolved by common descent from a single promitee life from.
- Evolution is the process when animals begin to experience or having feeling on meeting.
- The origin of life: life started as a result when God said let us make man in our own image and then God used soil and make man then he breath in his noise and man started to breath.
- The environment theory of natural selection is based on how quality of that species and capable of attaching disease.
- The process of isolation of animals make sure that all animal are tree of disease but implication is that some infected animal transmit the disease from one animals to another.

  Types of chromosomal mutation

  a. deviation chromosomal mutation

  b. invention chromosomal mutation.
- The fossil is natural decay of materials.
- The origin of life: firstly started as the union between the sperm and the ovary.
- Mutation is the study of life, plant and animal and it can change someone's life.
- Evolution is the situation which tend to address the reasons for diversity of organisms.
- Life begins when man was in the bush he life to gather fruits and wide animals as food.

- Charles Darwin explained evolution as the diversity or organism.
- It is the ability of organisms breathing over another and the environment that is the select through favourable condition.
- The survival of the fittest is to live freely in the habitat without any disturbance.
- They destroy the food of human beings.
- They pollute the environment with physics and environs.

  Types of chromosomal mutation

  a. genotype

  b. phenotype
- Evolution: is the history of origin of organisms that can be tend back it background.
- The origin of life: Generally it is believed that it is God breath in life.
- Vestigial structures: Structures that were used decades age kept references. Some of them were buried under the ground and they started for more than 100years and used to explain evolution.
- Geological time-table: Is the changes that exist in different and organism move to meet the favourable time. Organisms that may like in dry areas with.
- Life has no specific origin, but in the religious or biblical aspect originated when God started his work of creation.
- Evolution is the process of reviewing of the past to be considered in present in order to create new ideas.
- The origin of life here begins with the creation of life and the beginning of your knowledge.
- Mutation means being tocust and intense in the biological state of beings.
- Is only on the type reproduction that they produce.
- Charles Darwins explained the process of evolution as the beginning of the earth and have it function.
- Evolution is the process by which different living organisms believed to have developed from their history of origination.
- The importable of fossil in theory of evolution are:

  - the biology of scientific problem that yet to be solved.
- Charles Darwin explained the process of evolution that the sexual selection of member or there are special determines the quality of the offspring.

- Mutation: It is the process whereby observable period set out for discovery of natural organism most that are on the earth surface or nurtured.

  Types of chromosomal mutation

  a. osmosis

  b. chromosomes

  c. protozoa

  d. pdt mutation
- Move to a place where there is no rain.
- Life is something that exist and can be able to carry out activities.
- Charles Darwin explained evolution as the change that occurs and later on some of the changes may not be in a continuous process, that is discontinuity.
- Survival of the fittest:- is the reign of people who have power.
- Geographical isolation on animal may lead to:

  - The death of the isolated animal.
- Evolution base on a child from a childhood may have some certain characteristics. Some of the characteristics will suddenly stop for instance rolling of a tongue, crowing on the kneel etc.
- Homosapiens is the scientific name of a man.
- Mutation – is the change that occur within a life of an organism.

  Types of chromosomal mutation:-

  a. recessive mutation

  b. physical mutation

  c. sensitive mutation.
- Evolution: This is the living organism experience as heat period and also react to different changes.
- The origin of life:- Life specifically comes from God at the time when he create a man in his image and likeness.
- Vestigial structure explained evolution as just moving that is increasing rapidly. The importance of fossil on the theory of evolution is that the remnant of animals when they decay they go down the earth crust to from crude oil.
- Evolution:- can be defined as a process by which present organism or water move from higher concentration to that of low.
- The origin of life: us that life compresses of cell that in necessary in the body system and unable and all the activities to take place at as small unit of life.

- Environment select itself: as an area of land whereby a man live and continue with life activities or place by which biotic and abiotic compound live and manage each other.
- Vestigial structure explain evolution: as a theme of live looking structure as green or permeable tower.
- Survival of fittest: it is said be a unicellular cell wall and according it classes protozoa served as main polypharacha.
- Geographical isolation or animal:- mostly deals with this place of living and there cat it is more advisable that the animals isolated in a good areas as their may live well.
- Geological time-table:- It is a usual academic calendar time-table that has plan for academic staff in order to aid the student.
- Paleozoac means animals with many heads and legs.

  a. Mesozoic animals with many walking legs.

  b. Cenozoic animals with about 6^{th} appendix.
- Mutation is the number of living things in a geographical area.

  a. Pressure
  b. temperature
  c. human heredity
- When a man release his sperm on a woman's virginal acid fight with the

(1)
(2)
(3)

Question (1)

Chromosomes have many types

Question (11)

Study different Organism and known their life cycles.

Question (0)

Survival of fittest :- Simply means total Organism in particular place that huzoor to sustain their life.

Question (7)

Every Organism must known where they are moving or get secrity themselves.

Question (1)

Biologist get meaning of mutation.
Mutation :- Simply means to born or get bregenate to young ones.

Question (4)

Homo sapiens – One Character
Homo Erectus – One behavioural
Homo habiles – one Life Organism.
OR
Homo Sapiens – when you like monkey
Homo habiles – ~~When you like Chimpanzee~~
Homo Erectus – When you are normal on your fifties.

Question (3)

Evolution : Simply means to express a views in a lesson plan at the end lesson.

Question (2)

Question (4)

1 Homo sapiens – is a human been eg man
Homo habiles – is a non living organism eg bird.
Homo Ecrestus is a part of living Organism.

Question (5)

Question 6)

it bingins from the eggs and later on the maggot and get brings and mature.

Question (7)

Question (8)

Mesozoic is from the begining. eg Head
Cenozoic is from the Second eg abdomen
Palezoic is from the Third eg ~~thorax~~

Question (10)

Evolution stand to address the reason of diversity of Organism, because it study the behavioural of different Organism in a Community.

Question (11)

both of them have ~~the~~ same life Organism.

Q1

Biologist consider mutation as the process by which living organisms that developed in different stage of maturity

Q2

1. Detective chromosomes
2. Genus chromosomes
3. Mutation chromosomes

Detective chromosome are the one that can be detected in body of the parents or matured once.

Genus chromosome are one that can transfered from parent to young ones.

Q3

Evolution is the term use in express how the world and all living creature that lives in it was created or developed into existence

Q4

the relationship between Homo habilis, Homo Sapiens and Homo erectus is that all of them are belong to the same kingdom, phylum, class, orders and genus only the specie name is different

Q5

the importance of fossil on Theory of evolution is that it is living organisms from the evolution that we get the fossil that we used for practicals or experiment

Q6.

life was comes into existence when God use the moist man and He breath in his noise and that is where life begins.

Q7

(11) The implications are;

(1) Death rate

(2) Lack of food

(3) Competition.

(8) (i) Temperature

(ii) Pressure

(iii) Relative humidity.

(b) The Origin of man was as a result of Homo-Sapiens whereby a man use an old farm implement for farming. Man also eat fruit & drop for further germination. The origin of man started in acient days, when there was no availability of tractors for farming.

(12) The theory of Lamarks evolution states that the body organ is made up of the eye, nose, skin, tongue, which are the sense organ in the body.

(5) (c) Chromosomal

Answers

(1) mutation is the death of living thing in a geographical area.

(2) (i) XX chromosomal mutation

(ii) XY chromosomal mutation.

(3) Evolution means the evolving of body organ of an animal.

(10) Survival of the fittest is the competition of living organisms among themselves. What animals compete for are;

(i) food

(ii) Shadow

(iii)

(16) Diversity of organism means the difference that exist in living organisms. Therefore evolution tend to address the reason of evolution in the difference that exist among them.

① mutation: biology consider it meaning as the change which occur as permanent.

③ evolution: is the rebirth of ~~animal~~ animal on the surface of the earth

⑥ the origin of life started as result of ~~evolution~~

⑪ the implication of geographical location on animal
=> when the animal are isolated from each other the population will not grow very well.
=> there will be intra-specific competition
-> there will be adaptation of habitation

⑭ Intra-specific competition: is a kind of competition that exis among animal of different species. And while inter-specific competition: is a kind of competition that exist among ani of the same species.

⑤ geological timetable: is set as a guidance or direction to establish a common activities

⑩ Survival of the fittest: those are organism that are the lucky organism and could occupied a specific area.

② the chromosomal mutation there are
~~Genetic mutation~~
~~Food~~ mutation
~~Land~~ mutation

=> Genetic mutation: this ~~dem~~ kind of mutation is permanent and cannot be change by any means of biological, ~~or~~ chemical or physical

① Biologist Consider the meaning of mutation, due to the Seciencu blackground of a biologis thy view and observer the mutatin and know it can work as Chormosmal mutation.

② The different type of Chormosmal mutation are follow :

① Biotic
② Abiotic
③ Infution

Explanation of one type of Chormosmal mutation

- Biotic : This is a porcess of Study of animal.

③ Evolution : This ded with the period time when an live organsim is unheat period is kind of evolution

(b) The origin of life : th origin of life being with creation of the heave and eart when God Creafed world. He Created a man and gave him a life is form thy te origin of life being.

⑤ Te important of fossil on te theory of evolution is know te period when an organism is on heat.

⑦ Charle Darwin explain te process of evolutin, by Say, evolutin of a period of an organism is undergone on heat pano.

⑧ Te environment select for Uself favourable tract using te theory of natural selection. first, environment is a place where animal and plant are develop and for that te natural of selection of environment Should be environment habitat which is a place when both plant and animal are habited themself.

⑨ Vestigial structures have bee- used to explain evolution base on structure looking and yo discover that it is a structural of evolution

10 The survial of te fittest - is a process of testfly thare suveetable te food through te survial

(1) Mutation: is the permanent change.

(3) Evolution is the process by which different kinds of living things or organisms developed to produce

(13) Geological timetable: is the way and how geologist

(2) Mutation of food.
Mutation of land.
Mutation of property.

⇒ Mutation of land: It is the process by which a particular piece of land is permanently changed from where a piece of land which use to have good yield terns to produce pooly.

(14) Intra-specific competition: It is the process where by living organisms of different species compete for food
Inter-specific competition: is the situation where by living organisms of the same species compit for food.

(4) Homo habilis: is a species of Homo of living things the gelasia and early stage of man.

Homo Sapiens:

(16) Evolution tend to address the reasons for diversity of organisms because of all the living organisms are

1 mutation is the process is ~~the process~~ by which an organism is arranged in series of an organism, periods of birth or pregnancy.

2. - genetic mutation: it deals with origin & begining of organ
- nuclei mutation etc.

3. Evolution: is the origin and the conception of human organism.

4. The relationship between Homo habilis, Homo Sapiens, and Homo erectus is that
- it deals with the human organism
- Homo sapiens which is man.
- Homo erectus express the modern man in the ancient days, the africanus.

5. The importance of fossil on the theory of evolution are
- it helps to bring out new development of offspring
- it also assist to know the kind of offspring produced by organism.

6. Description of origin of life: The origin of life in an individual begins in the womb, when the male and the female met together, the man introduce the spermatozoa the (sperms) to the female ovum, then the woman get pregnancy that is the zoites begins to form blood, then suddenly it developed into a child, the placentation in woman helps to

13 The ~~geu~~ term geological timetable is ~~the~~ table use by geographer. ~~it has on it the date rate~~

14 Intra specific competition is the competition between ~~a spee~~ people of ~~the~~ same place or environment while inter competition is the competition be people of diffgerent place countries. ~~But all of this competi~~ the similarity between this is that is competition.

15

16 Evolution tends to adress the reason for diversity of organism. Because, if you alook at the case of man ~~and~~ many people believe that man was created by ~~god~~ God and ~~some be~~ other say that man came into exsistend as a result of evolution and this bring about the diversity of people in the society. So for this reason, as man is an organism you can see as ~~the~~ how evolution bring diversity among organism.

Answers:

1). Mutation :- is the replication of DNA. and these mistake lead to sickle cell. or birth rate.

2 These includes:

i) Delection chromosomal

ii) DNA chromosmal

DNA: is the deoxygennated acid which help in production of the new chromosomes of

3) Evolution :- is the process creating thing out of nature through natural resources.

4).

5) The important of fossil on the theory evolution that it help in finding natural resources

6) life find it origin from God. that is when God created man, he give life to him by breathing into him the air.

7)

8 Environment select for itself using the theory of natural selection by getting for itself all that environment has. i.e the an organism that live on the environment and other things.

9

10 Survival of fittest :- is simply the process by which fittest survive.

11 The implication are:- Emmigration, immigration, Death rate birth rate.

12

11. the geographical isolation on animal: It means the weather condition that can be affected by animal. or weather that organism can survive.

12.

13 Geological time table: is the time taken to ~~Red~~ Read a distance of a Land.

14 Intra-specific compitition means. the interaction ~~organism of~~ of ~~these~~ organism of the same species to know doe who can survive. While inter-specific compitio is interaction of different organism to know does that will survive.

(1) according to biologist mutation is the study of the human behaviou.

2

3 Evalution is the way in which anganism can excist for the formation of another orgenism.

4 Homon habilis it help anganism to transform Homon sapien

5

6 the origin of life: ~~is the~~ life is originated from the organ that are combine to form life suchas organ, species.

7 Charles Drawin the proces of evalution: when he conducted an experiment, He discover that evalution is the processes by which organism can exist.

8 The eavironment seleted for itself favarable fraits using natural selection : is a coin of selection that done withing the organism in the same environe + ~~to~~ which ie favvereable to them

9

10 Survival of the fittest : it is known that when organis are produce in an environment where were their is scacity of food and does that can servive are survival of ~~fittest~~

(1) Mutation can be define as the process where organisms compete with one another for food that will help them survive in an environment.

(2) (i) Field wave (ii) rotational wave.

(3) (i) genenotype (ii) phynotype (iii) gene

genenotype is the process whereby a female with genotype A·B and a male with genenotype A·A when they get married and give birth to a child they transfer gene to their children.

(4) Homo habilis: under the evolution of man.

Homo sapiens: this refer as man or human being

5 Fossils: this are remains of an organism which has decay examples skull, legs bones, e.t.c

(6) No idea

(7) Evolution: Simply mean an organism changing from simple to complex form. what cause evolution is knowledge, as man or organism get more understanding and knowledge he get to imaging some certain things around him which make him to used and have more ideas.

(8) No idea

(9) No idea

(10) No idea

(11) Survival of the fittest: this simply the competition of an organism in a particular habitat to survive and and live in a particular environment, if an organism is unable to live and survive in a particular habitat he die.

(12) No idea

(13) environmental factors are: temperature, humidity, atmospheric condition.

(14) the acceptable theory of evolution is by Darwin

(15) No idea

(1) Mutation: is the transfer of traits from parent to offspring. It has to do with Genetics.

(2) Electromagnetic waves that cause mutation are:
(1) ocean current
(2) wind
(3) disturbances.

(3) Types of chromosomal mutation are;
(1) (DNA)
(2) (RNA)
(3) synovial fluid.

(4) Homo habilis: are species that have the ability to holds things.

Homo sapiens: the species that ~~the~~ have thinking and reasoning E.g Human being.

(5) fossils: are dead remains of plant & Animals.

(6) Alternative names of fossils evidences are
(1) Charle's Darwins

(7) Evolution: means gradual changing with respect of time. It is the transitional from one state or form to another.

Question 1

Biologist Consider mutation as the process whereby animals come together in other to produce the same offspring.

Question (2)

Chromosomal mutation are of different types, There are:

i) cells in the chromosomal = is the process whereby the cells exists in the chromosomes which, leads to the formation of an organisms or embryo

2) tissues in the chromosomal = is the process whereby all the cells is been collected in other to enable reproduction.

Question (3)

Evolution is the process whereby an organism is being form or evolution is the formation of living things, how they come into existance.

Question (4)

The relationship is that they have the same features and similarities in the sense that they posses all the characteristic of living things, they are from same families.

Question (5)

fossil on theory of evolution: (1) it hences it the more.

Question (6)

The origin of life, life started in the year (2000) as evolution where man, was the head of other animals, man as an higher animal have authority over other animals, where man develop the sense of domesticalise some of the animals and the wild animals where in the forest because of their nature them man begins to utilize his resources.

Question (7)

Charles Darwin explained the process of evolution by making further investigation, observation, research, test and to crown it all experiment it with plant and animals.

Environment select for itself favourable traits

Question (8)

i) Mos because of the mode of feeding

ii) Mos because of the different evolution

Question ANSWER

1. mutation to biologist simply means the resemblance or inheritable characteristics posses by an organism/ie through their parents)

2. They are: (i) Dominant and (ii) Recessive Chromosomal mutation.
(i) Dominant chromosomal mutation is one which inherited, possess almost the exact character of the parent.

3. Evolution: simply means birth or the way an organism is bring about or come about.

4. Both Homo habilis, Homo sapiens and Homo electus falls on the same Kingdom called animalia. and also they are genetic terms use in describing higher organisms Man, Bambors and so on.

5. fossils are important in the theory of evolution because, they help in studying or understanding the theory. and

6. Life to many Scolars come about as a result of the passing of natural air in fossils.
To some religious bodies like The NIKST, Roman Catholics etc believed that God Created bones after which he join them together. attarched ligament and flesh and blood and then introduced breath into the structure and it becames life. Life is then a continuous multiplication or reproduction.

7. The evolution is a natural phenomena of life

(5) Live start from a living cell. This is possible as a result of the fusion for the male and female gament ~~from~~ fertilization. This union may be animals of the same species.

11. Geographical isolation or animals has the following implications
(i) It enable ~~growth~~ favourable growth and development.
(ii) It also has adverse effect on the live of the organisms.

16. Evolution like any other favorable factor, addresses the reason for diversity of organism in the sense that, it great an enabling environment for the growth of different environmental resources.

1. Mutation is defined as the union of various cell organs functioning as a distinct unit.

2. The types of mutation include;

(i) The liver
(ii) Tissue
(iii) Epithelia

Epithelia is a kind of mutation which is responsible for Smoothening of the body organs. An example is provision of lubricant during swallowing of food material in the gullet.

13. Geological timetable; This is a table showing the event that goes on in an environment. That is, it shows both the climate and weather condition of an environment at a given point of time.

15 Paleozoic, Mesozoic and Cenozoic are terms used simultaneous to mean or analys the make up of living things. In this regard;
Paleozoic extails the external part,
Mesozoic meaning the part that inward and can contain liquid fluids. while
Cenozoic is the pith which how the lively traits of the whole cell.

4. Homo habilis, Homo sapien and Homo erectus has its differences in the light of their cell building.
Homo habilis live most in arride areas and they depend largely on the homo sapien and homo erectus for continuity of live - This is to say, Both of them can not breed on their own hence need the next partner for live to continue.

(1) mutation: This is the change that exist the life of organism from generation to another — types of mutation.

- telophase
- interphase
- metaphase

interphase is the resting stage of organism.

(13) Geographical Timetable: This is the seasonal time through out the given year.

(7) Charles explonation on evolution. He say's, that stage which are involve in the change of organism, each stage has different change with structures.

(11) Mutation is the relationship that exist in the organism where one is benefiting from the order one without causing harm e.g Shark and a tilapia fish.

(6) origin of life: life begins as a cell. So the collection of cells lead to ~~org~~ tissue, tissue to organ, system.
life originated right from the cell which has nucleus and order cell components

(3) Evolution is the change in the step or stage in the ~~of~~ organisms from generation to generations.

(12) lamarks theory of evolution stated that, each body organ increase in size as a result of cell enlargement.

(12) intra-specific competition: This is the competition the involves different species while inter-specific competition is the competition between or within the same species or environment.

(16) Evolution adresses the diversity of organism, when the organisms are too much or are over crowd as ~~of~~ a result of increase in size or weight as ~~the~~ to balance ~~the~~ its environment

(1) Mutation: means the process in which animals immune to adapted in an environment

(2) chromosamal mutation is of different types:-

(i) adaptation
(ii) Reproduction
(iii) Respiration
(iv) Fertilization

(iv) Fertilisation is the process by which an animal to reproduce a offspring

(3) evolution: evolution is define as life style of and living organism

(4) i) Homo habilis is a types of living organism with many different layers

ii) Homo Sapiens:- these are organism of same structure and different two layers

iii) Homo erectus: these define as living organism that has all the same behaviour and characteristic

(5) the importance of fossil on theory of evolution is that fossil is responsible for supporting of tissue in are living organism

(6) the origin of life: these formulate in evolution to genetic which Fertilization take place by means of Reproduction were eggs are fertized to produced offspring by making of male and female

Answers

(3) Evolution involve the living ~~means evolution~~ of organism and human from one specie to another.

(i) biologists consider as the meaning of mutation as the arrangement or movement of organism ~~from other areas~~ living from one species or area.

(ii) The relationship between homo habilis is when human being where made has homohabilis in the ensence days. homo sapiens is when men ~~was~~ started doing some on his own ~~is also~~ which is called homo sapiens.

(b) Life started as far back ago before ~~thing~~ where created and put into the considerlation of human and living organison to produce and manunc ture their food and maintein themself.

(ii) Implecations of geographical isolation on animals are

i) Lack of food,

ii) Diease rates, and

iii) Competition

2) different types of chromosomal mutation are

i) XX chromosomal mutation and

ii) XY chromosomal mutation.

(4) Intra-specific competition: This is the kind of competition in which living organism of different species compete for the food.

while

Inter-specific competion is the type of competition in which living organism of the same species compete for the food.

(3) Evolution: is the process by which different kind of living organism are believed to develope from earlier during the history of the earth.

(1) mutation is the permanent change of the nucleotide sequential of an organism of the germ of the organism virus.

3 (1) mutation of property
(2) mutation of land
(3) mutation of ~~pond~~ pdf.

(2) mutation of land: This is the permanent change of of the nucleotide of sequence of an of the germ of the organism virus on the land.

(8) The ~~the~~ environment select for itself favoured trait using the theory of natural selection. This favoured the The environmental selection favour the natural selection because of the nature of which involved some factors which are climate, wheather, temperature

(3) Evolution is the rotation of Planates or organs. It is the changes that exist on earth.

(10) Survival of the fittest is how normal People (like people who have two eyes, two leg, etc) Survive or Plane for their futer. for example; the fishermen, famers etc.

(4) The relationship between Homo habilis, Homo-sapiens and Homo erectus is that, they are both scientific names of living things. They are both animals and both are vertebrates.

(6) Origin of life: life come in existence as a result of cells forming an tissue, tissue organ and organ to system.
According to the Bible, life come in existence by nature (God creation).

(11) Implications of geographical isolation on animals:-

(i) Preservation of food for animals
(ii) avoidance of distruction
(iii) avoidance of communicable disease

(12) Evolution of body organ parts: the organ parts are not mandatory with other living being to sense of thinking may be the same but not as much as human being

(13) geological timetable this means things that have suppose to do with human pattern but not do due to the way things happen according to their area of living.

14 The diversity of organism: the phenomenon (which means happening doing of pantology animus digits that have don sexual thing they way of living to earth crafts but having not, in time with other pentrons of organisms

many thing happen with life of human is circulating among our environment and times manufacturing time of earth time & organism.

12 When the body ~~Bgrans~~ etc

13 geological timetable is the process of getting

14 intra specific is the knowledge that ~~difference~~ Specise in the ~~organisms~~ inter the specise that belong to one

15

16 Diversity organisms the process that can gete number of specise that ~~breen~~ in environment

(1) It is because of the science to understand in such a that scientist

(3) evolution is simply means the organ that form in the body

4 Homo habilis are the gen. that or help in us to perform skill.
Homo sapine is the ability that we have in our body.

5

6 orginal life the mean the behaviour of of human that is been environment or in the community.

7 charles Darwin is

8 environmental select itself using natural selection in such a well that people in our community have ability of the environment select a leader lead them.

9

10 Survival fittest when organism are many species in environment order can not grow up because of feeding that given to them

11 The implications of geographical isolation on animal base on what type of you are feed - ing them if you don't feed them well the will not Survival.

(10) The survival of the fittest is the energy or process of ability to do work.

(11) The ~~import~~ implication of geographical isolation on animals ~~is that~~ are!

(i) The young animals are not allowed to be killed.
(ii) While keeping them you keep both male and female animals.
(iii) Kill those ones that are notorious.

(12) The Lamarck theory of evolution based on the use and the disuse of body organ partsare!

Use of body organ parts

(i) You are free to walk with two legs.
(ii) Free to make use of your five senses organ.

Disuse of body organ parts are!

(i) You are not to remove one of you brest.
(ii) You are not advice to use your private part any how.

(13) Geographical time table is the location of time on the map.

(16) Diversity of organisms means beeh different but in a same group.

(1) Mutation means been resistiant of ~~the~~ something you need to do.

(2) Types of mutations chromosomal and explaination of one of them are:

(i) Male sex chromosons

(ii) Female sex mutation chromosomal.

(i) Male sex chromosomal. When the male reached the age of 15–18 years he started expiriencing certain changing in him like the night dream, producing the sperm, hair in the armpit, and deep voice.

(3) Evolution means changes that occour with the enviironment at the paticular time.

(5) The importance of fossil on theory of evolution is that Development start the day you are born and end the day you die.

(4) The relationship between Homo habilis, Homosapiens and Homo erectus is that Homo habilis is when man look like a monkey where as Homosapiens is when man try to walk like a chepanzee and Homo erectus is the time man try to walk upright.

(6) The origin of life in Genesis chapter 1; 30 Says God made creaptures and sees that these creaptures are good and he made man Adam and sent air to his nostries and Adam was alive.

(7) charles Darwin explained the process of evolution as ~~the change and development~~ in the given society.

(8) The environment select itself favorable frauts using the theory of natural selection because for the consumption of animals.

(9) Vestigial structures have been used to explain evolution ~~because~~ of the ~~but~~ beauty of the environment.

(1) mutation is a biologists change;

(2) i) X Chromosomal
ii) Y Chromosomal

(2i) xx are the chromosomal that are found in male

(3) ~~relation~~ a evolution can be defin as the same fossil

(4) Homo sapiens are human, Homo habilis are gorilla

(5) the importance to ~~that~~ the ager of an ~~organ~~ organizm or plant.

(6) there help to ~~fi~~ facilitate the archeological

(6) life is form ~~form~~ the cell is form the pri-existing life

(7) Characters can be transfer to ~~ideas~~ Ideal of the f_1 & f_2 as a result of promozoma