EFFECTS OF TEACHING-WITH-ANALOGY ON ACADEMIC PERFORMANCE AND RETENTION OF EVOLUTION CONCEPTS AMONG NIGERIA CERTIFICATE IN EDUCATION BIOLOGY STUDENTS

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

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NIGERIA

MAY, 2011

DECLARATION

I hereby declare that this thesis titled "EFFECTS OF TEACHING-WITH-ANALOGY ON ACADEMIC PERFORMANCE AND RETENTION OF EVOLUTION CONCEPTS AMONG NCE BIOLOGY STUDENTS" has been written by me. It is a record of my own research work and it has not been presented in any previous application for a higher degree. All quotations and sources of information are fully acknowledged by means of references.

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JIYA Alice	**Date**

CERTIFICATION

This thesis titled "EFFECTS OF TEACHING-WITH-ANALOGY ON ACADEMIC PERFORMANCE AND RETENTION OF EVOLUTION CONCEPTS AMONG NCE BIOLOGY STUDENTS" by Jiya Alice meets the regulation governing the award of masters' degree in science education, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

……………………………………… ------------------------
Dr .(Mrs.) S.B. Olorukooba Date
(Chairperson Supervisory Committee)

Dr. (Mrs) F.K. Lawal ------------------------
(Member, Supervisory Committee) Date

Dr. Mamman Musa ------------------------
(Head, Department of Education) Date

Prof. A.A. Joshua ----------------------
(Dean, Postgraduate School) Date

DEDICATION

This work is dedicated to my parents Late Abraham Tsado, my Mummy Mrs. Rhoda Kaka Tsado and my husband Mr. Michael S. Jiya and my children Samuel, Doris, Judith, Theophilus for their concern, moral and financial supports.

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I give Almighty God all the glory, honour and adoration for he is a 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 could never have been completed. Your love, patience and words of encouragement are highly appreciated. I also wish to express my sincere gratitude to Dr. (Mrs.) F.K. Lawal my second supervisor for her advice. Your contributions and encouragement are highly appreciated.

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ABSTRACT

This study investigated the effects of teaching-with-analogy on academic performance and retention of evolution concepts among NCE biology students. A total of 280 students consisting of 100 females and 180 males formed the sample for the study. Purposive sampling technique was used because the population was small. The subjects were divided into two groups; the experimental group N=135 and the control group N=145. The study adopted the pretest, posttest, post-posttest quasi experimental and control group design. A pretest was administered before the treatment to establish the equivalence of the experimental and control groups. The subjects in the experimental group were taught using Teaching-With-Analogy (TWA), while the control group subjects were exposed to the lecture method for a period of six weeks. The topics taught were evolution concepts. The researcher instrument designed Evolution Achievement Test (EAT) was adopted from biology textbook questions and past moderated NCE III examination questions. These were validated for data collection. Three null hypotheses were tested. t-test statistic was used to determine significant difference of the two groups at $p \leq 0.05$. The major findings from the study include the following: there is significant difference in the mean academic performance scores of experimental and control groups in favour of experimental group. There is a significant difference in the retention ability of the students taught using analogy compared to those taught using lecture method of instruction in favour of experimental group. On the gender related issue Teaching-With-Analogy favoured male students over the female. Based on the findings it was concluded that NCE biology students learn evolution concepts better when taught using teaching-with-analogy it was therefore recommended that Teaching-With-Analogy should be used by biology teachers to teach the concepts of evolution.

ABBREVIATIONS

WAEC:	West African Examination Council
NCE:	Nigeria Certificate in Education
TWA:	Teaching-With-Analogy
NCCE:	National Commission for Colleges of Education
EAT:	Evolution Achievement Test
FCE:	Federal College of Education
COE:	College of Education

OPERATIONAL DEFINITION OF TERMS

The following are definitions of terms as used in this study:

Retention:this is the ability of the learner to store information which can be recalled at a later time after exposure to series of instruction or training.

A**nalogy** is a comparison of something unfamiliar with something familiar in order to explain a shared principle.

Constructivism: is a process by which the learner constructs his or her own conception of reality based upon the interplay of prior knowledge and present experiences.

Target Concept: This is the unfamiliar concepts that the analogy is being used to describe, explain or illustrate.

Mapping: Describes the identification of perceived similarities between the analogy and the target. Mapping links can be either valid or invalid.

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

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CHAPTER ONE

THE PROBLEM

1.1 Introduction

There has been a great shift in emphasis on science teaching and learning over the years worldwide. The shift concern in recent times is to have science classroom that is student-centred, activity-oriented and focused on understanding rather than rote-learning and simple recall of knowledge (Owolabi, 2007). Science education is a fundamental component of basic education that prepares children to live in a world increasingly defined by science and technology (International Council for Science ICS, 2002). Biology is central to science education. According to Gbamanja (1991), the study of biology involves exposing students to several opportunities which can help them to understand different types of concepts, principles and theories. Biology serves as prerequisite to the study of medicine, agriculture, pharmacy among others.

Biology concepts according to Chew (2004) can sometimes be difficult particularly when describing things that cannot be seen or abstract concepts that cannot be fully comprehended for the first time. Some of the concepts taught in biology that students perceived difficult are genetics, evolution, ecology, physiology among others (Oyedokun, 2002; WAEC Examination's Report, 2006). Research findings have also shown that a number of concepts in biology which includes evolution, contain topics which pose difficulty for biology students to understand, (Esiobu and Soyibo, 1995; Okebukola, 1995). Also Zarotiadous and Tsaparlis (2002) and Chew (2004) reported that some students have the notion that evolution concepts in biology are boring and requires only memory work to get one through. Some students find evolution concepts irrelevant, while others find them extremely technical with bombastic terms littering every sentence in a typical biology text. Also many students are said to have wrong perceptions about evolution concepts on the basis of how they were taught biology in schools (Usman, 2008). One of the learner factors that affect meaningful learning in biology generally is the wrong perception of evolution concepts held by the students. (Salin and Ozakaya, 2003; Sani 2006). This wrong perception according to Ezeliora (1999) and Akinsola and Igwe (2002) could be attributed to the inability of teachers to put across scientific ideas clearly to students. Maduabum, (1994) discovered that the major areas of problem in teaching biology, that resulted into students poor performance is rooted in the difficulty in the nature of some concepts in biology. In addition Maduabum (1994) also identified teachers' failure to use effective teaching strategy that would make the learning of these concepts easier.

Evolution concept is an aspect of biology curriculum, which students of Nigeria Certificate in Education (NCE) study at 300 level. It is however considered to be an abstract and difficult topic to learn (NCE Minimum Standard, 2008). Its abstract nature and difficulty as well as cultural and beliefs have resulted in poor performance and retention of the concepts by students at NCE level (Danmole and Femi-Adeoye, 2004).

Evidence of the performance can be seen in the NCE III students' result on evolution course as shown in Table I.1

Table 1.1: Results of N.C.E Students in BIO 311 Evolution

Year	Total Number of Students that sat For Exam	Total Number Passed	%Pass	Total Number Failed	% Failed
2006	98	50	51.02	48	48.98
2007	133	64	48.12	69	51.88
2008	97	42	43.30	55	56.70
2009	103	40	38.83	63	61.17

Source: Exam Office COE Minna, (2009)

Different instructional strategies have relatively differed in effectiveness on students' academic performance and retention. Jibrin (2007) and Nuru, (2007) independently identified poor methods of teaching as deficiency of biology teachers. Research reports by Nwosu (1993), Nwagbo (1999) and Okoli (2006) indicated that many biology teachers prefer the lecture method of teaching and therefore shy away from innovative and activity-oriented teaching methods. Lecture method is one of the teaching methods that is mostly used by teachers. It is teacher-centred and students are mostly passive listeners. On the performance of biology students, Bichi (2002) and Usman (2008) have separately observed that lecture method encourages rote-learning without aiding understanding, thereby resulting in poor academic performance in evolution concepts.

In an attempt to ensure result oriented biology delivery in schools, Akubuilo (2004) suggested the use of activity-oriented strategies such as guided-inquiry, cooperative learning, demonstration, thinks and do, use of analogy and many others. Thus, research in Science Education in Nigeria has continued to seek better ways of teaching biology in order to improve academic performance of students

(Okebukola, 1998). Therefore, in this study the researcher used analogy in the teaching/learning of evolution concepts to determine its effectiveness on performance and retention of concepts taught among NCE III Biology students.

Glynn-Russel and Noah (1997) defined analogy as a strategy that helps students form initial mental models of key science concepts by facilitating introduction of the concepts in ways that are concrete, meaningful and relevant to students. According to Ruhl (2003) an analogy is a comparison of something unfamiliar with something familiar in order to explain a shared principle. Like a bridge that spans the gap between what a teacher wants, a student to learn and what the student already knows. An analogy builds on the framework of the learners' existing knowledge so they are not starting from scratch. Sani (2006) opined that analogy is one of the teaching strategies within the constructivist frame that has evidently proved effective in preventing and overcoming poor performance and wrong perception of the students. Venvile and Thiele (1992) and Sani (2006) reported three benefits of the use of analogies as a teaching technique for abstract concepts. These are: (i) it provides visualization of abstract concepts (ii) it helps compare similarities of the students' real world with the new concept; and (iii) it has a motivational function.

There are two domains of analogy: the analogue domain that exists in memory from which the analogy is drawn and the target domains which contain the science concepts under study that form the instructional objectives of the analogy (Sarantopoulos and Tsaparlis, 2004). Analogies are of various types depending on the nature of what they represent and the problem they are intended to solve in the teaching and learning situation. Examples of analogy models are 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 (1995) Teaching-With-Analogy (TWA) model. In this study, the Teaching-With-Analogy model of Glynn (1995) was adopted.

Glynn (1995) observed that Teaching-With-Analogy (TWA) model emerged as the best suited for use in colleges of education biology classrooms. This is because according to him it focuses on the teacher in class presentation of the analogy, and can be easily implemented and evaluated. The goal of the Analogy is to transfer ideas from a familiar concept (the analogy) to an unfamiliar one (the target). If both the analogy and target share some similar features, an analogy can be drawn between them. The process of comparing the features is called mapping. When using TWA Glynn's Teaching-With-Analogy Model one has to go through the following steps.

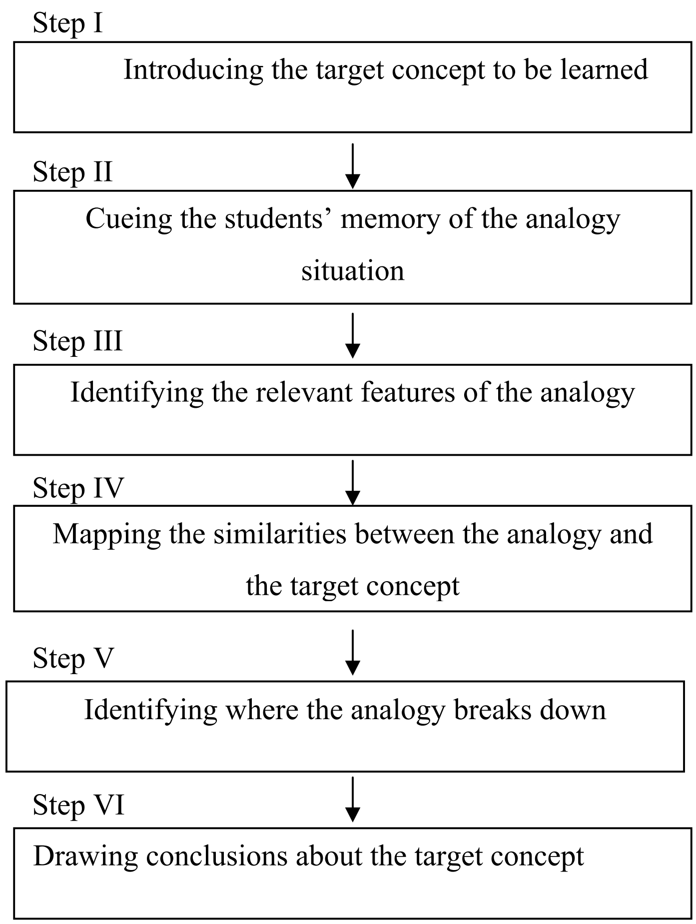

Figure1.1: A Flowchart of Teaching-With-Analogy Strategy used for the Study

Source: Glynn (1995)

This analogy has been used in Senior Secondary School biology teaching and found to enhance students' performance (Lagoke, 2000, Wushishi, 2006, Sani, 2006, Owolabi, 2007, Koroka and Ezenwa, 2009). This study intends to teach NCE III students of biology evolution using adopted version of Glynn's TWA model. The aim is to determine the effectiveness of the use of Teaching-With-Analogy on academic performance and retention of evolution concepts among the NCE students.

Considerable amount of researchers have focused on gender differences in school science learning. (Patrick and Ezenwa, 2000). Duniya (2009) opined that gender issues in science education as it affects performance remains unresolved. Lentz (1992), Lagoke et al (1997) and Usman (2000) in their individual studies noted that boys perform better than girls on activities that require manipulations and also boys are more mechanically and scientifically inclined than girls. 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 Tobin (1988), Bichi (2002) and 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 the gender related issues investigated by the researchers and the studies cited concentrated in teaching method, attitude among others at SSS level. As such this study will also investigate the effect teaching-with-analogy on performance and retention of concepts in evolution between male and female NCE III biology students so as to determine whether gender has any significant influence or not.

1.1.1 Theoretical Framework

The theoretical basis that is guiding the study on the use of analogy to teach concepts of evolution is the constructivism theory of learning. The theory of constructivism is generally attributed to Bruner (1960) and Piaget (1980) who articulated that knowledge is internalized by learners through the processes of accommodation and assimilation. This implies that when individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. Ideally, analogy can help students to build meaningful relations between what they already know and what they are setting out to learn. In general, this 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 (Yager, 1995). This activity of building relation between existing knowledge and new knowledge plays an important role when interpreting students' learning as a process of conceptual change (Demanstes, Good and Peebles, 1996). These theoretical speculations about the role of analogy in evolving conceptual change set the stage for empirical explorations of the contribution of analogy to conceptual change in science learning (Wushishi, 2006). According to Harrison (2001), constructivism is the process in which learners compare new information with old, within the context of their current conceptual framework and so reconstruct their knowledge. Ogunkunle and Gbamanja (2006) view constructivism as a process where learners actively take knowledge connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation. Constructivism is an innovation and interactive instructional theory which incorporate other desirable teaching strategies, such as cooperative learning, guided-inquiry, problem solving and use of analogy among others (Nwosu, 2003).

This study intends to investigate the effect of the use of analogy on performance and retention in evolution concept at NCE level.

1.2 Statement of the Problem

The issue of poor performance at NCE level in evolution course has been of great concern to many researchers as reported by (Salim 2000 and Olatoye 2002).

Maduabum (1994) and Oyedokun (2002) identified the difficulty of the concepts of evolution and teacher's failure to use effective teaching strategy, such as activity-based and use of analogy as the cause of students' poor performance in biology. One effective way to deal with this problem according to Treagust (1993) is for the teacher to provide a bridge between the unfamiliar concepts and the knowledge which the student possesses. This bridge can be the use of analogy which allows new materials, especially abstract concepts, to be easily assimilated with the students' prior knowledge thus enabling them to develop an understanding of the concept. Hence analogy may be a vital strategy for teaching evolution. Specifically, this study seeks to investigate the effectiveness of teaching-with-analogy on performance and retention of evolution concepts among NCE III biology students.

1.3 Objectives of the Study

The study has the following objectives to:

* investigate the effects of teaching-with-analogy on academic performance of NCE III Biology students in evolution concepts;

* find out whether there is any difference in the performance of male and female students taught evolution using teaching-with-analogy.
* determine whether or not teaching-with-analogy has effect on retention ability of NCE III biology students in evolution concepts;

1.4 Research Questions

This study has the following research questions

1. What is the effect of Teaching-With-Analogy on academic performance of students taught evolution concepts?
2. What is the difference in the performance of male and female students taught concepts in evolution using teaching-with-analogy
3. What is the effect of teaching-with-analogy on NCE III student's retention in evolution concepts?

1.5 Null Hypotheses

$H0_1$ There is no significant difference in the mean scores of students taught evolution concepts using analogy teaching strategy and those taught using lecture method.

$H0_2$ There is no significant difference in the mean scores of male and female students taught evolution concepts using teaching-with-analogy.

$H0_3$ There is no significant difference in the students' retention ability of evolution concepts taught using analogy teaching strategy and those taught using lecture method.

1.6 Significance of the Study

It is hoped that:-the findings of this study will be of significance to NCE Biology teachers, students:

* the findings of the study will provide empirical evidence for further research in the area of this study (i.e. teaching-with- analogy).
* the findings would also be beneficial to NCE teachers in helping them select the appropriate strategies for teaching evolution concepts more especially for the improvement students performance in biology.
* it will hopefully encourage active participation of the learners thus leading to meaningful learning as learners participate in the activities during teaching process.
* the professional development of teachers would be enhanced as its demands creative thinking in developing appropriate analogy to suit a topic.

1.7 Scope of the Study

The study is limited to two Colleges of Education in Niger State i.e. Federal College of Education, Kontagora and Niger State College of Education, Minna .They are accredited by National Commission for Collages of Education (NCCE). The colleges are similar in terms of manpower and quality of staff. The study is limited to NCEIII biology students of the two Colleges of Education and BIO311 Evolution.

1.8 Basic Assumptions

For the purpose of this study, the following assumptions are made, that:

1. the use of analogy is not used in teaching concepts of evolution in the selected schools.
2. the selected topics are appropriate for the level of the students used for the study.
3. the study sample i.e. NCE III students have been taught by qualified biology teachers.
4. the subjects under study have been taught using NCCE minimum standard by the teachers.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

In this chapter, the researcher reviews literature related to the study, The review is organized under the following sub-headings:-

* Evolution as a Concept in Biology
* Students Academic Performance in evolution concepts.
* Concepts of Analogy and Science Teaching
* Constructivism and Analogy in Science Teaching
* Analogy and Retention in Science
* Gender and Academic Performance in Science
* Overview of Related Studies on Analogy and Academic Performance in Science
* Implications of the Literature Reviewed on the Present Study

2.2 Evolution as a Concept in Biology

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 Ayo (2003) defined biology as the study of living things. Similarly Hornby (2006) defined biology as the scientific study of the life and structure of plants and animals. Biology has two main branches. These are botany and zoology. Botany is the study of plants while zoology deals with the study of animals. In biology, concepts like genetics, ecology, and evolution are studied. Evolution as a concept is studied in Biology at both secondary and tertiary institutions in Nigeria. It is infact a main branch of the subject of Biology. 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. Evolution is also regarded as the meeting point for the “ancient” and “modern” Biology. It is described as a unifying concept in the subject that it is in evolution that virtually all the other branches of Biology have made some contributions. This is the situation with the evidences of evolution, examples comparative morphology, fossils, comparative anatomy, comparative taxonomy, adaptive radiation and direct evidences. To further buttress these point Evolution is the change in the characteristic of a population of a species over several generations with the resultant formation of a new species (Ayo, 2003).

Evolution implies that species do change and 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. As geneticist Dozhansky (2005) put it that, “Nothing in biology makes sense except in the light of evolution”. The science of evolution allows biologists to compare common threads among organisms as seemingly different as bacteria, whales, lilies and tapeworms. Evolution also has important practical applications. In agriculture for example the evolution of pesticide resistance in insects and other pests, and agricultural scientists strive to develop techniques that slow the evolutionary process in pest organism. In medicine researchers use evolutionary principles to predict which flu strains are evolving more quickly information the scientist 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 micro-organisms are employed to clean up hazardous wastes sites. There are certain computer applications which make use of algorithms that mimic natural selection in biological systems.

The content of the syllabus for NCE III Evolution Bio 311 in all Colleges of Education is as follows:

1 concept of Evolution

2 evidence for evolution

3 the geological timetable

4 trends and theories of evolution including pre-Darwinism and Neo-Darwinism theories.

5 darwin's 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

The teaching of the above contents intends 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/BSc(ed) degree programmes.

This study therefore, will investigate the use of analogy teaching strategy on performance and retention in evolution concepts among NCE III biology students in Niger State to see whether the result was same or different.

2.3 Students Academic Performance in Evolution Concepts

Evolution in the broader sense as cumulative change in the natural world overtime is a similarly central and unifying principle in the natural sciences as a whole. However, the teaching and learning of evolution has faced difficulties ranging from teaching method 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. 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 Americans reject evolution-suggesting that they think scientists, textbooks, and teachers are simply wrong (Greg, 2007).The teaching of evolution theories to students has attracted the attention of many researchers. Bishop and Anderson (1990) investigated students' ability to solve problems in Darwinian terms and found that students were unable to do so. Jensen and Finley (1996) reported students alternative conceptions in the learning of evolution while Renner(1981) found that students were generally unable to comprehend geological time scale and this inability on the part of the students hinders the learning of evolution concepts. Bernardo and Clores (2007), reported that students understanding of evolution theory varied due to the following reasons: a) rejection of the theory due to challenge of religious beliefs. b) remaining skeptical about the theory due to ambivalence that emanated from conflicting theological ideas and misconceptions held about human evolution. The existence of poor performance and retention in evolution at NCE level among learners makes it imperative to search for better teaching strategies for effective learning of evolution concepts.

2.4 Concept of Analogy and Science Teaching

There are several definitions of analogy. Analogy is an exposition technique used for comparing sets of information which are adequately similar in important aspects to permit transportation of attributes across sets usually from familiar to unfamiliar. Treagust (1993) defined analogy as a process of identifying similarities between two concepts. Glynn, Russel and Noah (1997) defined analogy as a method of teaching that helps children form initial, mental models of key science concepts, by facilitating the introduction of the concepts in ways that are concrete, meaningful and relevant to children. Novak and a team of researchers (1999) defined analogy as a learning strategy that was developed as a research tool to represent learner's prior relevant knowledge and later as a tool to enhance meaningful learning. Abimbola (2002) refers to analogies as pictorial, metaphorical or model methods of thinking that suggests areas of similarities between two or more things that require observation and/or experimentation to empirically establish findings. Analogy according to the oxford advanced learners dictionary is a comparison of one thing with another thing that has features that are similar (Hornby, 2006).

Both science and science education literature contain many analogies that are proffered as ways for presenting difficult topics in science. For example, a cell making a protein molecule is likened to tradesmen building a house (Biermann's, 1988). Some analogies appear to be quite esoteric e.g. the ping-pong ball torture analogy for enzyme activity (Helser, 1991), the shot gun-diffraction of the light analogy (Murphy & Smoot, 1992). Then there are those analogies that are problematic, in that, they often generate alternative conceptions though they remain popular and are frequently used in science teaching. (Harrison, 2001). Examples: electric current is like water flowing in a pipe (Champagne, 1985).

Science classes are full of abstract or challenging concepts that are easier to understand, when related to something from everyday experiences. Thomas and Orgill (2007) reported that teachers made difficult or abstract concept understandable through use of analogy. Analogies can be useful as instructional tools. Infact, Glynn (1995), Chew (2004) clearly stated that analogies motivates students, clarify students' thought, help students overcome wrong perceptions, and give students ways to visualize abstract concepts, when they are used appropriately. Lemke (1990), Treagust, Harrison and Venville and Dagher (1996), Sani (2006), all agreed that analogies can also promote students' meaningful learning and conceptual growth and that students are more likely to pay attention to the familiar language used in analogies than to unfamiliar more "scientific" terminologies. It is therefore clear that analogy as a teaching strategy would demand, on critical thinking and reasoning on the part of the teacher, as well as creates meaningful classroom interaction for exchanging ideas. The strategy is student-centred, and thus helps to reduce misconceptions among learners.

Dagher (1995) and Ikeobi (1999) showed that analogies are effective conceptual change agents because they enhance understanding by making connections between scientific concepts and the students' life-world experiences, thereby helping students visualize abstract ideas. Dagher pointed out that analogies provoke students' interest and therefore motivate them. Treagust, Harrison and Venville (1998) clearly stated that analogies allow new materials, especially abstract concepts, to be more easily assimilated with students' prior knowledge, enabling them to develop a more scientific understanding of the concept.

Mustapha and Abimbola (2002) identified the following as advantages of the use of analogies in science teachings;

1 facilitates understanding of abstract concepts by pointing to similarities in the real world.

2 provides visualization of the abstract ideas

3 arouses students' interest that may have motivation function.

4 encourages the teacher to take students' prior knowledge into consideration.

In spite of the potentials that analogies might have in promoting the learning of science, several authors have expressed their concern that students often misinterpret the analogies provided by them. Infact, Duit (1991) warned that learning with analogies can create learning difficulties and that students are capable of getting wrong impression from analogies. There is also the tendency that students may confuse analogies with reality except the teacher is capable of showing where the analogy breaks from reality. In other words, the teacher must be conscious of the limitations of the use of analogy; if the students are to gain from its potentials.

This study therefore, will investigate the effect of teaching-with-analogy in teaching evolution concepts to NCE III biology students, to see whether it will improve students' performance and retention of the concept taught.

2.5 Constructivism and Analogy in Science Teaching

Constructivism is premised on the belief that learners actively create, interprets and reorganize knowledge in individual ways (Mark, 2000). The core idea is that learners actively construct their own understanding rather than passively absorb or copy the understanding of others. The construction of new understanding is stimulated by a problem situation, which disturbs the individual's current organisation of knowledge. This disturbance or disequilibrium occurs when his/her current cognitive structure do not adequately solve, explain, predict or allow for navigation within the situation encountered. This disequilibrium leads to mental activities and modification of previously held ideas to account for new experience (Zakariya, 2008).

Constructivist's theory was based on early empirical and theoretical work by Piaget who articulated mechanisms by which knowledge is internalized by learners. Constructivism suggests that students learn science best when they are actively engaged in doing science or in performing activities that allows them to think like scientists. As such, a major emphasis in science curricular reform is a change from a more traditional teacher-based learning to a more inquiry-based, student-centred learning (NRC, 1996).

Constructivism is more than a set of teaching techniques. It is a coherent pattern of expectations that underlie new relationships between students, teachers and the world of ideas. Constructivism has revolutionized the study of learning by emphasizing the individualistic way in which understanding is generated. According to Hoover (2000), constructivism central idea is that human learning is constructed, that learners build new knowledge upon the foundation of previous learning.

Today, it is generally recognized that learners do not come to science instruction with a “tabula rasa” (i.e. empty mind) but possess tenaciously held preconceptions concerning the phenomena with which they are familiar (Osborne and Freyberg, 1985; Joshua and Dupin, 1987;). As the principal tool of education is language, and the teacher’s goal is to establish valid grounds for the learner to explore scientist’s science, the meaning of individual words and expressions is a vibrant cog in this overall process of developing cogent understanding (Harrison, 2002) whenever an analogy is spoken or written, reference is being made to pictures and ideas in long term memory. During learning, the child’s preconceptions and misconceptions often act as a barrier to the reception of new, more valid propositions. Cosgrove and Osborne (1985) suggest a four 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 or her prior view. For this to occur, students must be motivated to see a 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 conception must appear initially plausible.
4. A new conception should suggest the possibility of a fruitful research program to open up new areas of inquiry.

According to constructivist approach, instructors have to adapt to the role of facilitators. A facilitator helps the learner to get to his or her own understanding of the content. In the former scenario, the learner plays passive role and in the latter scenario the learner plays an active role in the learning process. The emphasis thus turns away from the instructor and the content, towards the learner (Bauersfeld 1995, Germoran, Secada, and Marrette, 1998). This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher (Brownstein, 2001). A teacher tells, a facilitator asks, a teacher lectures from the front, a facilitator supports from the back; a teacher gives answers according to a set curriculum, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions (Rhodes and Bellamy, 1999).

The benefits of constructivism according to Educational Broadcasting Corporation (EBC, 2004) are:

- children learn more, and enjoy learning more when they are actively involved, rather than as passive listeners.

- 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 classrooms, 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 assessments as well. Constructivist assessment engages the students' initiatives and personal investments in their journals, research, reports, physical models, and artistic representations. Engaging the creative instincts develop student's abilities to express knowledge 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 group projects.

To Piaget, “knowledge is the transformation of experience by the individuals, not just the accumulation of pieces of information”. In this way the constructivist epistemology provides a sound platform for the study of teaching with analogy. Thus, constructivism currently provides the best explanation for the way an analogy generates meaning during analogical learning. Hence, constructivism is an instructional strategy which incorporates other desirable teaching strategy such as analogy in teaching.

Use of analogy as a constructivist instructional strategy has shown much promise in its application in science teaching. Abimbola and Mustapha (2002), reported that use of analogy in teaching will improve academic performance and retention in the students, as well as encourage active participation of the learners. On the part of the teacher the analogy in teaching enhances professional development of teachers and promotes culture of learning. The effects of teaching-with-analogy in teaching evolution concepts to NCE III students of biology was employed in this study to find its effectiveness on the performance and retention of the concepts by the students.

2.6 Studies on Analogy and Students’ Retention

Retention of concepts learnt would help in reflective thinking and the use of the retained concepts can be used in creative ways to solve novel problem. In the light of this Ochonogor (1997) said that in depth retention and achievement in science technology and mathematics is an important need that is becoming highly felt by the Nigerian populace.

Akubuilo (2004) reported that any instructional model, which elicits adequate students' participation, has a profound effect on students' retention. Njoku (2004) opined that models concretize and elucidate difficult and abstract concepts thereby reduce students' problems of comprehension and application of concepts in problem solving. In this way models improve retention of knowledge and transfer of learning. Research findings have shown that analogy enhances performance and retention of concepts in science while researchers such as Owolabi (2007) have shown that analogy improved student's performance and retention. Lagoke (2000) reported that use of analogy arouse students' interest and imagination and therefore lead to understanding and retention of concepts. Glynn and Yakahashi (1998) opined that analogy enhanced learning of science by making it meaningful that is making the target concept more understandable and memorable therefore improve students' retention. In this study, teaching-with-analogy would be used to see whether the result is same or different.

2.7 Gender and Academic Performance in Science

Gender is one of the factors interacting 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. Other studies confirmed the superiority of female students' performance over make students. (Mari, 1994 and Shuaibu and Mari, 1997). Yet other researchers found no significant difference between male and female performance (Price, 1993, Bello, 1996, Nussbaum, 2000, Danmole and Adebayo, 2004, Danmole and Femi-Adeoye, 2004). Hence, this study would look at the effect of gender on academic performance and retention among NCE III biology students in evolution concepts.

2.8 Overview of Related Studies on Analogy and Academic Performance in Science

Several studies were carried out on effect of analogy in the learning of science. Harrison (2002), Mustapha and Abimbola (2002) reported that when a competent teacher presents analogy systematically, the resultant students' understanding is compatible with a scientist's view. The point made here is that analogy can lead the mind to understand scientific concept (Sutton, 1993).

In the same vein Olusanya (1998) opined that analogies have been identified in the literature to be potent in enhancing knowledge and skills acquisition in science. Studies on the use of analogies in science teaching have indicated that teachers use analogy in their normal classroom settings when they believe that there exist a need for it (Mustapha, 2002) or when as a result of the teacher's experience and knowledge he or she anticipates that students will not understand a concept. According to Mustapha and Abimbola (2002) literature has revealed the following analogies that teachers have used in the teaching of science as classified under Physics, Chemistry, Biology :

Some analogies in the teaching of physics concepts:

1. an analogy that water flows downhill has been used to describe how electrons in a direct circuit, move from a region of high negative charge (hence, high energy) to a region of positive charge (lower energy) (Thiele,

1993). In this analogy, the analog of gravitational potential energy is used to explain the target that is the electrostatic potential energy or potential difference.

2. analogy of water flowing through pipelines has been used for electric current as the target domain.

3. the use of magnetic field for electric field and gravitational field. The three fields have been interchangeably used to explain each other.

4. the use of the motion of propeller blade as an analog to illustrate atomic volume, that is, how electrons can take up a large amount of space despite its size.

5. a pair of wheels traveling from hard flat surface to carpeted surface as analogy for teaching refraction of light.

6. water ripples to illustrate sound waves and electromagnetic waves.

7. heat as fluid to explain heat flow

8. lottery or dice throwing as analogy to half-life in radioactive decay. Analogy helps to explain every nucleus of the radioactive substance has equal chance of decay.

9. bath sponge as analog for air compressibility.

Some analogies in teaching chemistry concepts:

1. the use of the amount of energy required in breaking apart a pen and its cap as analogy to explain energy required to break chemical bonds.

2. the use of pulling and returning of elastic band as analog to explain the tendency of a chemical system to revert to backward reaction and to attain equilibrium.
3. the use of a pole vaulter attempting a vault jump to explain activation energy.
4. the use of snakes eating their tails as analogy to benzene molecular structure.
5. the use of the solar system as analogy to the structure of atom and the nuclear attraction on the electrons.

Some analogies in teaching biology concepts:

1. lock and key model as analogy for explaining the replication or function of the DNA and in explaining the mechanism of enzyme substance interaction
2. the brain is a computer, a metaphoric expression that gives insight into the structure and function of the brain from the perspective of the computer.
3. dice throwing as analogy to teach probability in genetics.
4. the reference to oxygen as a lively gas.
5. the reference to spinal cord as telephone cables.
6. the description of the heart as a pump.
7. the analogy of the embryo as a ball.

In biology, analogy has an additional meaning, that of the possession by organisms or their parts of similar functions but of different structure and origin. Within this definition, the wings of an insect are analogous to the wings of a bat or a bird. Also, similar body shapes in fishes, dolphins, and whales, that adapt them to locomotion in water, are analogous.

Culree (2005) taught an earth science lesson on the structure of the earth. She 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.

Conti (2005) taught a biology lesson on natural selection and “survival of the fittest” at secondary school level. He took his children outside to an area of green where earlier he had scattered an equal number of green, yellow and red uncooked noodles. He explained that the noodles represented different colored 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. This type of study is required at NCE more especially on retention and performance to see what the result was.

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 principles, common to both the camera and the eye.

Treagust, Harrison, Venville and Dagher (1996) used 54 Senior Secondary School Class I Physics students. They made a study on conceptual change effects of the analogy and they conducted three (3) months interview on the students. The study used 29 students who were taught refraction using wheels analogy and 25 students were taught the same concept without analogy by the same teacher. Both groups were interviewed and were scored. When the differences in the mean scores were compared, the interview result revealed that student taught with analogy had better understanding of the concept taught than those taught without analogy. Both classes were of comparable ability and achievement before treatment through the result of the first interview used as pretest. The analogy group students performed significantly better because the students' concept learning was enhanced by the spontaneous introduction of familiar experiences. The students were able to make connection between the analogy target and their experiences leads to performance seen on the part of treated group. Successful connections like these enrich the analogical mappings because the students see how the science concept explains their everyday happenings. This study was relevant to the present study in that the result has given some insight into the present study.

Owolabi (2007) worked on the use of analogy as vehicle for achieving effective physics delivery in some selected senior secondary schools in Lagos. The study sample consisted of 112 senior secondary school two physics students drawn from two randomly selected secondary schools in Lagos, Nigeria. He used questions adopted from Owaseye (2000). The 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 a 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, in that he used analogy to clarify concepts of mirror and lenses which students usually 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.

Sani (2006), made a study on effect of analogy on conceptual understanding of chemical equilibrium among SS2 students. Eighty SS2 students in Minna Niger State were used for both experimental and control group. The instruments used for posttest were two forms of multiple-choice chemistry tests which were used for data collection, the result obtained from the data analysis indicated that scores of the 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 (t=1.81, df

=39, $p<0.05$). Thus the two groups were equivalent before the treatment. The result of the posttest mean scores of the experimental 56.7 and control groups 31.3 indicates that there is statistically significant difference between the mean scores of the experimental group and control group at the 0.05 level ($t=1.52$, $df=39$, $p<0.05$). Thus, the null hypothesis was rejected. The experimental group taught with analogy performed significantly better than the control group taught with lecture method. The significant difference observed could be attributed to the effect of the experimental strategy… which had increased conceptual understanding of the chemical equilibrium and consequently higher performance of the experimental group. Sani (2006) study was relevant to the present study in that student in senior secondary school performed better when analogy was employed in teaching chemical equilibrium. The findings will serve as a guide for the present study.

Nworgu (2007) 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 sample for the study consisted of 186 SSI 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. Physics Achievement Test (PAT) developed by the researcher was used to collect data. Generally, 93.5 percent of the students 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. Effects of analogy and therefore 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 Nowrgu (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 conforms 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.

Harrison (2002) using analogies in chemistry teaching a case study of a teacher's preparations, presentations and reflections on a chemistry teacher 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 was interviewed about his reflections on his teaching. 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 analysed individually by both authors. Using investigator triangulation (Janestick, 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 very 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 is relevant to the present study because it will serve as a guide to teachers' preparation.

The above examples are inexhaustible; the ones listed here are just to give insight and to stimulate science teachers and educators to use their knowledge, experience and creative thinking in developing appropriate analogy in their teaching. In this study therefore, teaching-with-analogy was employed to find their effectiveness on performance and retention of concepts in evolution at NCE level to see what the result was.

2.9 Implications of Literature Reviewed to the Present Study

Researchers such as Mustapha and Abimbola (2002), Sani (2006) have identified the language teachers use in the teaching of science especially biology as a barrier to the students' understanding of science. Several learning difficulties arise and students have tended to have different conceptions of evolution concepts that teachers attempted to put across. To ensure meaningful learning and therefore, improve academic performance and retention, several and specific instructional strategies that are suitable to bring readiness to the problem have been found in the literature. One of such instructional strategies that is gradually gaining research attention of recent is teaching-with-analogy for students learning scientific concepts. From the literature cited, most of the studies carried out, were at the secondary school level. A similar study is hereby being undertaken at NCE level and on the concepts of evolution to find out the effect of teaching-with-analogy on this level of students.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The chapter is described under the following sub headings:

- Research Design
- Population
- Sample and Sampling Techniques
- Selection of Evolution Topics to be Taught
- Instrumentation
- Validity of the Instrument
- Pilot Test
- Pre-test Administration
- Reliability of Research Instrument
- Item Analysis
- Administration of Treatment
- Teaching-With-Analogy
- Data Collection Procedure
- Data Analysis

3.2 Research Design

The study adopted the pretest, posttest, post–posttest experimental control group design as recommended by Kerlinger (1973). Two groups were involved the experimental and the control groups. The two groups were pretested using

Evolution Achievement Test (EAT) before treatment in order to determine the equivalence of the two groups in their ability level. The experimental group was taught using Teaching-With-Analogy (TWA) while the control group was taught using lecture method. After treatment EAT was administered to the subjects of the two groups as posttest to determine the effectiveness of teaching-with-analogy compared to lecture method employed in the teaching of the concepts. After two weeks of administration of the posttest, EAT was administered to the subjects in the two groups as post-posttest to determine the retention ability of the subjects in the concepts taught. The same test was administered as pretest, posttest and post-posttest. The design of the study is represented as follows:

Group1: E $\longrightarrow O_1 \longrightarrow X_1 \longrightarrow O_2 \longrightarrow O_3$

Groups 2: C $\longrightarrow O_1 \longrightarrow X_0 \longrightarrow O_2 \longrightarrow O_3$

Adopted from Kerlinger (1973)

Fig 3.1 Research Design Illustration

X_1: Use of Teaching-With-Analogy (Treatment)

X_0: Lecture Method (Control)

O_1: Pretest Administration

O_2: Posttest Administration

O_3: Post-posttest Administration

E: Experimental Group

C: Control Group

(Where O_1, O_2, and O_3 are the same test instrument.)

This design has the following advantages

The scores from the pretest was used to:

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

3.3 Population

The population for this study consists of all NCE III students in Biology department in the two Colleges of Education in Niger State. The Colleges are Federal College of Education, Kontagora and Niger State College of Education, Minna. The two Colleges of Education were used in this study because they are the only Colleges of Education available in the state.

The total student population in the two colleges is two hundred and eighty students, consisting of 180 male and 100 female students. The colleges are co-educational and offer evolution courses in biology (Bio 311). The breakdown of the students in the population is presented in Table 3.1 below:

Table 3.1 Students in the Study Population

INSTITUTION	MALE	FEMALE	TOTAL
FCE KONTAGORA	100	45	145
COE MINNA	80	55	135
TOTAL	180	100	280

Source: Examination Office FCE Kontagora and COE Minna,2010

The colleges are accredited by the National Commission for Colleges of Education (NCCE). The colleges are similar in terms of the year of establishment, manpower, students' population and quality of staff. The average age of students in the population is the range of 17 to 21.

3.4 Sample and Sampling Procedure

Purposive sampling technique was used because the population is small i.e. 280. Sampling technique using throwing of the coin was used to assign the colleges unto experimental and control groups. The two groups were used for data collection and all the male and female subjects were used. The details of the sample are presented in Table 3.1

3.5 Selection of Evolution Concepts to be Learnt

Topics to be taught is from evolution in biology (Bio 311) of the NCCE minimum standard (2008) revised version. The contents are as follows:

1 The geological time table

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

3 Evidence for Evolution

4 The origin of life

5 Fossil and human evolution

These topics was selected for the following reasons

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

b The topic constitutes the areas students perceived to be difficult and have misconception of ideas about the concepts as observed by Bishop and Anderson (1990), Jensen and Finley (1996) and Bernado and Clores (2007)

c The topics lend themselves to the use of analogy instructions which was used for the present study.

3.6 Instrumentation

The instrument used for data collection is the Evolution Achievement Test (EAT)

3.6.1 Evolution Achievement Test (EAT)

Evolution Achievement Test (EAT) was adopted from biology textbook questions and some was obtained from past moderated NCEIII examination questions. Evolution Achievement Test was used for the pretest, posttest and post-posttest. The EAT test items was made up of 30 multiple choice questions with five options, to choose the correct option and ten true or false questions to choose the right option. The items in the test cover all the units that were taught. To ensure equal distribution of the test items over the units taught, a table of specification was prepared as shown in Appendix C and bloom's cognitive taxonomy table was prepared as shown in Appendix D.

3.6.2 Validation of the Instrument

The EAT with the marking scheme was validated by two chief lecturers from Biology department of Niger State College of Education, Minna, and two senior lecturers from Science Education Section of the Department of Education Ahmadu Bello University Zaria. The validator's qualifications are masters' degree in science education and PhD in science education.

- They were to check whether test items conformed with the concept they test
- They are to evaluate the test items whether they are clearly stated and appropriate in terms of the reading difficulty level of the student's understanding.

  The Analogy that was used for these topics was given to principal lecturers from College of Education, Minna to be validated. The purpose of validation is:

  a to determine the student level of familiarity with analogy

  b to ensure that there is one obvious similarity between the analogy and the target

  c to verify if analogy needs to be modified or not based on the objective of the study.

3.6.3 Pilot Test

During the pilot testing, two tests were carried out: NCE III biology students of Federal College of Education Zuba were used for pilot-testing of the instrument. The aim of pilot study is to determine the characteristics of the test items which include their facility and discrimination indices and the reliability coefficient. Sixty students made up of 45 boys and 15 girls participated in the pilot study. The groups were mixed sexes.

The results of the pilot study were used to:

i. determine the number of weeks that was suitable for conducting the study.

ii. assess the Clarity of the items of the EAT

iii. calculate the reliability coefficient of the EAT. Also the facility and difficult indices was determined using the scores of the students.

Pretest Administration for the samples: Pretest was carried out using the instrument for the study i.e. Evolution Achievement Test (EAT). The pretest was done to determine equivalence on the comparability level of the ability of study subjects. Two groups were subjected to t-test to determine the two group equivalence in academic achievement and they were used for the study. (Appendix F). The two groups were divided into Control A and Experimental B.

3.6.4 Reliability of the Instruments

The scores that was obtained from the pilot study was used to determine the reliability coefficient of the EAT. The study employed test retest method on the scores obtained from the Pilot study. After the first test two weeks interval EAT was given for second test which is retest. This is in line with Tuckman (1975) recommendation.

Pearson Product Moment Correlation Coefficient Statistics (PPMCC) was used to determine reliability coefficient. On the basis of the data obtained from the pilot testing of achievement test, the instrument used for this study was found to have a reliability coefficient of 0.80. This shows that the instrument is reliable and was used for this study.

3.6.5 Item Analysis of EAT

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 EAT

The facility index (F_1) 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:

$$F_I = \frac{R}{T}$$

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. For the present study 0.30 to 0.70 was chosen for the study. See Appendix G.

The discrimination index indicates the discriminating power of each of the test items or 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).

$$D_I = \frac{Ru - Ri}{\frac{1}{2} N}$$

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 is regarded as moderately positive and is accepted for the present study. This was used in selecting the final items of the test EAT. See Appendix G.

3.7 Administration of Treatment

Before treatment pretest was administered to both experimental and control group. The experimental group was taught the evolution concept using TWA while the control group was taught using lecture method.

Lesson note plan was prepared to teach study subjects based on the topic selected as specified in section 3.5 Chapter 3.

Teaching-With-Analogy

The treatment to be administered to the study students involves teaching of concepts in Evolution using Teaching-With-Analogy. The subjects were taught concepts of Evolution for six (6) weeks consisting of 2 hours per week.

Experimental group was taught using Teaching–With-Analogy (TWA) Model (Glynn, 1995). In this model, ideas from a familiar concept (the analogue) are transferred to an unfamiliar one (the target). If the analogy and the target shared some similarity in their features, an analogy can be drawn between them. The process of comparing the features is called mapping.

Teaching–With-Analogy (TWA) model is preferred to other Analogy model 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 constructivist view that meaningful learning must necessarily involves students in integrating new information or knowledge with pre-existing schemata (Millar, 1989).

Teaching–With-Analogy (TWA) Glynn (1995) model consists of six steps that the teacher carries out when drawing an analogy.

1. Introduce the target concept
2. Review the analogy concept.
3. Identify the relevant features of target and analogy
4. Map the similarities
5. Indicate where the analogy breaks down
6. Draw conclusions

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

1. **Introduce the target concept to be learned**

   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.

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.

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.

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.

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.

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.

3.8 Data Collection Procedure

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

3.8.1 Treatment to the Experimental Group

The teaching of the Concepts was done by the researcher. This is to ensure that the teaching procedure is followed accordingly as required by the model. It also removes teacher bias that might arise when using research assistants. Teaching lasted for 6 weeks, two hours per week based on lesson note demand in Appendix A, B, C and D. The experimental group was taught using Teaching-With-Analogy (TWA) model Glynn (1995).

Step I

Introduce the target concepts to be learnt.

↓

Step II

Then cueing student's memory to the Analogy situation, that is, reminding the subjects of what they are familiar with for example, the analogy between the camera and the human eye.

↓

Step III

Identify the relevant features of target and analogy, that is, identify the corresponding features between the target concept and the analogy concept.

↓

Step IV

Mapping the similarities between the analog and target concept that compare the target concept and analogy concept by writing out their similarities.

↓

Step V

Indicate where the analogy breaks down. Here the teacher explain how the target concept different from the analogy concept.

↓

Step VI

Draw conclusion the teacher emphasis more on the target concept so that the students don't exchange analogy concept for the target concept or to avoid misconception. Posttest was given after treatment and two weeks after post-posttest.

Figure.2 The teaching- with- analogy has the following flowchart:
Source: Glynn (1995)

3.8.2 Treatment of the control Group

The control group was taught the same concepts by the researcher using lecture method. Two hours per week for 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. Appendix A, B, C,D and E. After teaching the experimental and control group posttest was administered using EAT to both groups. After two weeks post-posttest was administered. The subject scores were collected for both the controlled and experimental groups and subdivided into male and female scores to test for gender effect. Later, the data was subjected for analysis.

3.9 Data Analysis

The response of the subjects to Evolution Achievement Test was scored using the marking scheme. (Appendix B). Each correct response was scored one point with a maximum score of 40 marks. The score that was obtained from EAT was used for testing stated hypotheses 1-3. The hypotheses stated and the statistical analyses that were used are as follows:

$H0_1$ There is no significant difference in the mean scores of students taught evolution concepts using teaching-with-analogy and those taught using lecture method.

$H0_2$ There is no significant difference in the mean scores of male and female students taught evolution concept using teaching-with-analogy.

$H0_3$ There is no significant difference in the mean score of students retention ability taught evolution concept using teaching-with-analogy and those taught using lecture method.

All the three null hypotheses stated were analyzed using t-test unrelated statistic. This is for the purpose of determining significant different (if any) between the experimental and control groups performances. Significant level of $P \leq 0.05$ was used to retain or reject the hypotheses tested.

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This study was carried out to investigate the effect of teaching-with-analogy on academic performance and retention of evolution concepts among NCE biology students. The analyses and results of the data collected and their discussions are presented in this chapter. The data collected were analysed using the Statistical Package for Social Science (SPSS) and the level of significance adopted for rejecting or retaining the stated hypotheses was $p \leq 0.05$.

4.2 Data Analysis and Results

The instrument used for the data collection was Evolution Achievement Test (EAT) which was used to measure the subject performance in the pretest, posttest and postposttest for both experimental and control groups. The data that were obtained in the course of the study were:

i. performance scores from pretest for both the experimental and control groups

ii. Performance scores from posttest for both experimental and control groups

iii. Performance scores from post-posttest for both experimental and control groups

4.2.1 Hypotheses Testing

The data collected as described in 4.2 above were used to test the stated hypotheses. The results are presented in Tables 4.1-4.3

4.2.2 Comparison of the Academic Performance of Experimental and Control Groups

Null Hypothesis 1

$H0_1$: There is no significant difference in the mean scores of students taught evolution concepts using teaching-with-analogy and those taught using lecture method.

To test this hypothesis the posttest mean scores of the subjects in the experimental and control groups were compared using t-test statistic Table 4.1 shows the results obtained.

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

Variable	N	$\bar{X}$	SD	SE	df	t-cal	p-value
Experimental	**135**	**26.17**	**2.61**	**0.22**			
					278	**35.99**	*** 0.001**
Control	**145**	**13.01**	**3.60**	**0.29**			

Significant at $p \leq 0.05$

From Table 4.1, the p-value obtained is 0.001 at $p \leq 0.05$ level of significant. Therefore there is significant difference. The null hypothesis of no significant difference between the academic performance of the experimental and control groups is rejected. The result thus shows that the teaching-with-analogy is better at improving students' performance in evolution concepts taught than the lecture method. The mean score value of experimental group is 26.17 and for the control group is13.01.

4.2.3 Test for Gender-Related Difference in the Mean Scores of male and female in Experimental Group

Null Hypothesis 2

$H0_3$: There is no significant difference in the mean scores of male and female students taught evolution concepts using teaching-with-analogy.

To test this hypothesis, the posttest mean scores of the male and female students were subjected to t-test statistical analysis. The result is shown in Table 4.3.

Table 4.2: t-test Analysis of Posttest Mean scores of Male and Female Students exposed to teaching-with-analogy.

Variable	N	X	SD	SE	df	t-cal	p-value
Male	80	27.12	2.20	0.25			
					133	105.78	*0.001
Female	55	24.73	2.33	0.31			

Significant at $p \leq 0.05$

Table 4.2 the p-valve obtained is 0.001 at $p< 0.05$ level of significant shows the result of the posttest mean scores for male and female students in the experimental group. The result showed that there is a significant difference in the performance of male and female students in favour of the male students.. Thus the null hypothesis of no significant difference is rejected.

4.2.4 The Effect of Teaching-With-Analogy on Retention of Concepts Taught in Evolution

Null Hypothesis 3

$H0_2$: There is no significant difference between the students' retention ability of evolution concept taught using teaching-with-analogy and those taught using lecture method.

To test this hypothesis the post--posttest mean scores of the achievement test of the experimental and control groups were subjected to t-test statistics. The result is shown in table 4.**3**

Table 4.3: t-test Analysis of the Post- Posttest Mean Scores of Experimental and Control Groups

Variable	N	$\overline{X}$	SD	SE	df	t-cal	p-value
Experimental	**135**	**26.17**	**2.46**	**0.21**			
					278	**122.40**	*** 0.001**
Control	**145**	**12.94**	**3.60**	**0.29**			

Significant at $p \leq 0.05$

Table 4.3 the p-valve obtained is 0.001 at p< 0.05 level of significant .Therefore there is a significant difference in the post-posttest mean scores of the experimental and the control groups. This shows that the retention ability of the subjects taught using teaching-with-analogy is significantly higher than that taught using lecture method. The null hypothesis of no-significant difference is therefore rejected.

4.3 Summary of Findings

The findings of the study are as follows:

- There is a significant difference in the posttest mean scores of the experimental and control groups.
- There is a significant difference in the post-posttest mean scores of the experimental group.
- There is a significant difference in the mean scores of males and females as strategy being gender friendly.

4.4 Discussion of the Results

The objective of this study was to investigate the effects of teaching-with-analogy on academic performance and retention of evolution concepts among NCE biology students. The data collected were analysed by employing t-test statistic at $p \leq 0.05$ level of significance.

What is the difference in the academic performance of students taught evolution concepts using teaching-with-analogy and those taught using lecture method? The research question one was answered by testing the corresponding hypotheses.

The result of testing hypotheses one showed a significant difference in the posttest performance mean scores of the experimental and control groups. The experimental group achieved significantly higher than the control group in the posttest scores (Table 4.1). the significant difference in favour of the experimental group suggests a greater effectiveness of the teaching-with-analogy strategy which was used to teach the experimental group over the lecture method used to teach the control group. This might be due to change in mode of instructions that is from teacher-centre (i.e. lecture method) to students-centre (i.e. teaching-with-analogy). The results was in accordance with the findings of Lagoke, Jegede and Harrison (1998) Sarantopoulous and Tsapartis (2004) Sani (2006) Wushishi (2006) that analogy teaching strategy are tools for improving performance of students.

Research question two sought for the difference if any, in the performance of male and female students taught concepts of evolution using teaching-with-analogy. The research question two was answered by testing the corresponding hypothesis. Hypothesis 2 which states that there is no significant difference in the mean score of male and female subjects taught evolution concept using teaching-with-analogy. The results showed that there is a significant difference in the mean scores of male and female taught evolution concept using teaching-with-analogy in favour of male whose performance is higher than that of the female. The results agrees with the finding of Usman (2000) who found out that there was gender difference in the academic achievement of students when exposed to activity-based methods of instruction such as discovery, problem-solving. Similar findings were reported by Lagoke, et al (1997) where boys performed better than girls in those instructional methods that are full of activities and manipulations and are found to be more aggressive towards laboratory work. They further reported that boys performed better than girls in process of measuring and experimenting. Also Lentz, (1992) observed that boys are more mechanically and scientifically inclined than girls. Other studies confirmed the superiority of female sex over the male in achievement. Driver, (1980) reported higher achievement of girls in mathematics and physical sciences than boys. Yet other researchers found no significant difference between males and females achievement (Nussaum, 2000, Bichi, 2002). Research question three sought for the effect of teaching-with-analogy on NCE III students' retention ability in evolution concepts? The research question three was answered by testing the corresponding research hypothesis, i.e. hypothesis 3, which states that there is no significant difference in the retention ability of the subjects taught evolution concepts using teaching-with-analogy. The result showed that there is a significant difference in the post-posttest mean scores of the experimental group. The experimental group has higher or better retention of the concepts taught than the control group. This shows that the teaching-with-analogy used enabled the students in the experimental group to retain more knowledge of the evolution concept taught. This is because the strategy allowed new materials, especially abstract concepts, to be more easily assimilated with the student's prior knowledge, enabling them to develop a more scientific understanding of the concept. These aid the memory retention resulting in higher performance of the students. This is inline with the findings of Owolabi (2007) who reported that teaching-with-analogy can clarify students doubt on specific information regarding scientific concepts, thus leading to better performance and retention of concepts compared to the lecture method. Treagust Harrison,Venville and Dagher (1996) also revealed in their study the effectiveness of teaching-with-analogy at aiding understanding of concepts learnt in terms of using familiar experiences and ideas which acts as a motivating influence in studying unfamiliar concepts. The findings from this study therefore indicate that teaching-with-analogy can enhance academic performance and retention of evolution concepts among NCE III biology students.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study was effects of teaching-with-analogy on academic performance and retention of evolution concepts among NCE Biology students. The data collected were analysed using mean and t-test statistical tools. This chapter is presented in the following sub-headings:

- Summary of the Study
- Major Findings
- Conclusion
- Recommendations
- Limitations
- Suggestions for Further Study

5.2 Summary of the Study

This study is the effect of teaching-with-analogy on academic performance and retention of evolution concepts among NCE Biology students. An adopted analogy teaching strategy model of Glynn (1995) was used to enhance the student performance and retention in evolution concepts. 280 students were used for the data collection. The study involved teaching –with- analogy model as the treatment in an attempt to improve performance and retention of evolution concept and lecture method was used as control.

The concepts selected for the study was geological timetable ,evidence for evolution , Drawins theory of natural selection, competition, variation and survival of the fittest, origin of life, and fossil and human evolution Three null hypotheses were stated and tested. Evolution achievement test made up of 30 multiple choice questions and 10 true or false was used to measure performance and retention of the students after treatment.

The data collected from the achievement test was analyzed using t-test statistic to test the stated hypotheses. The results and discussion are reported in chapter four.

The findings revealed the followings:

i. There is a significance difference in the mean academic performance scores of students taught using teaching-with-analogy compared to those taught using lecture method of instruction in evolution concepts in favour of the experimental group (i.e. taught using teaching-with-analogy).

ii. There is significant difference in the mean scores of the students retention ability of evolution concepts taught using teaching-with-analogy and to those taught using lecture method in favour of experimental group.

iii. There is significant difference in the mean academic performance scores of male and female students taught evolution concept using teaching-with-analogy in favour of male students.

5.3 Major Findings

i There was a significant difference between the posttest mean scores of the experimental and control groups in favour of the experimental group.

ii The retention level of the concept is significantly higher for those taught using teaching-with-analogy compared to those taught using lecture method.

Iii There was a significant difference in the academic performance of male and female students who were taught using teaching-with-analogy in favour of male students.

5.4 Conclusion

(a). Students learn evolution concepts better when taught using teaching-with-analogy at NCE level.

(b). Students in the study had better retention when taught evolution concepts using teaching-with-analogy at NCE level.

(c). Male students taught using teaching-with-analogy achieved higher in evolution concepts at NCE level than female students taught using the same strategy.

In conclusion on the findings of this study, teaching-with-analogy has the potential of enhancing NCE student academic performance and retention of evolution concepts.

5.5 Recommendations

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

(1) Teaching-with-Analogy should be encouraged for use by Biology teachers for teaching evolution concepts to NCE biology students.

(2). Teaching and learning materials should be provided by government agencies such as State Governments, Federal Ministry of Education, National Commission for Colleges of Education (NCCE) and National University Commission for effective utilization of teaching-with-analogy in the teaching/learning of evolution concept at NCE level.

(3). Non-governmental organization (NGOs) and Parent Teachers Association (PTA) and other stakeholders in education should be encouraged to provide adequate financial and material resources for effective teaching/learning of evolution concepts at NCE level using teaching-with-analogy.

(4). Teaching-with-Analogy helped encourage visualization and reorganization of science facts in the learner's cognitive structure. It should therefore be encouraged for teaching in the science classroom.

(5). Professional associations like Science Teachers Association (STAN), Mathematics Association of Nigeria (MAN) and research centres like Nigerian Educational and Research Development Council (NERDC) should incorporate teaching-with-analogy in their science curricula at the junior and senior secondary school levels to encourage the use of the strategy among teachers. Workshops may be needed for this by STAN.

(6). Teachers should select teaching-with-analogy that are familiar to students because such analogies are motivational to students, avoid time wastage and easy to use by the teachers.

(7). Biology teachers should adopt the use of teaching-with-analogy in teaching difficult and abstract topics like evolution concept at NCE level.

(8). The research on teaching-with-analogy should not only be geared towards developing analogy only but should be used in the classroom settings to determine their effectiveness.

(9). The teaching-with-analogy should be incorporated into teacher education curriculum and be taught as other teaching methods being taught since it is relatively a new technique with many stages for its successful implementation.

5.6 Limitations of the Study

The following limitations were noted in the course of this study:

1. The study was restricted to the NCE III biology students of the two colleges of education in Niger State (i.e Federal College of Education Kontagora and Niger State College of Education Minna) because they are the only colleges of education in the state.
2. The concepts taught, were limited to geological timetable, Darwin theory of natural selection, survival of the fittest, variation and competition, evidence for evolution, origin of life, fossils and human evolution because the topics were established by the researchers to be difficult for students.

   Studies can also be carried out to cover other topics in evolution and biology in general.
3. The large experimental class was possible because students are matured.
4. t-test unrelated was used for analysis for unequal number of experimental and control groups.

5.7 Suggestion for Further Studies

(i). TWA was used as a method of instruction for teaching/learning of evolution concept among NCE students. There is need to carryout a similar research using junior or senior secondary schools.

(ii). This type of study could be extended to other institutions, universities, polytechnics inclusive in various disciplines to see what the result will be.

(iii). 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.

iv. This type of study could be extended to other state and federal colleges of education in Nigeria for widening and generalizing the scope of the findings of such studies.

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APPENDIX A

Evolution Achievement Test (EAT)

Instruction: Answer all questions

Time: 1 Hour

1. Organic evolution takes place in living things True or False? ....

2. Fossils are used as evidence to support the occurrence of plant and animal evolution. True or False? ....

3. Evolution is defined as the changes that take place over several years. True or False? ....

4. Competition amongst members of the same species is called

   (a) Inter competition ☐

   (b). Intraspecific competition ☐

   (c). Interspecific competition ☐

   (d). Exploitation ☐

   (e). None of the above ☐

5. Which of these animals is commonly used to support Lamarck's theory of use and disuse of body parts?

   (a) Horse ☐

   (b). Monkey ☐

   (c). Giraffe ☐

   (d). Donkey ☐

   (e). None of the above ☐

6. The struggle amongst organisms for limited resources is known as competition. True or false?

7. Charles Darwin based his theory of evolution on

   (a) Isolation ☐

   (b). Natural selection ☐

   (c). Use and disuse of body parts ☐

   (d). Mutation ☐

   (e). None of the above ☐

8. The following are factors that affect competition among plants and animals except

   (a) Shelter ☐

   (b). Water ☐

   (c). Light ☐

   (d). Temperature ☐

   (e). Giraffe ☐

9. Interspecific competition is competition amongst members of same species. True or false?................

10. Isolation is a major step towards the formation of new species. True or false?...................

11. Fossils are used to reconstruct evolutionary history of organism. True or false?..................

12. The following accounts for the modern theory of evolution, except

   (a) mutation ☐

☐

(b). genetic recombination

(c). natural selection

(d). geographical Isolation

(e). light

13. Evolution tends to address the reasons for diversity of organisms. True or false?……………

14. Lamarcks theory of evolution is based on use and disused of organs. True or false?................

15. Sedimentary rocks in which fossils are found can be dated using

(a) carbon dating method

(b). nitrogen dating method

(c). calcium dating method

(d). bitumen dating method

(e). none of the above

16. Charles Darwin's theory of natural selection is based on survival of the fittest. True or false?......................

17. Caste is a form of fossil. True or false?.................

18. Adaptive radiation is also known as….

(a) Divergent evolution

(b). Convergent evolution

(c). Bivalent evolution

(d). Homologous evolution

(e). None of the above

19. Geologic time table scale shows the flora and fauna of evolution at various time. True or false?.............

20. People that dig up fossils and other artifacts are called

(a) Biologist ☐

(b). Anthropologist ☐

(c). Zoologist ☐

(d). Statistician ☐

(e). None of the above ☐

21. The time of greatest evolutionary diversification in history of life occurred during the

(a) cambrian period ☐

(b). ordovician period ☐

(c). silurian period ☐

(d). carboniferous period ☐

(e). permian period ☐

22. Geologists divide earths history, from precambrian time to the present, into

(a) three periods ☐

(b). three epochs ☐

(c). three era ☐

(d). five periods ☐

(e). five era ☐

23. Flowering plants and animals diversified and became dominant during the…

(a) Paleozoic era ☐

(b). Mesozoic era ☐

☐

(c). Cenozoic era

(d). Devonian period

(e). Cambrian period

24. About how many years passed between the earth's formation and the appearance of recognizable cells?

(a) 10 million

(b). 100 million

(c). 800 million

(d). five million

(e). 10 billion

25. Energy, the absence of oxygen, chemical building blocks, and time were the requirements for

(a) Chemical evolution

(b). Biological evolution

(c). Cambrian explosion

(d). the mass extinction episode at the end of the cretaceous period

(e). None of the above

26. Features that are similar in underlying form in different species because of a common evolutionary origin are called

(a) Homoplastic

(b). Homologous

(c). Vestigial

(d). Convergent

(e). Synthetic

27. The molecular record found inside cells suggest that evolutionary changes are caused by an accumulation of

(a) traits acquired through need

(b). alternation in the order of nucleotides in DNA

(c). characters acquired during an individual's life time

(d). hormones

(e). environmental changes

28. Aardvarks, anteaters, and pangolins are only distantly related but are similar in structure and form as a result of

(a) homology

(b). convergent evolution

(c). biogeography

(d). vestigial structures

(e). artificial selections

29. In………., the selecting agent is the environment, where as in……….. the selecting agent is humans.

(a) natural selection, convergent evolution

(b). mutation, artificial selection

(c). homoplasy, homology

(d). artificial selection, natural selection

(e). natural selection, artificial selection

30. The first primates evolved about 55 million years ago from

(a) shrew-like marsupials

(b). therapsids

(c). shrew-like placental mammals

(d). trasiers

(e). shrewlike monotreme

31. The peking man and javaman are classified as

(a) homo habilis

(b). homo erectus

(c). homo sapiens

(d). apes

(e). Hominids

32. The…………..in humans is centred at the base of the skull positioning the head for erect walking

(a) Supra orbital ridge

(b). foramen magnum

(c). pelvis

(d). bony skull crest

(e). femur

33. Evolution is based on which of the following concepts

(a) organisms share a common origin

(b). overtime, organisms have diverged from a common ancestor

(c). an animals body parts can change over its life time, and these acquired changes are passed to the next generation

(d). only a and b are correct

(e). only a, b and c are correct

34. Charles Darwin proposed that evolution could be explained by the differential reproductive success of organisms that resulted from their naturally occurring variation. Darwin called this process:

(a) co-evolution

(b). Convergent Evolution

(c). Natural Selection

(d). Artificial Selection

(e). Homoplasy

35. The source of all new alleles is

(a) Gene flow

(b). Natural selection

(c). Mutations

(d). Genetic drift

(e). The heterozygotic advantage

36. If a population's allele and genotype frequencies remain constant from generation to generation

(a) The population is undergoing evolutionary change

(b). The population is said to be at genetic equilibrium

(c). Microevolution has taken place

(d). Directional selection is occurring, but only for a few generations

(e). Genetic drift is a significant evolutionary force

37. The largest unit within which gene flow can occur is the

(a) Species

(b). Subspecies

(c). Population

(d). Individual organism

(e). Deme

38. The evolutionary conversion of reptilian scales into feathers is an example of….

(a) Allometric growth

(b). Paedomorphosis

(c). Gradualism is an example

(d). Hybrid breakdown

(e). Preadaptation

39. Protobionts

(a) Form spontaneously in hydrothermal vents in the ocean floor

(b). Are heterotrophs that obtain the organic molecules They need from the environment

(c). are assemblages of abiotically produced organic Polymers that resemble living cells in several ways

(d). are autotrophs that use sunlight to split hydrogen sulphide (e). are fossilized mats of cyanobacteria ☐

40. The consensus among scientists is that the first cells were

(a) aerobic autotrophic ☐

(b). anaerobic autotrophic prokaryotes ☐

(c). aerobic heterotrophic prokaryotes ☐

(d). anaerobic heterotrophic prokaryotes ☐

(e). anaerobic heterotrophic eukaryotes ☐

APPENDIX B

EVOLUTION ACHIEVEMENT TEST (EAT) MARKING SCHEME

S/N	Answer	S/N	Answer
1.	True	21.	a
2.	True	22.	c
3.	True	23.	c
4.	b	24.	c
5.	c	25.	a
6.	True	26.	b
7.	b	27.	b
8.	e	28.	b
9.	False	29.	e
10.	True	30.	c
11.	True	31.	b
12.	e	32.	b
13.	True	33.	d
14.	False	34.	c
15.	a	35.	c
16.	False	36.	b
17.	True	37.	a
18.	a	38.	e
19.	True	39.	c
20.	b	40.	d

APPENDIX C

Table of Specification

S/N	Topics	Total number of Questions	The questions
1.	Concepts of Evolution	4	1, 3, 13, 33
2.	The geological time table	5	19, 21, 22, 23, 24
3.	Darwin's theory of natural selection, competition, variation and survival of the fittest	10	4, 6, 8, 9, 7, 16, 27,29, 34,35
4.	Evidence for Evolution	7	5, 10, 12, 14,18,28,38
5.	The Origin of Life	6	25, 26, 36, 37, 39, 40
6.	Fossils and Human Evolution	8	2, 11, 15, 17, 20, 30, 31, 32
	Total	**40**	**40**

APPENDIX D

Bloom's Cognitive Taxonomy

S/NO	Bloom Taxonomy	Items	Total
1	Knowledge	1,6,17,18,33,39	6
2	Comprehension	3,9,11,14,20,29,40	7
3	Application	4,8,10,12,15,25,35,	7
4	Analysis	13,21,22,23,37,31,32	7
5	Synthesis	5,7,26,27,28,34,38	7
6	Evaluation	2,16,19,24,30,36	6

APPENDIX E

The Experimental Group

Lesson 1

Teaching-With-Analogy Model

School: College of Education, Minna

Level: 300

Course: Bio 311

Credit Unit: 2

Topic: Geological Time Table

Duration: 2hours

Instructional Materials: Picture of earth clock with representative life forms for each era.

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

(a). Define the term Geological Time Table

(b). Describe various sections of the Geological Time Chart

- (i). Cosmic Era
- (ii). Azoic Era
- (iii). Archeozoic Era
- (iv). Proterozoic Era
- (v). Paleozoic Era
- (vi). Mesozoic Era
- (vii). Cenozoic Era

Entry Behaviour: The students had some knowledge about evolution from their O' levels. They have being seeing charges in the characteristics of a population of a species over several generations, with resultant formulation of a new species.

Introduction

The teacher introduces her lesson by defining the term Geological Time Table. It is a chart 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. It also gives summary of the plants and animals that are characteristics of each period.

Presentation: The teacher presents the lesson to the student using Teaching-With-Analogy model as follows

Step I:

1. The cosmic Era: This is the gaseous stage of the earth. It is an era when the earth was in the gaseous state without any form of life. This era was about 3 billion years ago. The era lasted for about 400,000 million years.
2. The Azoic Era: This is an era that followed the cosmic era. It is the era when the earth was in the formation stage. This era too had no form of life. It was about 600 million years in duration.
3. The Archeozoic Era: This era came after the Azoic Era. It is the Era when the first evidence of life in the form of traces of carbon was found in rocks which were formed from living mud and sands. It is often referred to as an era of the first traces of life. Infact, the name of the Archeozoic means beginning of life. The era lasted for about 1 billion years.

4. The proterozoic Era: This era came after the Archezoic Era. The name of the Era-proterozoic means former life. During this era, simple forms of life continued to develop such simple forms of life included primitive worms and algae. These were rarely preserved in the rocks of this era, as such their fossils are difficult to come by. The proterozoic Era lasted for about 500 million years.

All the Era before Paleozoic Era which are the Cambrian as its first epoch, are collectively known as Precambrian Era. These Era lacked good fossils. Most texts do not indicate these Era in their Geological Time chart, which in most cases started with the paleozoic era.

Step II: The Paleozoic Era

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 unlike-the rocks of the Paleozoic 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. These are listed below along with their duration.

	Period/Epoch	**Duration (years Ago)**	**Duration (No. of Years)**
1.	Cambrian	500 million to 425 million	75 millions
2.	Ordovician	425 million to 375 million	50 million
3.	Silurian	375 million to 350 million	25 million
4.	Devonian	350 million to 300 million	50 million
5.	Carboniferous	300 million to 225 million	75 million
6.	Permian	225 million to 200 million	25 million

The Cambrian and Ordovician epochs, are known as the age of invertebrates. The Silurian and Devonian epochs, are known as the age of fishes. The carboniferous and Permian epochs are known as the age of amphibians. The characteristics dominant lives of each epoch are outlined below against each of the epochs of the Paleozoic.

	EPOCH/PERIOD	DOMINANT PLANTS	DOMINANT ANIMALS
1.	Cambrian	Algae	Marine invertebrates such as tritobites were dominant. Other species include crustaceans, molluses, echinoderms, sponges, Cnidarians annelids and tunicates
2.	Ordovicia	Algae	First vertebrates appeared (These were armored fishes called astracoderms). Dominant species include brachiopods and cephalopods.
3.	Silurian	First land plants appeared	Arthropods also invaded the land. Other species of animals include brachiopods and primitive jawless vertebrates.
4.	Devonian	First trees appeared	Fresh water species; first amphibians appeared
5.	Carboniferous	Ferns become dominant	Amphibians many: Sharks and bony fishes and bony fishes common; first reptiles appeared
6.	Permian (period of Wide –Spread)	Cycads and conifers present	Reptiles abundant; extinction of marine invertebrates

Step III: The Mesozoic Era

This 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 are listed below.

	EPOCH/PERIOD	DOMINANT PLANTS	DOMINANT ANIMALS
1.	Triasic	200 million to 160 million	40 millions
2.	Jurassic	160 million to 125 million	35 millions
3.	Cretaceous	125 million to 60 million	65 millions

The characteristics dominant lives of each epoch of this era are outlined below against each of the epoch of the Mesozoic era.

Dominant life of the main epochs of the Mesozoic era

	EPOCH/PERIOD	DOMINANT PLANTS	DOMINANT ANIMALS
1.	Triasic	Cycads and conifers become dominant	Origin of dinosaurs, turtles, icthysosaurs and plesiosaurs, rise of bony fishes
2.	Jurassic	First dominant Angiosperms appeared	Dominance of land sea and air. Archaic mammals appeared
3.	Cretaceous	Dominance of flowering plants commences	Extinction of and other large reptiles and animonites. Rise of mammals and modern insects.

Step IV: The Cenozoic era: This era came after the Mesozoic era. Its own rocks too contain a large number of fossils. The era lasted for about 60 million years, starting from 60 million years ago to the present time. The era covers 6 epochs. The period between Paleocene epoch and pilocene epoch is also known as the tertiary period. It is about 70 million years in duration, from 7o million years ago till the present time. This tertiary period is known as the Age of Mammals. The period between Pleistocene epoch and recent epoch is known as the quaternary period. It is about 1 million years in duration, spanning a period from 1 million years ago till the present time. This quaternary period is also known as the Age of Man.

2. Cueing students' memory to the analogy situation. Because it is difficult to interpret time in millions or billions of years, using a clock helps represent such vast span of time.

   – Have you ever seen a wall clock?
   – Do you have one in your house?
   – How does it look like?
   – What do we use it for?

3. Identify the features of the analogy that are relevant. Life began 3800-3000 million years ago, at 12.00 midnight. More than 10 hours later, at 10.18, the paleozoic era began. The beginning of the Mesozoic era, 200 millions years ago would be at 11.13. The Cenozoic era, which began 60 million years ago, would start at 11.52. The last epoch of the Cenozoic era, the Holocene epoch, began 10,000 years ago, which would be represented by the last 0.1 second before 12.00 noon.

   1 Second = 104,000 years

   1 minute = 6,250,000 years

   1 hour = 375,000,000 years

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

	Target	**Analogy**
1.	The earth begins about 3800 million years ago before cosmic era started from 3000 million years ago.	12.00 midnight
2.	Cosmic era started from 3000-2600 million years ago	12midnight-2:25
3.	Azoic era started from 2600-2000 million years ago	2.25-4.20
4.	Archeozoic era started from 2000-1000 million years ago	4.20-7.58
5.	1000-500 million years ago from Archeozoic era to proterozoic era	7.58-10.18
6.	Palezoic era from 500m-200 million years ago	10.18-11.13
7.	Mesozoic era 200 million years ago to 60 million years ago.	11.13-11.51
8.	Cenozoic era started from 60million years ago to the present day.	11.52-0.1 second before 12.00
96.	Last epoch which is Holocene began 10,000 years ago	0.1. second before 12.00

5. Identify where the analogy breaks down

– Different epoch/periods for each era are mental models while in the target concept different epoch/periods are real scientific findings with the duration which they began and lasted.

– Dominant animals for each epoch are not classified while in the target concept dominant animals for each epoch/periods are classified.

– Dominant plant species for each epoch/periods are not classified while in the target concept dominant plant species are classified.

6. Summarizes, drawing conclusions about the target concept.

– Earth begins about 3800 million years ago equivalent to 12.00 on the clock

- Cosmoc era is the gaseous stage of the earth from 3000-2600 million years ago
- Azoic era when the earth was in the formation stage from 2600-2000 million years ago
- Archeozoic era is the era of the traces of life about million years ago from 2000-1000 million years ago
- Proterozoic era lasted for 500million years ago, is the era of lowest forms of life from 1000-500 million years ago
- Paleozoic era is the reflection of the ancient type of life. The era contains dominant life, a large number of fossils and lasted for 300 million years, starting from 500 million to 200 million years ago. It has 6 major epochs or periods.

Mesozoic era has a lot of fossils and lasted for about 140 million years starting from 200 million years ago to 60 million years ago. The era referred to as the age of reptiles. The era is composed of 3 major epochs.

The Cenozoic era is known as age of mammals. It contains a large number of fossils started from 60 million years to the present time and the era covers 6 epochs. The period between paleocene and Pliocene is also known as the tertiary period. The period between Pleistocene and recent epoch is known as the quaternary period which is also known as age of man.

Evaluation: The teacher evaluates her lesson by asking students questions based on what she taught.

(i). Explain or discussed geological timetable in your own words.

(ii). Outline the eras in geological timetable

(iii). Write briefly on the main feature of the tertiary period of geological time scale.

Assignment

(1). Write briefly on the Cenozoic era

(2). Describe briefly the main features of the quaternary period of the Geological Time Scale.

The Experimental Group

Lesson 2

Teaching-With-Analogy Model

School: College of Education, Minna

Level: 300

Course: Bio 311

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

(v). Survival of the fittest

Entry Behaviour: Students have been seeing how people struggle for food, how they 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

The teacher introduces the lessons as follows:

Nature is always at work in any environment to pick on those individuals of a species that process desirable or favourable variations for survival whereas those with undesirable variations which cannot compete effectively in the environment die off.

Presentation: The teacher presents the lesson to the student using Teaching-With-Analogy model as follows

Step I

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.

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?

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, 135 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, student collect the colour noodles are just like natural selection.

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.

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

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 have favourable characteristics which adapt them for survival and are 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 Darwin theory of natural selection, competition, variation and survival of the fittest.

The Experimental Group

Lesson 3

Teaching-With-Analogy Model

School: College of Education, Minna

Level: 300

Course: Bio 311

Credit Unit: 2

Topic: Evidence for Evolution

Duration: 2hours

Instructional Materials: Polythene bags, cambium of the plant, shell of the snail, pictures of wings of different animals, models of different animals heart, models of different animal forelimbs, models of human being and rabbit skeleton, models of different embryo of animals, chloroquine injection or anti-malaria drug, and grasshopper of two colours brown and green.

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

(i). List the main evidences for evolution

(ii). Explain each evidences for evolution with examples

Entry Behaviour: Students have been taught concept of evolution that organisms do change from one type to another type over a long period of time, because of a number of facts which can be put forward to prove this.

Introduction

The teacher introduces her lesson that evidences have been gathered from several sources, among which are various fields of biology, such as taxonomy, morphology, anatomy among others. The evidences for evolution differ not only in their sources, but also in their degrees of complexity and the ease with which they can be demonstrated to people. These evidences can be grouped into two: Direct and Indirect evidences.

Presentation: The teacher presents the lesson to the student using Teaching-With-Analogy model as follows

Step I

1. Introduce the target concept to be learned.

Direct evidences for evolution are those evidences which are either documented in the life time of many people or can be affected in present day time. These are:

(i). Evidence from industrial melanism in the peppered moth: The peppered moth *(Biston betularia)* was known to be existing in two varieties. These varieties were the light coloured and the dark coloured varieties. The moth with the light colour was easily recognized against dark coloured background by predatory birds which fed on them. It was observed that in Manchester-an industrial city in Britain, that as from 1850 upwards, the form with uniformly dark colour grew in number, while that with light colour decreased. At a time, the proportion of the dark to the light colour variety was about 98% of the whole population of the moths. This dark coloured variety because of its being well camouflaged was not easily recognized by the predatory birds against the dark and sooty background of this industrial city. With time, all the light coloured types disappeared, while the dark coloured type flourished. This helps to illustrate the evolution of a new type from a previously existing type, through natural selection.

Evolution from resistance of organisms.

Several examples of resistance of organisms to chemicals used in attacking them or drugs used in treating diseases caused by them are now known. Such organisms are known to develop certain individuals within their population, which are resistant to the chemicals or drugs used in attacking them. With time, all the non-resistant individuals within their populations are killed off, while only the resistant individuals are left. These resistant individuals multiply their type and with time, only such resistant types are left as new species. An example of resistant to penicillin, examples of resistance of organisms to pesticides are seen in insects to certain insecticides e.g. DDT and rats and rodents to rodenticides such as warfarm.

Selective Breeding by Man

Man has over the ages brought about selective breeding in plants and animals to produce new strains of plants and animals. Examples of plants are maize and rice while examples of animals are dogs and horses. These examples represent the involvement of man in bringing about what nature is doing through mutation.

Step II: Indirect evidence for evolution include:

Fossils are remains of plants and animals or impressions of plants and animals structure that were once buried in sedimentary rocks. Animals parts commonly found as fossils include bones, shells, teeth and scales. The cellwalls of plants, especially the lignified cellwalls are also common among plant fossils. The sedimentary rocks which are found occurring in layers (strata) in undisturbed places, have the fossils in the various layers. It is therefore easy to have an idea of the age of fossils and their relationships to each other in order in which they are found in the rock strata. From studies carried out on fossils of vertebrates, it has been established that the amphibians originated from the fishes, while the amphibians give rise to reptiles and the reptiles have also given rise to both the birds and the mammals. Evidence from fossils has also been used to construct the probable life forms of the ancestors and the sequence of evolution of the modern day horse. Fossil evidences have also contributed immensely to the understanding of the evolution of man.

Besides the use of fossils to reconstruct the evolutionary history of different organisms, studies on fossils have also been used to construct the geological periods and the evolutionary history of different organisms that form fossils in the rocks of the various geological periods. This is possible through radioactive dating methods. The potassium-argon method of radioactive dating has been found to be useful in dating samples of rocks that are over three billion years in age. Radioactive fossils and other carbon-containing rock samples of relatively younger age can be dated using radioactive carbon dating.

Step III: Comparative Embryology

Embryologists who study the development of organisms from conception to birth that various groups of organisms, although different as adults, possessed early developmental stages that were quite similar. Example, the embryological development of vertebrate animals is similar in that all vertebrate embryos have a similar number of gill arches, seen as pouches below the head. Only fish, however, actually develop gills. Likewise, the embryological development of the backbone of vertebrates is similar, but some organisms develop a tail, and others such as humans do not.

Evidence from Taxonomy

Taxonomists can place organisms in a sort of hierarchical system of classification on the basis of their structure. In this classification, the simple organisms come before the complex ones. This is only possible because the organisms are related by descent with modification.

Step IV: Evidence from Comparative Morphology

Structure present in different groups of organisms which have similarity of embryonic origin and development together with basic structural similarity, are said to be homologous. Such structures indicate common ancestor and relationship in the evolution of organism possessing them, irrespective of whether they serve the same or different functions in these organisms. Homologous structures are in contrast to analogous structures which are structures that are similar in their functions, but not in their origin or evolution. Examples of analogous structures include wings of insects, those of birds and those of bats. Homologous structures that help to indicate evolution of the vertebrates from a common ancestor include their skulls, vertebral column, skeletal girdles and the form of the limbs which are the same in all vertebrate groups except the fishes. The tetraped vertebrate limbs are based on a common pentadactyl plan, which is also described as a five-digit plan. The epidermal tissue of vertebrates may also be modified into hairs, hooves, nails, claws, feathers and scales.

The modifications in the basic plan in homologous structures are brought about the process of adaptive radiation which leads to divergent evolution. Where however structures that have different origin have became adapted to a common function as in analogous structure such structures are said to show convergent evolution.

Evidence from Comparative Anatomy

Vertebrates are similar in some other anatomical structures. Examples of these include the ventral muscular heart, hollow dorsal central nervous system and the kidneys which are composed of kidney tubules. Other anatomical structures in vertebrates show similarity in the general plan of construction in both the living and fossil types, indicate evolution of the vertebrates from a common ancestor which posses all the afore listed characteristics.

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

– Have you ever seen a polythene bag buried in the ground?

– Have you ever seen the shell of a snail?

– What are the wings of birds used for?

– Have you ever seen the Cambium of tree?

– Have you ever seen an embryo before?

– Do you know that you have a tail?

– Where is your fore–limbs?

– Does all animals have a heart? Touch it

– Look at a grasshopper, how many colours are they.

- Where are they found?

– Have you ever been given anti-malaria injections?

– How do you feel after taken it?

3. Identify the features of the analogy that are relevant

Teacher will take the students to the outside environment an area of former refuse disposal then teacher will ask them to dig out a polythene bag from the ground with a hoe. The shell of a snail that have kept for long in the laboratory can be showed to the student to predict how old the shell has existed or live. Evolution produces seemingly similar structures in organisms having quite different ancestral origins. Such structures are described as analogous. Generally they perform the same function, though possibly in a different ways. Possession by organisms or their parts of similar functions but of different structure and origin are homologous. The wings of an insect are analogous to the wings of a bat or a bird. Different animals' hearts show how evolutionary relationship exists between individuals on the basis of structural similarities and also suggesting a common origin.

The embryos of various groups of vertebrate animals show the primitive features that all vertebrate animals share early in development, such as gill arches and a tail. This is evidence that they evolved from a common ancestor. Homologous among the fore-limbs of four mammals and a frog show the ways that the proportions of the bones have changed in relation to the particular way of life of an organism and that the forelimbs of each animal has the same basic bone structures.

Structures which are thus reduced are known as vestigal, and their existence has been used as strong evidence for evolution. The third digit is very much reduced and the fourth and fifth are missing altogether in birds wing human beings have a tail bone but no tail because it is not in used. Vestigial structures occur because organisms inherit their anatomy from their ancestors. Teacher will take the students to an outside environment where I will have spread two colours of grasshopper earlier. Teacher will then ask the student to go into the field to catch the grasshopper they see and then unseen colour grasshoppers are left. Mosquito parasite do resist the anti-malaria drugs because they were able to produce individuals that are resistant to drug or ineffectiveness of the drug or not powerful enough. When a tree is cut down, the cambium can be study to know how long the tree has live or exist.

– In analogy the buried polythene bag, shell of a snail and cambium of a tree are just like the fossils in the target.
– In analogy the two colour grasshoppers are just like industrial mechanism in the peppered moth in the target.
– In analogy mosquito parasite resistant to anti-malaria drugs are just like Evolution from resistance of organisms in the target.
– In analogy models of the fore-limbs, wings, tails and reduce digit are just like comparative morphology in the target
– In analogy the models of heart and skull are just like comparative anatomy in the target.
– In analogy the models of different embryo are just like comparative embryology in the target.

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

Target	**Analogy**
Industrial melanism in the peppered moth of light and dark coloured	Grasshopper of two different colours brown and green
Bird predatory to catch moth	Students to catch grasshopper
Fossils	Buried polythene bag, shell of a snail and cambium of a tree.
Heart, fore-limb, wings are comparative morphology and anatomy	Pictures and models of heart, fore-limbs and wings
Embryo of different animals as comparative embryology	Models of different embryo
Bacteria resistance to antibiotics as resistance of organism	Malaria parasite resistance to anti-malaria drug.

5. Identify where the analogy breaks down

- In the target the light coloured moth peppered disappeared while in analogy none of the grasshopper disappeared.
- In the target potassium-argon method of radioactive dating samples of rocks that are over three billion years ago are mention while in analogy this is not mention.
- In the target evidence from taxonomy is explain while in analogy is not explained.
- In the target, tail in human being is not seen but can be seen in rabbit as vestigial structure while in the model of human being and rabbit skeleton tails are seen.

6. Drawing conclusion about the target concept

Fossils are impressions organisms that once lived; provide a record of the past. Comparative studies of animal anatomy show that many organisms have groups of bones, nerves, muscles and organs with the same anatomical plan but with different functions. These homologous structures provide evidence of evolutionary relatedness. Comparative embryological studies show that many organisms have early developmental stages that are quite similar. These similar developmental forms provide evidence of evolutionary relatedness. In some groups organisms, some of these structures which are poorly developed in a number of organisms, well developed in some of their living relatives. Such structures in this poor state of development are called vestigial organs. Evidence from taxonomy is concern with the sort of hierarchical system of classification on the basis of their structure.

Evaluation: The teacher evaluates her lesson by asking students questions based on what she taught.

(i). What are fossils?

(ii). Where are they commonly found and how do they get there

(iii). Differentiate between homologous and a analogous structures giving examples.

Assignment

(i). Where are vestigal structures

(ii). Give 5 examples of vestigal structures in man

(iii). Explain how vestigal structures have been used to explain evolution

The Experimental Group

Lesson 4

Teaching-With-Analogy Model

School: College of Education, Minna

Level: 300

Course: Bio 311

Credit Unit: 2

Topic: 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

(iii). Biochemical evolution

Entry Behaviour

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

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 student using Teaching-With-Analogy model as follows

Step I

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: Life from Outer Space

This hypothesis explains the origin of life as being due to certain materials described as meteorites, being forcibly ejected into this planet earth, from an outer space well above the earth. These materials are said to be transformed into living things on landing on earth.

Theory of Steady State

This theory which is also known as the theory of eternity is a theory which states that the universe has no beginning. It also has no end. This theory believes that the organisms living on earth today were as they are now in the past, and will remain unchanged till eternity.

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 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.

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?

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

You are made up of cells. Infact 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 will quickly get a box of building bricks or blocks from the drawer. Teacher will 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.

4. Map the similarities between the analogy and the target

	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.

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.

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. Explain briefly the modern day belief on the origin of life.

Assignment

Write briefly on the hypotheses that have been postulated to explain the origin of life.

The Experimental Group

Lesson 5

Teaching-With-Analogy Model

School: College of Education, Minna

Level: 300

Course: Bio 311

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
2. Write briefly note on
    - i. Dryopithecus
    - ii. Australopithecus
3. Discuss
    - i. Homo habilis
    - ii. Homo erectus
    - iii. Homo sapiens

Entry Behaviour: Student have been seeing 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 using Teaching-With-Analogy model 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. 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: 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 V: 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.

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?

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, 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.

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

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.

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. Write briefly on
   i. Dryopithecus
   ii. Australopithecus

Assignment

Explain the following

i. Homo habilis

ii. Homo erectus iii. Homo sapiens

APPENDIX F

The Control Group

Lesson 1

Lecture Method

School: Federal College of education, Kontagora

Level: 300

Course: Bio 311

Credit Unit: 2

Topic: Geological Time Table

Duration: 2hours

Instructional Materials: Picture of a clock with representative of life forms for each era.

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

(a). Define the term Geological Time Table

(b). Describe various sections of the Geological Time Chart

(i). Cosmic Era

(ii). Azoic Era

(iii). Archeozoic Era

(iv). Proterozoic Era

(v). Paleozoic Era

(vi). Mesozoic Era

(vii). Cenozoic Era

Entry Behaviour: The students had some knowledge about evolution from their O' levels. They have being seeing charges in the characteristics of a population of a species over several generations, with resultant formulation of a new species.

Introduction

The teacher introduces her lesson by defining the term Geological Time Table. It is a chart 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. It also gives summary of the plants and animals that are characteristics of each period.

Presentation: The teacher presents the lesson to the students as follows:

Step I:

1. The cosmic Era: This is the gaseous stage of the earth. It is an era when the earth was in the gaseous state without any form of life. This era was about 3 billion years ago. The era lasted for about 400,000 million years.
2. The Azoic Era: This is an era that followed the cosmic era. It is the era when the earth was in the formation stage. This era too had no form of life. It was about 600 million years in duration.
3. The Archeozoic Era: This era came after the Azoic Era. It is the Era when the first evidence of life in the form of traces of carbon was found in rocks which were formed from living mud and sands. It is often referred to as an era of the first traces of life. Infact, the name of the Archeozoic means beginning of life. The era lasted for about 1 billion years.

4. The proterozoic Era: This era came after the Archezoic Era. The name of the Era-proterozoic means former life. During this era, simple forms of life continued to develop such simple forms of life included primitive worms and algae. These were rarely preserved in the rocks of this era, as such their fossils are difficult to come by. The proterozoic Era lasted for about 500 million years.

All the Era before Paleozoic Era which are the Cambrian as its first epoch, are collectively known as Precambrian Era. These Era lacked good fossils. Most texts do not indicate these Era in their Geological Time chart, which in most cases started with the paleozoic era.

Step II: The Paleozoic Era

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 unlike-the rocks of the Paleozoic 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. These are listed below along with their duration.

	Period/Epoch	**Duration (years Ago)**	**Duration (No. of Years)**
1.	Cambrian	500 million to 425 million	75 millions
2.	Ordovician	425 million to 375 million	50 million
3.	Silurian	375 million to 350 million	25 million
4.	Devonian	350 million to 300 million	50 million
5.	Carboniferous	300 million to 225 million	75 million
6.	Permian	225 million to 200 million	25 million

The Cambrian and Ordovician epochs, are known as the age of invertebrates. The Silurian and Devonian epochs, are known as the age of fishes. The carboniferous and Permian epochs are known as the age of amphibians. The characteristics dominant lives of each epoch are outlined below against each of the epochs of the Paleozoic.

	EPOCH/PERIOD	DOMINANT PLANTS	DOMINANT ANIMALS
1.	Cambrian	Algae	Marine invertebrates such as tritobites were dominant. Other species include crustaceans, molluses, echinoderms, sponges, Cnidarians annelids and tunicates
2.	Ordovicia	Algae	First vertebrates appeared (These were armored fishes called astracoderms). Dominant species include brachiopods and cephalopods.
3.	Silurian	First land plants appeared	Arthropods also invaded the land. Other species of animals include brachiopods and primitive jawless vertebrates.
4.	Devonian	First trees appeared	Fresh water species; first amphibians appeared
5.	Carboniferous	Ferns become dominant	Amphibians many: Sharks and bony fishes and bony fishes common; first reptiles appeared
6.	Permian (period of Wide –Spread)	Cycads and conifers present	Reptiles abundant; extinction of marine invertebrates

Step III: The Mesozoic Era

This 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 are listed below.

	EPOCH/PERIOD	DOMINANT PLANTS	DOMINANT ANIMALS
1.	Triasic	200 million to 160 million	40 millions
2.	Jurassic	160 million to 125million	35 millions
3.	Cretaceous	125 million to 60 million	65 millions

The characteristics dominant lives of each epoch of this era are outlined below against each of the epoch of the Mesozoic era.

Dominant life of the main epochs of the Mesozoic era

	EPOCH/PERIOD	DOMINANT PLANTS	DOMINANT ANIMALS
1.	Triasic	Cycads and conifers become dorminant	Origin of dinosaurs, turtles, icthysosaurs and plesiosaurs, rise of bony fishes
2.	Jurassic	First dominant Angiosperms appeared	Dominance of land sea and air. Archaic mammals appeared
3.	Cretaceous	Dominance of flowering plants commences	Extinction of and other large reptiles and animonites. Rise of mammals and modern insects.

Step IV: The Cenozoic era: This era came after the Mesozoic era. Its own rocks too contain a large number of fossils. The era lasted for about 60 million years, starting from 60 million years ago to the present time. The era covers 6 epochs. The period between Paleocene epoch and pilocene epoch is also known as the tertiary period. It is about 70 million years in duration, from 7o million years ago till the present time. This tertiary period is known as the Age of Mammals. The period between Pleistocene epoch and recent epoch is known as the quaternary period. It is about 1 million years in duration, spanning a period from 1 million years ago till the present time. This quaternary period is also known as the Age of Man.

Summary: Earth begins about 3800 million years ago equivalent to 12.00 on the clock

– Cosmic era is the gaseous stage of the earth from 300-3600 million years ago

– Azoic era when the earth was in the formation stage from 2600-2000 million years ago

– Archeozoic era is the era of the traces of life about million years ago from 2000-1000 million years ago

– Proterozoic era lasted for 500million years ago, is the era of lowest forms of life from 500-200 million years ago

– Paleozoic era is the reflection of the ancient type of life. The era contains dominant life, a large number of fossils. The era lasted for 300 million, starting from 500 million to 200 million year ago. It has 6 major epochs or periods.

Mesozoic era is the era has a lot of fossils and lasted for about 140 million years starting from 200 million years ago to 60 million years ago. The era referred to as the age of reptiles. The era is composed of 3 major epochs.

The Cenozoic era is known as age of mammals. It contains a large number of fossils started from 60 million years to the present time and the era covers 6 epochs. The period between palesocene and Pliocene is also known as the tertiary period. The period between Pleistocene and recent epoch is known as the quaternary period which is also known as age of man.

Evaluation: The teacher evaluates her lesson by asking students questions based on what she taught.

(i). Explain geological timetable in your own words.

(ii). Outline the era geological timetable

(iii). Write briefly on the main feature of the tertiary period of geological time scale.

Assignment

(1). Write briefly on the Cenozoic era

(2). Describe briefly the main features of the quaternary period of the Geological Time Scale.

The Control Group

Lesson 2

Lecture Method

School: College of Education, Kontagora

Level: 300

Course: Bio 311

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

(v). Survival of the fittest

Entry Behaviour: Students have been seeing 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

The teacher introduces the lesson by as follows:

Nature is always at work in any environment to pick on those individuals of a species that process desirable or favourable variations for survival whereas those with undesirable variations which cannot compete effectively in the environment die off.

Presentation: The teacher presents the lesson to the student as follows

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.

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: Federal College of Education, Kontagora

Level: 300

Course: Bio 311

Credit Unit: 2

Topic: Evidence for Evolution

Duration: 2hours

Instructional Materials: Polythene bags, cambium of the plant, shell of the snail, pictures of wings of different animals, picture of different animals heart, picture of the animal fore-limbs, grasshopper of two colours brown and green, models of different embryo of animals, models of human and rabbit skeleton and chloroquine injection or anti-malaria drug.

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

(i). List the main evidences for evolution

(ii). Explain each evidences for evolution with examples

Entry Behaviour: Students have been taught concept of evolution that organisms do change from one type to another type over a long period of time, because of a number of facts which can be put forward to prove this.

Introduction

The teacher introduces her lesson that evidences have been gathered from several sources, among which are various fields of biology, such as taxonomy, morphology, anatomy among others. The evidences for evolution differ not only in their sources, but also in their degrees of complexity and the ease with which they can be demonstrated to people. These evidences can be grouped into two: Direct and Indirect evidences.

Presentation: The teacher presents the lesson to the student as follows

Step I: Direct evidences for evolution are those evidences which are either documented in the life time of many people or can be effected in present day time. These are:

(i). Evidence from industrial melanism in the peppered moth: The peppered moth *(Biston betularia)* was known to be existing in two varieties. These varieties were the light coloured and the dark coloured varieties. The moth with the light colour was easily recognized against dark coloured background by predatory birds which fed on them. It was observed that in Manchester-an industrial city in Britain, that as from 1850 upwards, the form with uniformly dark colour grew in number, while that with light colour decreased. At a time, the proportion of the dark to the light colour variety was about 98% of the whole population of the moths. This dark coloured variety because of its being well camouflaged, was not easily recognized by the predatory birds against the dark and sooty background of this industrial city. With time, all the light coloured types disappeared, while the dark coloured type flourished. This helps to illustrate the evolution of a new type from a previously existing type, through natural selection.

Step II: Evolution from resistance of organisms.

Several examples of resistance of organisms to chemicals used in attacking them or drugs used in treating diseases caused by them are now known. Such organisms are known to develop certain individuals within their population, which are resistant to the chemicals or drugs used in attacking them. With time, all the non-resistant individuals within their populations are killed off, while only the resistant individuals are left. These resistant individuals multiply their type and with time, only such resistant types are left as new species. Examples of resistance of organisms to pesticides are seen in insects to certain insecticides e.g. DDT and rats and rodents to rodenticides such as warfarm.

Selective Breeding by Man

Man has over the ages brought about selective breeding in plants and animals to produce new strains of plants and animals. Examples of plants are maize and rice while examples of animals are dogs and horses. These examples represent the involvement of man in bringing about what nature is doing through mutation.

Step III: Indirect evidence for evolution include:

Fossils are remains of plants and animals or impressions of plants and animals structure that were once buried in sedimentary rocks. Animals parts commonly found as fossils include bones, shells, teeth and scales. The cellwalls of plants, especially the lignified cellwalls are also common among plant fossils. The sedimentary rocks which are found occurring in layers (strata) in undisturbed places, have the fossils in the various layers. It is therefore easy to have an idea of the age of fossils and their relationships to each other in order in which they are found in the rock strata. From studies carried out on fossils of vertebrates, it has been established that the amphibians originated from the fishes, while the amphibians give rise to reptiles and the reptiles have also given rise to both the birds and the mammals. Evidence from fossils have also been used to construct the probable life forms of the ancestors and the sequence of evolution of the modern day horse. Fossil evidences have also contributed immensely to the understanding of the evolution of man.

Besides the use of fossils to reconstruct the evolutionary history of different organisms, studies on fossils have also been used to construct the geological periods and the evolutionary history of different organisms that form fossils in the rocks of the various geological periods. This is possible through radioactive dating methods. The potassium-argon method of radioactive dating has been found to be useful in dating samples of rocks that are over three billion years in age. Radioactive fossils and other carbon-containing rock samples of relatively younger age, can be dated using radioactive carbon dating.

Step IV: Evidence from Taxonomy

Taxonomists can place organisms in a sort of hierarchical system of classification on the basis of their structure. In this classification, the simple organisms come before the complex ones. This is only possible because the organisms are related by descent with modification.

Evidence from Comparative Morphology

Structure present in different groups of organisms which have similarity of embryonic origin and development together with basic structural similarity, are said to be homologous. Such structures indicate common ancestor and relationship in the evolution of organism possessing them, irrespective of whether they serve the same or different functions in these organisms. Homologous structures are in contrast to analogous structures which are structures that are similar in their functions, but not in their origin or evolution. Examples of analogous structures include wings of insects, those of birds and those of bats. Homologous structures that help to indicate evolution of the vertebrates from a common ancestor include their skills, vertebral column, skeletal girdles and the form of the limbs which are the same in all vertebrate groups except the fishes. The tetraped vertebrate limbs are based on a common pentadactyl plan, which is also described as a five-digit plan. The epidermal tissue of vertebrates may also be modified into hairs, hooves nails, claws, feathers and scales.

The modification in the basic plan in homologous structures are brought about by the process of adaptive radiation which leads to divergent evolution where however structures that have different origin and have became adapted to a common function as in analogous structure such structures are said to show convergent evolution.

Evidence from Comparative Anatomy

Vertebrates are similar in some other anatomical structures. Examples of these include the ventral muscular heart, hollow dorsal central nervous system and the kidneys which are composed of kidney tubules. Other anatomical structures in which vertebrates show a similarity in the general plan of construction in both the living and fossil types, indicate evolution of the vertebrates from a common ancestor which possesses the fore listed characteristics.

Comparative Embryology

Embryologists who study the development of organisms from conception to birth that various groups of organisms, although different as adults, possessed early developmental stages that were quite similar. Example, the embryological development of vertebrate animals is similar in that all vertebrate embryos have a similar number of gill arches, seen as pouches below the head. Only fish, however, actually develop gills. Likewise, the embryological development of the backbone of vertebrates is similar, but some organisms develop a tail, and others such as humans do not.

Summary: Fossils are impressions organisms that once lived, provide a record of the past. Comparative studies of animal anatomy show that many organisms have groups of bones, nerves, muscles and organs with the same anatomical plan but with different functions. These homologous structures provide evidence of evolutionary relatedness. Comparative embryological studies show that many organisms have early developmental stages that are quite similar. These similar developmental forms provide evidence of evolutionary relatedness. In some groups organisms, some of these structures which are poorly developed in a number of organisms, well developed in some of their living relatives. Such structures in this poor state of development are called vestigial organs. Evidence from taxonomy is concern with the sort of hierarchical system of classification on the basis of their structure.

Evaluation: The teacher evaluates her lesson by asking students questions based on what she taught.

(i). What are fossils?

(ii). Where are they commonly found and how do they get there (iii). Differentiate between homologous and a analogous structures giving examples.

Assignment

(i). Where are vestigal structures

(ii). Give 5 examples of vestigal structures in man

(iii). Explain how vestigal structures have been used to explain evolution

The Control Group

Lesson 4

Lecture Method

School: Federal College of education, Kontagora

Level: 300

Course: Bio 311

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

(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). Life from outer space

(d). Steady state

(e). 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 materials.

Step III: Life from Outer Space

This hypothesis explains the origin of life as being due to certain materials described as meteorites, being forcibly ejected into this planet earth, from an outer space well above the earth. These materials are said to be transformed into living things on landing on earth.

Theory of Steady State

This theory which is also known as the theory of eternity is a theory which states that the universe has no beginning. It also has no end. This theory believes that the organisms living on earth today were as they are now in the past, and will remain unchanged till eternity.

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.

Lesson 5

Lecture Method

School: Federal College of Education, Kontagora

Level: 300

Course: Bio 311

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
2. Write briefly note on
   - i. Dryopithecus
   - ii. Australopithecus
3. Discuss
   - i. Homo habilis
   - ii. Homo erectus
   - iii. Homo sapiens

Entry Behaviour: Student have been seeing 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: 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 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
   i. Dryopithecus
   ii. Australopithecus

Assignment

Explain the following

i. Homo habilis

ii. Homo erectus

iii. Homo sapiens

APPENDIX G

t-test Analysis of the Mean Performance Scores of the Experimental and Control Groups on the Pretest.

Variable	N	$\overline{X}$	SD	SE	df	t-cal	p-value	Remarks
Experimental	135	10.18	2.80	0.24	278	41.96	0.001	S
Control	145	9.44	2.63	0.21				

APPENDIX H

Item Analysis of EAT 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

F = Facility Index

D = Discriminatory Index

* = Items which were reconstructed