# EFFECTS OF SCIENCE - TECHNOLOGY - SOCIETY (STS) INSTRUCTIONAL STRATEGY ON ACADEMIC PERFORMANCE IN SELECTED GENETIC CONCEPTS AMONG NCE STUDENTS.

**BY**

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## DECLARATION

I hereby declare that this thesis written by me, titled **"Effects of Science – Technology – Society Instructional Strategy on Academic Performance in selected Genetic Concepts among NCE Students",** is a true record of my research work in the department of education under the supervision of Dr. A. I. Usman and Dr. J.S Mari and has not been presented in any previous application for a higher degree or published in any book. In the course of writing this thesis, references were made to various sources of information. These were duly acknowledged.

_____ _____

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# CERTIFICATION

The under signed certify that the thesis entitled "EFFECTS OF SCIENCE-TECHNOLOGY - SOCIETY INSTRUCTIONAL STRATEGY ON ACADEMIC PERFORMANCE IN SELECTED GENETIC CONCEPTS AMONG NCE STUDENTS" by Dambana Bature Tete meets the regulations governing the award of a Masters Degree of Ahmadu Bello University, Zaria and it is approved for literacy presentation.

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## DEDICATION

This thesis is dedicated to my family who stood by me during the course of my study.

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## ABSTRACT

This study was carried out to determine the effects of Science- Technology- Society (STS) instructional strategy on NCE students performance in selected genetic concepts. The effect of this strategy on gender difference was also investigated. The target population was the NCE students studying biology in the colleges of education in north-west zone of Nigeria totaling 837. For the teaching treatment two schools were purposefully selected based on some factors common to both of them. One college served as the experimental and the other as the control, after sampling using balloting method . The study sample consisted of one hundred (100) students, 50 from each college. There were 59 male and 41 female students. The control group was taught using the traditional (lecture) method while the experimental was taught using the STS strategy which was based on the jurisprudential model of Pederson (1992). Both groups were pre and post tested. The major instrument for the study was Genetic Concepts Achievement Test (GAT). The data collected were analyzed using t-test statistics at a significant level of 0.05. Four questions which translated to hypotheses were tested. The findings of the study are as follows: The experimental group(exposed to STS strategy) performed significantly better than the control group(exposed to traditional method of instruction). There was no statistically significant difference between the performance of male and female students taught using STS approach, showing that STS is gender friendly. Based on these results recommendations were made, one of which was the sensitization of various stakeholders on the need for the adoption of STS instructional approach in the teaching and learning of genetics, biology and science courses at all levels.

## TABLE OF CONTENTS


Title Page - - - - - - - - - - i

Declaration - - - - - - - - - - ii

Certification - - - - - - - - - - iii

Dedication - - - - - - - - - - iv

Acknowledgement - - - - - - - - - v

Abstract - - - - - - - - - - vi

Table of Contents - - - - - - - - - vii

List of Tables - - - - - - - - - - x

List of Figures - - - - - - - - - - xi

List of Appendices - - - - - - - - - xii

Abbreviations - - - - - - - - - - xiii

Operational Definition of Terms - - - - - - - - - xiv

**CHAPTER ONE: THE PROBLEM**

1.1 Introduction - - - - - - - - - 1

1.1 Theoretical Frame Work - - - - - - - - - 7

1.2 Statement of the Problem - - - - - - - - 8

1.3 Objectives of the Study - - - - - - - - - 10

1.4 Research Questions - - - - - - - - - 10

1.5 Hypotheses - - - - - - - - - - 10

1.6 Significance of the Study - - - - - - - - 11

1.7 Delimitation of the Study- - - - - - - - - 11

1.8 Basic Assumptions - - - - - - - - - 12

## CHAPTER TWO: LITERATURE REVIEW


2.1 Introduction- - - - - - - - - - 13

2.2 Science Teaching Methods - - - - - - - - 13

2.3 Lecture Method in Science Teaching - - - - - - - 16

2.4.1 STS Instructional Strategy - - - - - - - 17

2.4.2 Rationale for Teaching Biology by STS Strategy - - - - - - 24

2.4.3 Studies on Genetics and Achievement in Science - - - 24

2.4.4 Studies on genetics and Achievement - - - - 25

2.5 Gender and Achievement in Science - - - - - 26

2.6 Overview of Related Studies on STS Strategy - - - - 28

2.7 Implications of Literature Review on the Present Study. - - 29


## CHAPTER THREE: METHODOLOGY


3.1 Introduction - - - - - - - - - 31

3.2 Research Design - - - - - - - - - 31

3.3 Population of the Study - - - - - - - - 32

3.4 Sample and Sampling Procedure - - - - - 33

3.5 Selection of Topics for the Study - - - - - - - 34

3.6. Pilot Testing - - - - - - - - - 35

3.7.0 Instrumentation - - - - - - - - - 35

3.7.1 Validation of Genetics Achievements Test (GAT) - - - - 35

3.7.2 Reliability of Genetics Achievement Test (GAT) - - - - 36

3.7.3 Item Characteristics (Facility Index FI) - - - - - 36

3.7.4 Item Characteristics (Discriminatory Index DI) - - - - 36

3.8 Administration of Treatment - - - - - - - 38

3.9 Data Analysis - - - - - - - - - 40

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

4.1 Introduction - - - - - - - - - 41

4.2 Hypotheses Testing - - - - - - - - - 41

4.3 Summary of Findings - - - - - - - - - 43

4.4 Discussion - - - - - - - - - - 44

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

5.1 Introduction - - - - - - - - - 47

5.2 Summary - - - - - - - - - - 47

5.3 Conclusions - - - - - - - - - 48

5.4 Recommendations - - - - - - - - 49

5.5 Limitations - - - - - - - - - 50

5.6 Suggestions for Further Studies - - - - - 50

References - - - - - - - - - 51

## *LIST OF TABLES*


Table 1.1: First Semester Examination Reports of NCE II 2004-2009 - - 9

Table 3.1: The Study Population - - - - - - 33

Table 3.2: Sample for the Study - - - - - - 34

Table 4.1: t-test Analysis of Mean Scores of STS Group and Lecture Method Group 41

Table 4.2: t-test Analysis of Mean Academic Scores of Male Experimental Group and Male Control Group. - - - - - 42

Table 4.3: t-test Analysis of Mean Scores of Female STS Group and Female Lecture Method Group - - - - - 42

Table 4.4: t-test Analysis of Mean Scores of Male STS Group and Female STS Group - - - - - - - 43

## LIST OF FIGURES

Figure 3.1: Research Design - - - - 32

Figure 3.2 STS Jurisprudential Model - - - 39

**LIST OF APPENDICES**


| | | |
|---|---|---|
| Appendix A: | Item Analysis for Achievement Test - - - | 58 |
| Appendix B: | Table of Specification of Questions - - - | 59 |
| Appendix C: | Lessons for Control Group - - - | 60 |
| Appendix D: | Lessons for Experimental Group - - - | 94 |
| Appendix E (i, ii iii): | Requests for Validating a Research Instrument - | 130 |
| Appendix F: | Genetics Achievement Test (GAT) - - - | 139 |
| Appendix G: | GAT Marking Scheme - - - | 144 |


3

## ABBREVIATIONS

| | |
|---|---|
| STS | – Science – Technology – Society |
| GAT | – Genetics Achievement Test |
| STAN | - Science Teachers Association of Nigeria |
| NCCE | - National Commission for Colleges of Education |
| IT | - Information Technology |
| CALI | - Computer Assisted Learning Institution |
| ANOVA | - Analysis of Variance |
| PPMCC | - Person Product Moment Correlation Coefficient |

## OPERATIONAL DEFINATION OF TERMS

1. **Science – Technology – Society (STS)**: is a teaching strategy in which Science is presented in the content of societal issues through relevant technology.
2. **STS Jurisprudential Model**: this is just one of the many STS instructional strategies. This model was adopted by Pederson (1992).

**Traditional Method of Learning**: prevalent lecture method of teaching

# CHAPTER ONE
# THE PROBLEM

## 1.0 Introduction

Biology is a widely read subject in schools probably because of its greater relevance to man and other organisms than any other science subject. The importance of biology to man is seen in its application in agriculture, medicine and psychology. At the secondary school level, whether the school is purely commercial, technical or comprehensive, the study of biology is compulsory. This is not so with other sciences. It becomes necessary therefore, not only to produce teachers who can teach biology but to teach would-be teachers how the subject can be presented through the use of appropriate methods of teaching. The effectiveness of any subject is measured in terms of the knowledge of what to teach, how and when to teach it, (Archibong 1997).

The 'how' of teaching constitutes what is called 'teaching strategy'. Investigations into teaching strategies especially in biology have received greater attention now than ever before. Pwol (1999) traces the poor performance of Nigerian students in Senior School biology examination to activities of the teachers and students in the biology classroom. Nwosu(1999) reported that students performance in biology has not shown any remarkable improvement over and above what it used to be following the introduction of the innovative curricular materials and strategies. Nwosu (2004) also observed that the performance of students in biology is not any better than in the years that preceded the introduction of the new curricular materials and teaching strategies. The major reason for the prevalent poor performance among students has been attributed to teachers' persistence in adhering to traditional method of teaching in Nigeria (Akinsola & Igwe 2002). The major problem that comes with traditional method of teaching according to [Yager 1993], is that concepts are presented as bits of information which are to be mastered for teachers' tests. This results in poor mastery and retention of concepts. This method

does not only promote teachers centered learning, it fails to relate science to personal needs of the learner and the society at large. The concepts are not presented in a way learners can recognize and relate them to solve real life problems. Akubuilo (2004) observed that creativity is not spurred up nor students' interest ignited in the classroom by the teacher.

What are the present strategies used by teachers? As of now it is difficult to point at a particular strategy used by a biology teacher. However, strategies reported in literature include lecture, discussion, field trips, inquiry, concept mapping e.t.c, (Nkadi 1998). While many strategies abound in teaching various concepts of biology, their effectiveness vary by as wide a margin as 10 – 90 percent, (Adara 1996). Cronchback and Snow (1997) noted that differences in intellectual functioning among learners require variations of and differences in instructional strategies. Bajah (1995) points out that unless science is taught through different forms of teaching, development in science will not be effective.

The NCE biology curriculum revised by the National Commission for Colleges of Education (2005) has as one of its objectives, the production of highly motivated, knowledgeable and effective teachers of biology who will be able to develop in students appreciation and understanding of biological processes and principles. The NCE biology programme is also destined to develop confidence in the biology teacher and enhance his ability to adapt to changing situations in science and technology oriented society.

The curriculum for NCE biology has ten objectives clearly stated. That at the end of the program the NCE teacher will be able to:

a. view biology as a process of inquiry into the living world;
b. develop in students the ability to use biological processes and principles to solve social problems;

c. apply concepts and methods acquired in the new areas of study and in every day situation;
d. critically analyze the activities of living things in their environment;
e. make rational judgment based on the sound understanding of the methods of sciences;
f. demonstrate practical skills in handling scientific apparatus;
g. demonstrate excellence and professional competence in teaching secondary school biology;
h. inculcate positive scientific attitudes and values in the society and promote positive disposition towards biological science and scientific enterprise;
i. make a cover in biology teaching;
j. achieve a B.Ed, B.Sc (Ed) degree after spending a minimum of two years in the university;

It can be deduced from the objectives of the minimum standard stated above that any biology curriculum materials intended for the NCE must include, or give room for teaching strategies that will inculcate the kind of experiences that have relevance with the ever changing situations in science and our technologically oriented society.

Science education in Nigeria has continued striving to influence Nigerians into cultivating technological culture, (Nworgu 1995). The aim, according to the New National Policy on Education the Federal Government of Nigeria (2005), is to build a strong and self – reliant nation. Like any nation, Nigeria views science and technology as a most appropriate and fastest vehicle for the planned transformation of any society, (Jegede and Inyang (1995). For any government, an awareness of the importance of science education usually prompts the formation of polices that enhance science development. To achieve mass science education the Federal

Government of Nigeria (2004) New Policy on Science and Technology Guidelines stipulates that the educational system shall emphasize sciences at all levels of education. The aim here is to achieve mass re-orientation of the society towards scientific thinking. The basic strategy for implementation of the policy includes:-

i. making it possible for the average child to have early contacts with the concepts and materials related to science and technology even before attaining primary school age ;

ii. ensuring a sound foundation during the first six years of the 6-3-3-4 educational system;

The aim of this educational system is to help the child acquire appropriate skills, abilities and competences both mental and physical as well as equip the individual to live in and contribute to the development of his society. In fulfillment of this desire the Federal Government (1977) sponsored the development and production of innovative curricula at all levels of education to reflect the aims and objectives of activity and child – centered education. However, Ukwungu (1997) observes that science education in Nigeria has continued to be ineffective in promoting socio –economic transformation of our nation. Nworgu (1995) noted that contrary to the spirit of science, science teachers still teach without the necessary activities needed for proper understanding of the concept. Pwol (1999) reported that Nigerian students still perform poorly in the senior secondary school biology examinations.

Genetics, a branch of biology that studies the function and behavior of genes influences many aspects of our daily life, from the food we eat to identification of criminals, treatment of diseases etc. In agriculture, genetic advances have enabled scientists to alter a plant or an

animal's structure to make it more useful. For instance, food crops such as oranges, potatoes, wheat, soybean and rice have been genetically altered to make them withstand insect pests and harsh weather conditions. Tomato and apple have been modified so that they can withstand discoloration and bruising on their way to the market, thus, enhancing their appeal on supermarket shelves (Hartwell, 2000).Soybean pod has bean modified to prevent it from breaking open and scattering the seeds in the farm when it dries and is not harvested in good time (University of Uyo, 2005).

The study of genetics today is so important that from primary to tertiary institutions it is considered as crucial to the scientific and technological development of the society. However, the understanding of the concepts of genetics and their mode of operation appears to be more difficult than any other topic in biology. This is evident in the results of students' performances in public examinations (WAEC 2009). This study is therefore, an attempt to find out a more suitable way of presenting genetic concepts to the understanding of students in the classroom. The NCE biology course outline does not stipulate a particular teaching method for any course, except the practical courses where laboratory works are suggested for the teachers. Teaching methods are courses on their own. It is observed that out of the twenty nine courses to be taken in three years of the NCE programme, only two courses; B10 123 and 215 are concerned with teaching methods in biology. While this is not enough it however, gives room for the teachers to take to any method they deem appropriate for teaching biology. STS teaching strategy is relatively a new innovation which is not incorporated in biology teaching methods being currently used, more especially in the teaching of genetics. In this study the effects of STS on academic achievement in genetics at NCE level will be investigated.

STS strategy presents science in the context of societal issues through relevant technology. STS focuses upon personal needs of students i.e. science concepts and process skills that are useful in the daily living of students (Yager 1993). It also focuses on societal issues in the homes, school and community as well as the more global issues that concern all mankind. STS is seen by many as a response to many of the perceived problems with the traditional science teaching method (lecture method). The most critical problems with the traditional method are:-

i. Students generally cannot use the science concepts and processes that they learn, (Champagne and Clopfer, 1994);

ii. In all, over 90% of all high school graduates do not attain scientific literacy even though they pass courses and generally perform well, (Otuka 2006);

iii. Positive attitudes about science, science teachers, further study of science and usefulness of science to living, declines the more science is studied in school (ETS, 1990; Yager and Pennick, 1990);

The effort of STS assumes that equating science only to specific concepts and processes and then assessing the degree each has been acquired is not an adequate indicator or real learning. This provides no information concerning how the concepts and processes can be used in the lives of students and for the future. STS therefore, deals with students in their environment and within their own frames of references. It means moving into the world of applications, the world of technology, in the world where the student makes his own connection to living and to the traditional disciplines.

Dealing with everyday real life issues tends to sharpen students' attitudes and to use and sharpen creativity skills. Yager (1993) refers to this as 'enabling domains.' The domains provide

access to the concepts and processes as seen, advanced and practiced by the professionals in a given discipline. Dele (1997) further stresses this point as he observes that some teachers teach biology without reference to its social applications. He maintains that biology should be taught with emphasis on the relevance of the subject to the society. The learners should be made to see the connection between the school and the real life situation outside the school. This is essential for scientific and technological development of the nation.

The objectives of the NCE biology curriculum also corroborate to strengthen the position of STS in science teaching. You can only give what you have. The NCE certificate holder therefore, can only handle secondary school biology, which also has some social relevance, confidently if he is able to develop the right teaching skills expected of him. Biology at the NCE level should be taught with the aim of achieving these objectives.

This study is aimed at finding out how much STS can contribute to equipping NCE students to handle biology with relevance to social issues. To this end the study compared the effects of STS instructional strategy with lecture method on students' academic achievement in genetics concepts at NCE level.

**1.1 Theoretical Frame Work**

Science teaching in schools over the previous years has so much been adjudged as inadequate by science educators (Ada, 2003; Cage & Turpin, 2004, Adejo, 2006 Adeyemi, 2008). This is because it was characterized by emphasis on acquisition of body of knowledge, often with unrelated facts that could not be harnessed to solve problems.

As this method was found inadequate and a recognition that the world around us today is based on technology, it calls for grooming of learners in a technology that surrounds them and in addition, issues and conflicts that are related to the use of that technology in the society (Yager,

1993). The grooming of learners into technology leads to a deep understanding of science that is related to the technology and to an informed opinion on the likely hood of promoting it. According to Yager (1991), this leads to recognition of problems and consideration of how to solve these problems and the ability to make decisions based on sound judgment. This method of learning is in line with the psychological theory of learning which emphasizes that exposing learners to experiences, questions and issues which are related to their lives motivates them to learn. Gagne, (1977). Holdbrook (1992) discovered that STS creates situations where students learn and easily understand basic concepts and process skills which are fundamental in the study of science. STS stimulates learners to create ideas that are related to the problems facing them in their immediate environment, in keeping with the constructivists' learning model which states that real learning results when individuals construct meaning of objects and events they encounter on their way.

The understanding of genetic concepts has been found to frustrate students, as shown in their performance in public examinations (WAEC 2009). Lack of knowledge of the real concept of 'gene' and inadequate teaching aids have been adduced as reasons for this (Evans, 1981 & Umeh, 2002). The abstract nature and high level mathematics of genetics also make genetic concepts hard to understand by learners (WEAC, 2009). However, the importance of genetics to the society is so paramount that it cannot be skipped when teaching biology. Genetic concepts find wide range of application in areas such as medicine, agriculture, sanitation and biotechnology industries. There is therefore, the need to intensify efforts in creating new strategies of presenting these concepts in a classroom situation so that learners can have a better grasp of their nature. The efforts made to create new strategies of presenting genetic concepts

here should also take gender issues into consideration. The low enrolment of females in sciences calls for double effort along that direction.

This study was thus, undertaken to see how much STS strategy can improve the understanding of genetic concepts that prove too difficult to learners. It also investigated how this strategy affects gender difference.

## 1.2 Statement of the Problem

Evidence from the annual reports on performance of students in examinations for the past five years in the department of Biology, FCE Zaria shows that BIO 214 (Genetics) has consistently recorded the lowest performance. This is based on the number of higher and lower grades earned by students and the number of carry over cases in this course. Comments from the reports sometimes adduce this low performance in genetics to its high abstract nature and the mathematics or statistics involved in it (Examination office, 2003). Table 1.1 shows that from 2005 – 2009 the performance of the students in BIO 214 has been below that of other courses in biology.

Teaching practice supervision reports in the department of biology FCE Zaria over the same period also showed that most student-teachers tend to shy away from teaching genetics topics during their teaching practice (Teaching practice office, 2008). The high rates of failure in BIO 214 could be attributed to inappropriate teaching methods used(Teaching practice office, 2008). STS strategy has been investigated at senior secondary school level Okorafor, (2003), Wasagu, (1999), Amos, Zumuyil & Ezema, (2002), Eloebhose (2002). However, not much has been done at the NCE level.

Despite the use of various teaching methods such as 'Discovery', (James 2000) 'Problem solving', (Atadoga 2000; Moemeka 2003); 'Activity base', (Abu 1998), there has been consistent low performance of NCE students in genetics. In this study therefore, attempt was made to find out the effects of STS on the performance of students in genetics at NCE level.

**Table 1.1 First semester Examination Reports of NCE II, 2009, (Source: FCE, Zaria).**

| Course | Year and Percentage Pass | | | | | |
|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Bio 211 | 88.3 | 90.2 | 92.8 | 93.8 | 91.1 | 90.8 |
| Bio 212 | 83.8 | 93.4 | 91.6 | 93.3 | 96.3 | 91.8 |
| Bio 213 | 91.2 | 89.3 | 87.9 | 91.6 | 92.3 | 90.6 |
| Bio 214 | 51.6 | 65.4 | 50.6 | 56.8 | 48.9 | 51.6 |
| Bio 215 | 78.9 | 89.2 | 91.6 | 95.5 | 92.3 | 93.1 |

## 1.3 Objectives of the study:

The objectives of the study are to:-

i. investigate if there is any significant difference in performance of students taught genetics by STS instructional strategy and those taught by lecture method.

ii. determine the effect of exposure to STS and lecture methods on performance in genetics among male NCE students.

iii. determine the effect of exposure to STS and lecture methods on performance in genetics among female NCE students.

iv. determine the effect of STS teaching strategy on male and female NCE students.

**1.4 Research Questions:**

This study was carried out specifically to provide answers to the following research questions:

1. Will the use of STS instructional strategy enhance students' performance in genetics concepts?
2. Will there be any difference in academic performance in genetic concepts between male students taught using STS strategy and those taught using lecture method at NCE level?
3. Is there any difference in academic performance in genetic concepts between female students taught by STS strategy and those taught by lecture method at NCE level?
4. What effects has STS instructional strategy on gender difference?

**1.5 Hypotheses**:

The study put the following hypotheses for tasting:

HO1 there is no difference in achievement in genetic concepts between students taught using STS strategy and those taught using lecture method.

HO2 there is no difference in performance in genetic concepts between male students that are taught using STS strategy and those taught using lecture method.

HO3 there is no difference in performance in genetic concepts between female students taught using STS and those taught using lecture method.

HO4 there is no difference in performance in genetic concepts between male and female students after exposure to STS teaching strategy.

## 1.6 Significance of the Study

The finding of this study will hopefully be useful in the following ways:

Institutions that are training teachers in instructional innovations will it to the already existing strategies. It would help the NCE students to improve in science instruction at the secondary level where they will teach Students to address societal issues scientifically and hopefully highlight the effectiveness of STS teaching method in genetics. Research and professional organizations like Science Teachers Association of Nigeria (STAN), National Education Research and Development Centre (NERDC) and Science Association of Nigeria (SAN) might consider the result of the research with a view to using the strategy to promote science instruction in schools.

Curriculum developers might consider the findings of this study and make appropriate review of the curriculum where necessary. Textbook publishers might consider incorporating STS ideas in their publications where appropriate. Research Fellows will also benefit from the findings of this study because results of this research will form a basic foundation for further studies using STS teaching strategy.

## 1.7 Delimitations of the Study:

This study was delimitated to NCE students of Biology Department of Federal College of Education, Kano and Zaria.

The subjects of the study were NCE II students. This is because genetics (Bio 214) is taught only at this level in the whole of the NCE programme.

The study lasted for eight weeks. Two methods of teaching were used for this study: STS strategy and traditional (lecture) method.

The topics selected for use were drawn from Bio 214 – Genetics of the NCE 'Minimum Standard' (NCCE 2005). This does not cover all the topics in genetics. Only two variables were investigated: performance and gender.

## 1.8 Basic Assumptions.

This study assumes that:

i. the NCE II students under study are being taught by qualified lecturers.

ii. the study sample subjects have also been exposed to genetics in their secondary school years.

iii. the topics selected and used for this study are familiar to the students used for this study.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This study is aimed at investigating the effects of STS teaching strategy on the performance of students in genetics. In this chapter the literature review is presented under the following sub headings:

. Science teaching methods;

. Lecture method in science teaching.

. STS instruction strategy.

. Empirical studies on STS.

. Concept of genetics.

. Gender and achievement in science teaching.

. Rationale for teaching genetics by STS strategy.

. Implications of literature review on the present study.

## 2.2. Science Teaching Methods:

There are widely recognized methods of teaching by the professional teachers (science teachers inclusive). There are some teaching methods referred to as student – centered because they take the interest of the student into consideration and involve him in doing the activity, e.g. the project, assignment, problem solving, discovery, individualized instruction, laboratory, field trip, discussion methods etc.

Other methods such as demonstration and lecture methods are teacher – centered because they are in full participation with the students in the activity (Shaibu & Bichi 2003).In problem – solving method, students are encouraged to find solution to problems themselves. This makes

learning become more meaningful to them as the students become independent and develop critical thinking. In this method, a problem within the reach or understanding of the student is posed and the student is left to find solution to it, (Hunt & Leuton 1992 ).This method helps students to approach problems in a specific way rather than simply ascribing causes to superstitious beliefs.

Rowland (1992) defined discovery method as a lesson designed in such a way that a student through his own mental process discovers concepts and principles. Many science educators advocate for this method because they believe that science should not be taught to a child, but he/she should be left to discover it. Discovery method of teaching involves students arguing, measuring, predicting and inferring. In discovery method, a student has a problem to solve while the teacher acts as a facilitator or a guide.

Demonstration is concerned with showing how an object looks like, how something is done or how a instrument works. It is basically interesting to students and it affords freedom from the boring repetition of lecturers. Project method is the cooperative study situation by a group of individuals under the guidance of the teacher (Akubuilo 2004). This method develops students' skill in writing, communication and higher level of thinking. Individual instruction takes into cognizance the individual differences where by students are taught according to their needs, interests and abilities. The individual and nature of the material to be learnt dictate the pace of learning, learners process is guided through the evidence of the performance (Oyeduso 2001).

Field trip is an excursion taken outside the classroom for the purpose of making relevant observation and to obtain specific information. Field trip sharpens the Keen observation abilities, helps to verify scientific laws, develops teacher – students relationships. Field trip is however difficult to plan, creates financial burden on both the school and students, it is also difficult to

conduct (Dambana 2007). In discussion method, the students talk over a subject from various points of view and the teacher acting as a moderator. The teacher does not dispense or communicate knowledge. The teacher does not dictate or influence the viewpoints of the students. Students are free to express their reasons rather than recall. Discussion implies that the students have background information about the subject. It develops positive interpersonal relationship, provides pupils with a sense of confidence and enables students to gain knowledge through active participation. A laboratory activity method is an activity carried out by an individual or a group for the purpose of making personal observation of processes, products or events (Osobonye 2002). Laboratory activity is characterized by two aspects: laboratory exercise and experiment operation or procedures. Laboratory exercise consists of activities carried out in order to provide practice in designing, operating and interpreting experiments, while experiment operations or procedures are used for testing a supposition to confirm the known and to discover the unknown. Laboratory method affords students the opportunity to see and use some equipment and tools, to develop mental processes, increase students ability to think critically and leads to better retention of information

Assignment method involves strong participation of the students. Assignments may be long or short, difficult or easy, general or differentiated, related to a single lesson, a unit or full school. Assignment encourages and assists students to reach specified goals, though employed quite frequently but often inappropriately (Itamah 2007). Ugah (2005) has provided evidence that the nature of computer presentation (pig action and labels) helps children, suggesting that media presentation and computer novelty have some impact on the amount of interest and time spent with a task. Cheryl, Braken and Lombard (2004) have also provided evidence that children do have social responses to computers and that such responses can lead to increase in learning

(recall and recognition) in your children (praise, intrinsic motivation and learning with computer). The techniques employed in presenting any subject matter are of much importance to the success of teaching and learning process and this influences students' attitude towards the subject.

## 2.3 Lecture Method in science teaching.

s Lecture method is sometimes known as 'Expository method' or simply 'talk – chalk method' (Bajah 1993). In this method the main preoccupation of the teachers is talking – giving facts, asking or answering questions and writing on the blackboard. The teacher is looked upon as the repository of the knowledge to be transmitted and the students the recipients. The advantage of this method is that the teacher presents a large amount of material to a large class in a relatively short period. This helps the teacher to cover the syllabus before examinations begin. This favors an educational system that lays emphasis on paper qualification. The use of this method has also generated a number of interesting studies among science educators; Abdullahi (1992) revealed that it does not promote meaningful learning of science as it appeals only to the sense of hearing. Science is a doing subject, and for effective learning to take place many senses must be involved. Hearing alone easily leads to forgetting.

Remember the Chinese say:

I hear and forget

I see and remember

I do and understand

The disadvantages of lecture method as given by Abdullahi (1992) are:

i. It does not develop manipulative skills

ii. It does not take individual differences into consideration

iii. Students soon get tired and bored as they are not involved in any activities.

iv. It encourages rote learning which is not a good way of learning science.

Hussaini (2002) and Okoro (2002) revealed that lecture method makes students to develop dislike for lectures, especially when the lecturer is one who is inaudible. The teaching learning process involves both the teacher and the students in an active way. Lecture method in most cases makes the students "passive" listeners. To overcome this limitation the teacher and the students must be active participants. Lecture method however, has proved successful where the teacher adopts an open – ended questioning technique and where the course task is straight – forward, (Bajah 1993).

### 2.4.1 STS Instructional Strategy.

STS as a term was coined by Ziman (1980) in his book 'Teaching and Learning about Science and society. Ziman identified several courses and titles and special projects which had many common features. All were concerned with science in a societal context – a kind of curriculum approach designed to take traditional concepts and processes found in typical science and social studies program more appropriate and relevant to the lives of students.

There have been many attempts in the United States to initiate STS programmes in the secondary school (Yager 1993). One such attempt was made by the University of Iowa in the early 1960s. Two faculties, science and social studies conceived a course called 'science and culture' which met graduation requirements in science or social studies. The course continued to operate until 1972 when the school was closed. It received a grant from the department of education and was the subject of a PhD dissertation (Cosman 1990) and several publications (Yager and Casteel 1996,). The research indicated that students were able to attain and retain

skills and competencies defined as science literacy. Such skills and competencies were not developed as a result of study in standard social studies or science processes.

Although the efforts of many  such results were encouraging, STS did not get under way in the United State until 1981 with the report of Noris Hams project synthesis study. . In the report Hams (1977) included STS as one of the five programmes which were studied in terms of how they met criteria for excellence established by expert table forces. Project synthesis was organized around four goal clusters which served as one basis for a variety of analysis. These goal areas offered justification for the inclusion of science in schools and requiring it each year for ten to thirty years.

i. Science for meeting personal needs: Science education should prepare the individuals to use science for improving their own lives and for coping with an increasingly technological world.

ii. Science for resolving current societal issues: Science education should produce informed citizens to deal responsibly with science related social issues.

iii. Science for assisting with career choices: science education should give all students an awareness of the nature and scope of a wide variety of science and technology related careers open to students of varying aptitudes and interests.

iv. Science for preparing for further study: Science education should allow students who are likely to pursue science academically as well as professionally to acquire knowledge appropriate for their needs.

Hams' project synthesis reported several findings concerning the actual state of science teaching which combined to encourage more attention to STS approaches.

These findings were:

i. Ninety percent of all science teachers used text books for science instruction in excess of 90% of the time.

ii. Textbooks were devoid of any considerations of the first three goal areas (material dealing with personal needs, societal issues and for career awareness).

iii. The curriculum was determined by the textbooks where variation from one another was less than 10%.

iv. Instructions focused on textbooks readings, teachers lectures, questions and answers techniques and verification – type laboratories.

v. Over 90% of the evaluation in science classes was based upon the recall of information.

vi. Teachers viewed themselves as the determiners of information to be covered and the evaluator to see what information was acquired by each student.

vii. The only goal area of concern to teachers and in evidence in schools was the fourth one, i.e. preparing the students for the further study of science.

The findings above reveal the exact state of science education in Nigeria today as is reported in the findings of Banu (1985) Wasugu (1998), Umeoduagu (1997) and Abu (1998).

Ham's (1977) synthesis report then recommended that to meet the emerging challenges for science education, there should be a shift in the goals, programs and practices from the current overwhelming emphasis on academic preparation for science careers for a few students to an emphasis on preparing all students to grapple successfully with science and technology in their own everyday lives, as well as to participate knowledgeably in the important science related decisions our country will have to make in the future (Harms and Yager 1981).

As can be seen from above the challenges posed by the state of science education are to be taken up by STS by focusing mostly on science for resolving societal issues, meeting perceived

needs and assisting career choice. These three goals turned out to be the meaning of STS. STS is an approach to teaching science to achieve these three most important goals. STS is seen by many as a response to many of the perceived problems of traditional science teaching approach:

i. In the traditional approach students generally cannot use the science concept and processes (Champagne & Clopfer,1994).

ii. Over 90% of all high school graduates do not attain scientific literacy even though they pass courses and generally perform well, (Miller 1999).

iii. Interest in science and further study of science declines across the k – 12 +/ years (ETS 1990), (Yager& Penick 1990).

iv. It results in diminution of the creativity skills originally assessed (Pwol 1999).

v. No evidence to show that traditional science teaching results in persons who posses the traits which characterize a scientifically literate person.

A scientifically literate person has the following characteristics (NSTA 1990):

i. He uses science concepts, technology and ethical values in solving everyday problems and making responsible decisions in everyday life, including work and leisure;

ii. He engages in responsible personal and civic actions after weighing the possible consequences of alternative options;

iii. Defends decisions and actions using national arguments based on evidence.\;

iv. Engages in science and technology for the excitement and the explanation they provide;

v. Displays curiosity about the appreciation of and the human made world;

vi. Applies skepticism, careful methods logical reasoning, and creativity in investigating the observable universe;

vii. Values scientific research and technological problem – solving;

viii. Locates, collects, analyses and evaluates sources of scientific and technological information and uses these sources in solving problems, making decisions and taking actions;

ix. Distinguishes between scientific and technological evidence and personal opinion and between reliable and unreliable information;

x. Remains open to new evidence and the tentativeness of scientific and technological knowledge;

xi. Recognizes that science and technology are human endeavors;

xii. Weigh the benefits and burdens of scientific and technological development;

xiii. Recognizes the strength and limitations of science and technology for advancing human welfare;

xiv. Analyses interactions among science, technology and society;

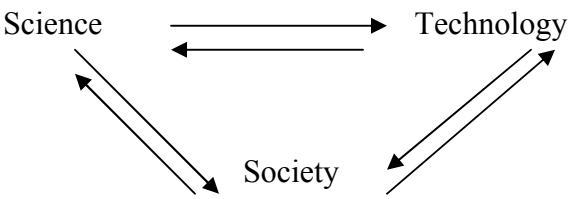
xv. Connects science and technology to other human endeavors of history, mathematics, the arts and humanities;

xvi. Considers the political, economic moral and ethical aspects of science and technology as they relate to personal and global issues;

xvii. Offers explanation of natural phenomena which may be tested for their validity.

During the 1960s every effort was made to distinguish between science and technology. Science was in and technology was out (Yager 1993). Abdullahi (1992) defined science as activities culminating into testable, falsifiable and verifiable body of knowledge, while technology is 'applied' science. He maintained that science teachers should be able to distinguish between conceptual science and applied or technological science. The conceptual or basic science has a dual nature, it is a body of knowledge, and the process of acquiring and refining the

knowledge. The emphasis is placed upon ideas, principles, theories, symbols and the understanding of natural objects and phenomena. Applied or technological science on the other hand, is primarily concerned with finding solution to practical problems, i.e. production of goods for the welfare and use of man. However, the two alternate by giving rise to each other. Science principles lead to technological production of materials like vehicles and many machines. Technology in turn produces equipments needed by science for further investigation. The science, technology and society equilibrium system may be represented in the scheme given by STAN( 2001) as shown here:




**Science, Technology and Society Equilibrium. (Source : STAN, 2001).**

The diagram above shows that each of three makes input into the others and vise versa.

STS means using technology as a connection between science and society (Yager 1993). The applications of science are seen as closer to the lives of students, including food, clothing , shelter transportation, communication and careers.

In a survey of the problems of teaching and learning science and technology in the rural environments of Anambra State, Ndu (1991) found that inadequate equipment of science laboratories, insufficient number of science teachers, inadequate facilities for students to study at home and insufficient number of science laboratories to be the major problems of teaching

science and technology. STS strategy looks at the problems of the society and thinks of how to solve them. The world is full of problems such as population, crisis, environmental pollution, famine, pestilence, war, etc. STS education is concerned with solving these problems.

The instructional strategies of the STS teacher fall along a continuum ranging between those that are expository and those that are completely inquiry based (figure 2.1) depending on the nature of the content or the specific objectives that are to be achieved (STAN 2001).

STAN (2001) had given the following strategies which have been used in STS education literature: lecture, discussion, investigative, values clarification and problem – solving. The activity carried out in any strategy could also be modeled to suit the ability of the learner. For example, Otuka (1997) presents one that looks like this: during the lesson you and your students make decisions everyday about your own welfare and that of others, the environment in which you live and directly or indirectly, the world's environment. You assist your students in making wise decisions, by providing them with practice, skills, actively involving your students in their real life problems and decision – making situations. Guidance here means helping them to develop skills in solving these problems and making decisions, and consequently avoiding telling them what and how to decide on alternative. This means that you must become familiar with ways of approaching problem -solving / decision making and then learn how to guide your students. Another model given by Holbrook (1990) is called SEARCH, CREATE, SOLVE, SHARE and ACT. The purpose is to conduct research from what is known (previous knowledge) and extend that knowledge through application of action taking.

The carry over and use of knowledge acquired in a noble situation also suggests that learners alternative frame works carried by Driver and Easley (1990) should be taken into consideration. You should examine what understandings, ideas and views learners have, to help

learners to shape new information and experience. Generally we come to understand things in terms of what we already understand. Learners' ideas can shape how they make sense of new data and information and that they can even persist in the face of counter argument and evidence to the contrary.

Watts 1992) suggests that when choosing which learning experiences to device for classes, teachers are expected to satisfy such criteria as: "Will the experience give opportunity to apply scientific ideas and skill to real life problems including those which require a technological solution?". In most of the STS programs of study the curriculum are prefaced by the words 'investigate' and 'explore'. The discussion that precedes these statements are based on a very strong child centered 'constructivist' model (Watts and Pope 1989) which sees the learner understanding much of the discovery and practical work involved. It is the learners who, on the whole, are expected to investigate and explore, not the teacher.

### 2.4.2 Rationale for Teaching Biology by STS Strategy

Watts (1992), gives the following as the rationale for adopting STS strategy in presenting science generally:

It involves problem – solving which enables youngsters to take ownership of a task;

It encourages decision – making and many social skills;

It is a vehicle for teaching many scientific skills and for teaching the content aspects of science;

It allows cross – circular activity;

It provides relevance and real life contexts and creative thinking which are among the highest and most complex forms of human activity.

STS has the potential of doing these for students because the strategy incorporates the teaching and learning in the classroom to the environment of the child as observed by Bukola and Jegede (1995).Woolnough and Allsop (1995) found that it builds up a more meaningful grasp than can be acquired through theoretical argument alone, and Students get a 'feel' for the phenomenon.

Biology, being a science subject, provides a good and interesting ground for applying STS strategy. This is supported by the fact that most of the problems of man in the society have connections with biology concepts. These problems are found in the areas of sanitation, soil and food conservation, diseases, population control, nutrition, first aid, balance of ecosystem, recreation, explanation of natural phenomena etc, all of which are biological in nature. The teaching of biology can therefore, be tried the STS way to see if it can enhance the understanding of genetic concepts.

**2.4.3 Concept of Genetics**

Genetics, a branch of biology that studies the function and behavior of genes and how they influence many aspects of daily life, from the food we eat to how we identify animals and treat diseases. In agriculture, genetic advances enable scientists to alter a plant or animal to make it more useful. For instance, some food crops such as oranges, potatoes, wheat, soy beans and rice, have been genetically altered to withstand insect's pests and harsh weather conditions. Tomatoes and apples have been modified to resist discoloration or bruising on their way to the market, thus, enhancing their appeal on super market shelves. Soy beans pods have been modified to prevent them from breaking open and scattering the seeds away when they are not harvested in good time on the farm( )

The study of genetics today is so important that, from primary levels of academic institutions, it is considered as crucial to the scientific and technological development of the

society. However, the understanding this concept and its mode of operation appears to be more difficult than any other topic in biology. This can easily be seen from students' performance in examination results. (WAEC, 2000). This study is therefore, an attempt to find out a suitable way of teaching genetics in the classroom so that students can understand it better.

**2.4.4 Studies on Genetics and Achievement in Science** :

Studies have been reported in literature showing attempts to present genetics in ways that will reduce the fears students entertain in genetics and to improve their performance in the subject. Umeh, (2002) in a study, discovered genetics to be one of the content areas teachers in senior secondary schools encounter instructional difficulties. Some teachers exhibit apparent phobia towards teaching genetics while students are somewhat completely disinterested in studying it (Fakunle, 1986). It may be assumed that the teachers' apathy towards teaching the subject is a major factor responsible for the students' poor background and performance in it (Oyewole, 1982). Similarly, Okpala, (1991) noted that because teachers are not interested in teaching genetics, they cannot arouse the interest of students who are rather given the impression that the subject is difficult.

The understanding of genetics has been observed to be further frustrated by lack of teaching aids such as recorded films on Mendel's work, mitotic and meiotic cell divisions (Willerman, 1979), coupled with the opinion that good experiments in genetics are not easy to conduct in schools (Shone, 1980). Nevertheless, Reynolds, (1994) maintains that genetics presents students with ample opportunities for experiments with real world problems. The fear teachers have in teaching genetics may be as a result of their poor background in the course. Evans,(1981) also noted that lack of knowledge of the real concept of 'gene' makes it difficult for them to use the correct language needed in teaching the concept. In view of this Umeh,(2002)

suggested that teachers should use a practical approach in teaching such difficult areas. Since STS strategy is a practical approach that links concepts with real societal problems, this study is an effort to find out if it will improve NCE students' performance in genetics.

## 2.5 Gender and Achievement in Science.

Apart from seeking effective instructional strategies, science educators are faced with the problem of attracting girls into science. A considerable amount of research has focused on gender differences and school learning. In science education there is the concern that girls are not achieving as much as they should (Erickson & Erickson , 1984, Kelly; 1987; Welch, 1985). The differences seem to be more pronounced in physical sciences.

Some studies have revealed small but consistent differences between the performance of males and females in science achievement task (Ukwungwu, 2002; Onafowokan & Okpala, 1999; Shaibu & Usman 200). Jegede and Inyang (1995) have observed a significant superior achievement of boys over girls in school science. Eseonu (1995) also found the performance of male students to be better than the female. A few studies have however, reported better performance by female students than males in science (Ezeliora 1994; Nworgu, 1990 and Obodo, 1990).

Some researchers have advanced some reasons for the difference. Tracy (1990) postulated that sex–related differences in science achievement might be related to three areas: social (Sex – role model and orientations), Educational (parent, teachers , poor expectation class extra – curricular activities) and personal (spatial ability) factors. Haggerty (1987) is of the opinion that the more active participation of boys in science class maybe an important factor responsible for the variation. A conflicting report was given by (Comber and Keeves 1973; Jacobson and Aaron,

1985; and Otuka 1986) who found no significant differences in the science achievement of girls and boys.

Heller & Hollanbaugh (1992) investigated the impact of homogenous and heterogeneous cooperative group structures on problem solving performance. They reported that the best problem –solving performance was achieved with cooperative groups of three students that were either all male or one male two female students. It was observed that male students tend to dominate the group problem – solving performance. When male students were placed in groups with a female majority, the groups tended to demonstrate better problem – solving performance. The study also found that male and female introductory physics students performed equally well on physics problems after students were taught how to use STS strategy in a cooperative group environment. In terms of conceptual understanding, they reported that among those students who had taken high school physics, the male students scored significantly higher than female students. At the beginning of the course there were no significant differences between male and female scores on a multiple - choice test of conceptual understanding.

It was reported that a cognitive apprenticeship in situational approach using cooperative group instruction and STS strategy appeared to help close the gap between male and female physical students. In both of these studies using STS strategy, it was reported that there appeared to be differences in male and female students' willingness to use the STS strategy, with a large proportion of the women than men adopting the explicit strategy (Heller and Hallobangh 1992; Heller and Lim, 1992). The research on gender differences with respect to performance is still not conclusive. This study intends to find out whether STS strategy will have gender related differences.

## 2.6 Overview of Related Studies on STS Strategy.

A number of studies have been carried out in many places at different times which are related to this study. STS strategy has been found to increase students' engagements with science and thus has the potential to improve inclusivity (Wasagu 2002). It has also shown that socio – scientific approach considers wider social, political and economic aspects of science, thus, STS curricula can give science an accessible social contact (Wasagu 1999).While this study differs in scope, it is however, related in the sense that the societal problems tackled in the study give students an accessible social contact. STS strategy has been reported to be very effective in class room instruction as it addresses areas of controversy, economic, social and political concern, such as health or the environment (Hughs 2002). The concepts dealt with in this study also address the same issues.

Adeniyi (2001) found that STS strategy creates a techno – scientific awareness in individuals concerning the society in which they live. Such individuals develop the ability to think or analyse situations in the society critically and resolve them effectively by techno – scientific methods. This is exactly what the jurisprudential model of STS addresses in this study. It however, differs in the contents of the instruments.

Amos, Zumyil and Ezena (2002), discovered that STS education serves as an appropriate leverage for rural development. This study serves both for rural and urban development. Ojaleye (2002) constructed a technological model for sustaining development and found it to alleviate poverty in a community to a large extent. This study extended its scope to health and other social issues.

The author drew insight from these related works as a guide for this study.

## 2.7 Implications of Literature Reviewed on the Present Study :

Studies reviewed all show that learners do not have a better grasp of concepts taught and also the ability to use them in real life situations. What this means is that as we continue to create more strategies of presenting science concepts for better understanding to students, there is the need to examine the characteristics of the learners and construct learning activities that relate to their immediate environment – society. This makes it possible for them to connect new knowledge with the old experiences. This makes it easier for them to have proper grasp of the concepts being taught. We can achieve this if we modernize our teaching strategies in line with latest ones such as STS.

Learners by nature always want to see the immediate outcome of any effort they have put in doing a typical learning activity. This motivates them to repeat the action. Researches on STS strategy show immediate rewarding efforts. The literature reviewed served as a guide to areas where efforts needed to double and areas to avoid vague repetition in this study. This implies that the topic must avoid ambiguity, hypotheses must be researchable, instruments must gather the data demanded by the hypotheses, the sample and sampling procedure must be such that the researcher can handle. Lastly, the statistic must suit the hypotheses being tested. All these were with the aim of attaining the objectives of the study.

The variables enshrined in the title of this study i.e. performance and gender also took some bearing from the literature reviewed. This suggests that areas with similarities and differences with the present study were carefully identified. This study used genetics as its instrument and as such studies reviewed which touched on genetic concepts were used to

pinpoint any new idea and contribution found in the study. Some of the studies reviewed showed that a lot of researches have been carried out in teaching more especially at the senior secondary level using various teaching strategies, but exposing genetics to STS teaching strategy is relatively new. At NCE level this type of study is needed to see what the result will be.

# CHAPTER THREE

# METHODOLOGY

## 3.4 Introduction

This chapter deals with the methodology for this study. It is presented under the following sub headings:

- Research Design;
- Population of the study;
- Sample and sampling procedure;
- Selection of Topics for the Study;
- Pilot Testing;
- Instrumentation: Validity of Genetics Achievement Test (GAT); Reliability of Genetics Achievement Test (GAT); Item Characteristics.
- Data Collection Procedure;
- Administration of treatment;
- Data Analysis.

## 3.5 Research Design

The research design for this study is the quasi experimental – control groups with pretest and post test. Two groups of students were involved, i.e. experimental and control groups. The pretest/post test was adopted for the purpose of data collection. Experimental group was exposed to STS strategy while control group was exposed to lecture method. A pretest was given for the purpose of determining the equivalence of the two groups before treatment. A posttest was

administered after the treatment administration to determine weather STS strategy has an effect. The design of this study is represented thus:

C $\longrightarrow 0_1 \longrightarrow X_0 \longrightarrow 0_2$

E $\longrightarrow 0_1 \longrightarrow X_1 \longrightarrow 0_2$

Figure 3.1: Research design Illustration

Where: C = control group

E = Experimental group

$X_0$= Lecture method

$X_1$= STS Strategy

$0_1$= Pretest measurement

$0_2$= Posttest measurement

### 3.3. Population of the Study:

The population for this study was made up of all the NCE biology students of the five Federal Colleges of Education in the northwest geopolitical zone in Nigeria, which include FCE Bichi, FCE Gusau, FCE Kano, FCE Katsina and FCE Zaria. NCE II students were used for this study because they are the ones offering genetics course Bio 214 at NCE II level. The researcher purposefully chose two of these five colleges of education, FCE Kano and FCE Zaria for the study. The reasons for choosing these two colleges are:

i) the two colleges are owned by the Federal government, thus they enjoy equal sponsorship in terms of provision of teaching materials and funds;

ii) the two colleges are among the first generation colleges of Education, formally known as Advanced Teachers Colleges (ATC), they therefore, have the same old and experienced lecturers.

iii) the two colleges were formerly under Ahmadu Bello University, Zaria before their disarticulation in 1992, thus, they both have experienced university lecturers who opted to stay back in the college;

iv) the two colleges are situated in the same geopolitical zone (Northwest) of this country; most of the students in both colleges thus, come from the same cultural background.

The total population of NCE students from these five colleges is 837. The table below shows the proportion of biology students in each of the five colleges.

**Table 3.1 Population of the Study.**

| COLLEGE | NO OF MALE STUDENTS | NO OF FEMALE STUDENTS | TOTAL |
|---|---|---|---|
| FCE BICHI | 90 | 51 | 141 |
| FCE GUSAU | 0 | 90 | 90 |
| FCE KANO | 101 | 62 | 163 |
| FCE KATSINA | 84 | 36 | 120 |
| FCE ZARIA | 183 | 140 | 323 |
| TOTAL | 458 | 379 | 837 |

**Source-( NCCE, 2010)**

From table 3.1 the target population consisted of the following: FCE Bichi 141, FCE Gusau 90, FCE Kano 163, FCE Katsina 120 and FCE Zaria 323, making a total of 837. From this population the subjects for the study were sampled.

### 3.4 Sample and Sampling Procedure:

This study consisted of 100 subjects who were of mixed gender. From the study population the sample was drawn, 50 from FCE Kano (control group) and 50 from FCE Zaria

experimental group. A random sampling method adopted from Kelinger (1973) (that is using the random table of numbers) was used in selecting the 100 subjects for this study. This 100 study subjects is viable for this experimental study as recommended by the central limit theorem which proposed a minimum of 30 subjects as viable for experimental research (Tuckman1975).

**Table 3.2: Sample for the Study.**

| SCHOOL | NO OF MALE STUDENTS | NO OF FEMALE STUDENTS | TOTAL |
|---|---|---|---|
| FCE KANO | 31 | 19 | 50 |
| FCE ZARIA | 28 | 22 | 50 |
| TOTAL | 59 Males | 41 females | 100 males and females |

### 3.5 Selection of Topics for the Study:

Topics for teaching in this research were from the genetics course (BIO 214) of the NCCE minimum standard (2005) reviewed version. The whole course outline is shown in appendix c, genetics topics were chosen for this research because:

i. the general performance of students in genetics has been found to be lower than that of other courses, as observed by (Exam office FCE Zaria 2003).

ii. the course is an applied science which cuts across various subjects areas, such as crop and animal breeding science. It also has direct influence on human social life e.g. heredity, blood grouping, sickle cell anemia etc.

iii. it is one of the core courses that students must pass to graduate from the program.

The topics selected for teaching in this study and in line with the reasons given above are as follows: (a) Variation among living organisms; (b) Basic concepts in genetics; (c) Mendel's work (d) sex chromosomes and sex determination (e) sex linkage; (f) Mutations and their effects.; (g) Human heredity e.g. color blindness, paternity, blood groups, hemophilia,; (h) applied genetics.

The reasons for choosing the topics above are:

i. they have easy application to real life situation.

ii. the topics have direct influence on human social life

iii. their areas of application in real life situations are very interesting and thus, become a source of motivation during the lessons. This is likely to enhance their understanding.

**3.6. Pilot Study**

A pilot study was carried out before the main study. The purpose of the pilot study was to determine the reliability of the instruments. This was done in a different school (FCE Kontagora) from the ones used for this study.

**3.7 Instrumentation**

An achievement test, Genetic concepts Achievement Test (GAT), constructed by the researcher was used to measure the performance of the subjects. This test served as the pretest and posttest. The test is a forty item multiple choice format. A multiple choice form was used because it allows for a wide coverage of the content. Also, an objective test has no bias in the scoring. The items covered the topics in BIO 214 – genetics

**3.7.1 Validity of Genetics Achievements Test (GAT)**

The validity of the Genetics Achievement Test (GAT) was determined by experts from the departments of Science Education and biological sciences of Ahmadu Bello University Zaria,

and departments of biology Federal Colleges of Education Zaria and Kano, who looked at the content validity to see whether it is in line with the study objectives, to determine whether the questions asked are within the students learning ability and to look for any ambiguous statement. From the 50 test items constructed, 40 were accepted based on the valuators' recommendations.

### 3.7.2 Reliability of Genetics Achievement Test (GAT)

The reliability of the Genetics Achievement Test (GAT) was determined using the test retest method, in which the researcher administered the same test two times at an interval of two weeks. To analyze it the Pearson Product Moment Coefficient (PPMC) formula was used. A reliability Coefficient of 0.86 was established.

### 3.7.3 Item characteristics (Facility Index FI):

Facility index of each item for the achievement test was conducted. Each item facility index calculation was done as recommended by Mehren and Lehman (1985) and adopted by Atadoga (2000) and Usman (2000). Mehren and Lehman (1985) formula for item difficulty is expressed as follows:

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

Where FI = facility Index

R = Number of students who answer the items correctly

T = Total number of students tested.

According to Furst (1958): if 30 – 70% can answer correctly, then the items are recommended for use. The results of the analysis are contained in appendix A

### 3.7.4 Item Characteristics, Discrimination index (D I):

The discrimination index (DI) of a test is the capacity of such a test to discriminate or distinguish between high and low achievers among students in the sample. It gives room for the ranking of students in a given test. It can be calculated by using the formula given by Mehren and Lehman (1985) which is:

$$DI = \frac{Ru - RI}{\frac{(1)}{(2)T}}$$

Where:

DI= Discrimination Index

RU – Number among upper 27% who responded correctly to the item.

RL = Number among lower 27% who responded correctly to the item.

T= number of respondents in each of the lower 27%

According to Mehrens and Lehman (1985), the value of discrimination index is usually expressed as a decimal and in positive value. And going by range, it can range from -1.00 + 1.00, and that for its value, the item has positive discrimination.

This implies that a large proportion of the more competent student than the poor ones got the item right. If the value is zero, the item has zero discrimination, meaning that the item is unable to distinguish between the competent and incompetent students on the tasks. The negative value of the discrimination index indicates that more of the poorer students got the item right compared to the more competent ones. Mahrens and Lehman stressed that the higher the discrimination indexes the better, recognizing that there are situations where low discrimination is to be expected (e.g classroom tests). Furst (1958) in Usman (2000) states that discrimination indices which range from 0.30 to 0.49 are described as moderately positive, and above this is highly positive.

The magnitude of discrimination indices of the achievement test for this study was from 0.30 to 0.80, therefore, a large proportion of the more competent students than poor ones got the items right. The FI and DI calculated from the initial test (GAT) items which did not fall within the theoretically accepted range suitable for use were rejected. Therefore, the achievement test was reduced to 30 items. The table of specifications for the topics for teaching is in the appendix.

### 3.8 Administration of Treatment.

Instructional materials for this study are topics in BIO 214 (Genetics). Two methods of teaching were used; lecture method and STS strategy. Lecture method was used in FCE Kano while STS method was used in FCE Zaria. For lecture instructional method, lesson plans were prepared and taught by the researcher. The STS strategy was taught by the researcher using the STS jurisprudential model adopted from Pederson (1992) in Britain. This model has the following stages:

1. **Orientation phase:** - This phase introduces the students to the topics. The students at this stage are prompted to search for information or knowledge on the topic under study. For example, on the topic 'variations among living organisms' the researcher asks the students such questions as:

   'Why are some people short while others are tall?

   'Can you explain why a brown goat sometimes gives birth to a black one?
2. **Identification and definition phase: -** At this phase students are allowed on their own to go for a wide search of information or knowledge on the topic. The students engage in brainstorming search or possible answers to the questions raised in phase 1 on the topic. Students look for information, observe specific phenomena and possibly experiment with

materials to enable them identify and define the parameters of an investigation or the topic under study

3. **Synthesis phase:** - this is the phase that the students come up with designs in the form of charts, graphs or write ups for presentation as possible solution to the questions raised in phase 1.

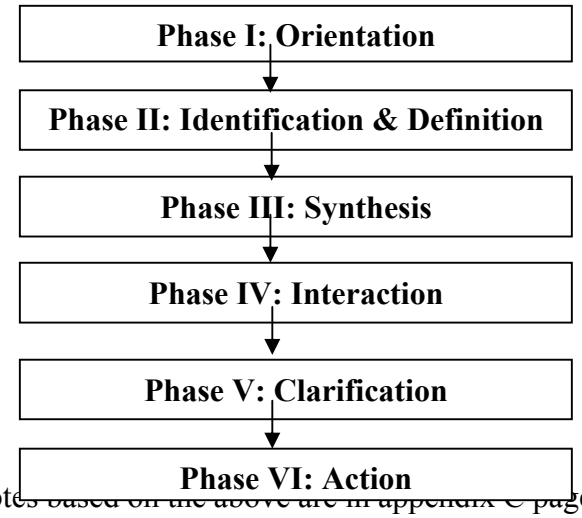
4. **Interaction phase: -** this phase involves the students in a mock public meeting. It is at this stage that students come up with their respective answers, findings or solution on the topic. This is meant for sharing with other groups. This is the time for communicating their individual and group findings, interacting with their fellow student's i.e. sharing ideas in a co-operative manner. This could be oral or written reports**.**

5. **Clarification phase:** At this phase students come together collectively and cooperatively to identify possible solutions or answers to the searching questions raised in phase 1 with the researcher. This is the phase the researcher uses the STS strategy along with prepared lesson plan to teach the students the topic under investigation. The teacher begins with the social implications of the topic, through the technological skills needed to be acquired under the topic, and then to the scientific concepts and facts about the topic. And finally, the teacher then re – emphasizes the scientifically corrected ideas about the topics.

6. **Action phase: -** this is the decision making or action – taking phase. Here the students rely on information they gain from debating issues with each other and from their own search and shared information from other groups and information gained through the STS classroom for decision making and action taking. The cause of action students follow is decided after a consensus clarification on the topic is reached. With the level of students used in this study (i.e. NCE II), the actions expected of them involved identifying types of aberrations among

all living organisms and their causes – whether chromosomal or gene mutations are caused by X – rays, smoking excessive drinking drug taking or some natural phenomena. They may also find out that induced mutations produce desired species of organisms.

**Table 3.3 STS Jurisprudential Model (Adopted from Pederson, 1992).**




Lesson notes based on the above are in appendix C pages 64-135.

### 3.9 Data Analysis

For analysis of the data collected, the statistic used for each hypothesis is stated as follows:

HO1 There is no significant difference in the mean scores of NCE students exposed to STS teaching strategy and those exposed to lecture method in genetics.

t-test statistic was used to test the hypothesis above.

HO2 There is no significant difference in achievement in genetics between male students taught by STS strategy and those taught by lecture method.

t – test statistic was used to test the hypothesis above.

HO3 There in no significant difference in achievement in genetics between female students taught by STS strategy and those taught by lecture method.

t – test statistic was used to test the hypothesis above.

HO4 There is no significant difference in achievement in genetics between male and female students when they are exposed to STS strategy.

t – test statistic was used to test the hypothesis above.

# CHAPTER FOUR

# ANALYSIS, RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter contains the data collected, the analysis and the results obtained from the analysis. These are presented in Tables 4.1-4.4. The chapter ends with the discussion of the results. The data were analyzed using the Statistical Package for Social Sciences (SPSS) computer software.

## 4.2 Hypotheses Testing

For the purpose of data analysis the hypothesis tested in this study are presented as follows:

$H0^1$: There is no significant difference in the mean scores of NCE students exposed to STS teaching strategy and those exposed to lecture method in genetics. To test hypothesis one, the data collected from the two groups based on the two variables i.e. STS and lecture teaching strategies were analyzed using t-test statistics at $P \leq 0.05$. The result is presented in Table 4.1.

**Table 4.1: t-test Analysis of Mean Scores of Experimental Group (those exposed to STS) and the Control Group (those exposed to lecture method).**

| Group | N | X | Sd | SE | Df | t-cal | P | Remarks |
|---|---|---|---|---|---|---|---|---|
| Experimental group | 50 | 27.90 | 6.59 | 43.43 | 96 | 7.54 | 0.001 | * Significant |
| Control group | 50 | 20.12 | 3.13 | 9.80 | | | | |

***Significant at P = 0.05.**

From Table 4.1 the result shows that the t-cal of 7.54 at P-value of 0.001 is less than p-0.005, df = 96. This result shows that there is significant difference in the academic performance of NCE

students exposed to STS and those exposed to lecture method. The result is in favor of the experimental group as shown in their mean scores.

$H0^2$: there is no significant difference in the mean scores of male students exposed to STS teaching strategy and male students exposed to lecture method in genetics. To test hypothesis 2, the data collected from the two groups were analyzed using the t-test statistics at P = 0.05.

**Table 4.2: t-test Analysis of Post-test Mean Scores of Male Experimental and Control Groups.**

| Group | N | X | Sd | SE | Df | t-cal | P | Remark |
|---|---|---|---|---|---|---|---|---|
| Experimental group | 28 | 28.32 | 6.73 | 43.43 | 57 | 5.73 | 0.001 | *Significant |
| Control group | 31 | 20.45 | 3.45 | 11.90 | | | | |

***Significant at P = 0.05.**

From Table 4.2 the result shows t-cal of 5.73 at P-value of 0.001, which is less than p=0.05, df = 57. This result shows that there is significant difference in the academic performance of male students exposed to STS and male students exposed to lecture method. The result is in favour of the experimental group as shown in their mean scores.

$H0^3$: There is no significant difference in the mean scores of female students exposed to STS teaching strategy and female students exposed to lecture method in genetics. To test hypothesis 3, the data analyzed using the t-test statistics at $P \leq 0.05$. The result is presented in table 4.3.

**Table 4.3: t-test Analysis of Post-Test Mean Scores of Female Experimental and Control Groups.**

| Group | N | X | Sd | SE | Df | t-cal | P | Remark |
|---|---|---|---|---|---|---|---|---|
| Experimental group | 22 | 27.36 | 6.54 | 42.77 | 39 | 4.88 | 0.001 | * Significant |
| Control group | 19 | 19.58 | 2.52 | 6.35 | | | | |

***Significant at P = 0.05.**

From Table 4.3, the result shows a t-value of 4.88 at P-value of 0.001, which is less than P=0.05, df = 39. This result indicates that there is significant difference in the academic performance of female students exposed to STS and female students exposed to lecture method. The result is in favour of the experimental group as shown in their mean scores,

$H0^4$: There is no significant difference in the mean scores of male students exposed to STS teaching strategy and female students exposed to STS teaching strategy in genetics. To test hypothesis 4, the data collected from the two groups were analyzed using the t-test statistics at $P \leq 0.05$. The result is presented in Table 4.4.

**Table 4.4: t-test Analysis of Post-Test Mean Scores of Male Experimental Group and Female Experimental Group.**

| Group | N | X | Sd | Sd2 | Df | t-cal | P | Remarks |
|---|---|---|---|---|---|---|---|---|
| Male | 28 | 24.1 | 6.55 | 42.90 | 48 | 0.33 | 0.75 | Not Significant |
| Female | 22 | 23.76 | 6.38 | 40.70 | | | | |

**Not Significant at P =. 0.05**

From Table 4.4, the result shows a t-cal of 0.33 with observed p-value of 0.75, which is more than P=0.05, df = 48. This result shows that there is no significant difference in the academic performance of male and female students after both groups were exposed to STS teaching strategy.

## 4.3 Summary of Findings

Based on the four hypotheses tested in this study, the results of the study are summarized as thus:

(i) There is significant difference in performance in genetics between the experimental (STS) group and the control (traditional) group. Hypothesis 1 is therefore, rejected.

(ii) There is significant difference in performance in genetics between male experimental (STS) group and the male control (traditional) group. Hypothesis 2 is therefore, rejected.

(iii) There is significant difference in performance in genetics between the female experimental (STS) group and the female control (traditional) group. Hypothesis 3 is therefore, rejected.

(iv) There is no significant difference in performance in genetics between male experimental (STS) group and female experimental (STS) group. Hypothesis 4 is therefore, retained.

## 4.4 Discussion

The results in tables 4.1 - 4.4 show that the experimental group achieved significantly better than the control group. One can infer from this result that the STS teaching strategy was more effective than the traditional method in promoting the students' understanding of the genetics concepts taught. Despite the fact that the STS instructional strategy was relatively new in the school where the investigation was conducted, the students in the experimental group performed significantly better than those in the traditional instructional method. This shows that STS instructional strategy facilitated the students understanding of the genetics concepts more, compared to the traditional instructional method. This finding which shows the superiority of the STS strategy over the lecture method is in agreement with those of Myers (1998); McComas (1999); Yager, (1993) Mackinne, (1991), Albert (2001), Okorafo (2003) and Ebere (2006).

Hunt and Leuton (1992), Mathew, Ajere and Eule (2001), Olagunju (2001) and Ofonime (2007) also found from their studies that STS strategy makes learning very interesting, enjoyable and relatively easy, due to the fact that learning is related to students' common issues and the problems in their immediate environment. The subjects showed they have clear understanding of the concepts because it has helped in bringing the abstract nature of the concept to the level that they can understand its mechanism. STS strategy has proved effective in teaching genetics here because it has reduced the complex mechanisms of genetics to the level that learners do not only easily understand it but apply it in solving problems that have been a mystery to them. Solomon (1993) discovered in his 'Discussion of Issues in School Science[ DISS] project' that students taught using STS approach achieved better than the traditional lecture method because STS strategy contains challenges that students experience in their daily lives. Yager (1993) also found that students taught using STS strategy achieved better in mastery than those taught using traditional method.

The result on Table 4.2 shows that the experimental group (exposed to STS strategy) performed significantly better than the control group (taught by traditional method) in the post test. The result shows that STS strategy may be superior to the traditional method in enhancing learning among male students. This corroborates to strengthen the effectiveness of STS strategy.

The result in table 4.3 shows that the female experimental (STS) group performed significantly better than the female traditional group in the post test. This result further strengthens the fact that STS strategy is very interesting and thus, capable of removing the wrong notion some female students have: that science subjects are too hard for them. STS is capable of doing this probably because the activities involved in this strategy make the students to really work like scientists, i.e. solving problems confronting them in their daily lives. STS offers

occasions to practice some of the 'humanistic' skills that are largely excluded from the hard sciences,(Yager 1993). This is one of the reasons for introducing the subject into science education.

These findings are in line with those of Okpala (1991) who found that STS strategy makes learning very interesting and thus improves learners' understanding in genetics. This is probably because STS strategy deals with learners' immediate environment with which the learners are very much conversant.

The result in table 4.4 shows that there is no significant difference in performance between male experimental group and female experimental group in the post test after the two groups have undergone STS treatment. This finding agrees with those of Heller and Hollanbaugh (1992), Atadoga(2000) and Oke (2004) who found no difference in problem-solving abilities between boys and girls. Comber and Keeves (1973), Jacobson and Aaron (1985), Otuka (1986),Bichi (2008),James (2000 ), Mari (2007) and Usman (2005) also found no significant difference in the science achievement of boys and girls exposed to activity-based method of instruction such as STS. The result indicates that STS teaching strategy is gender friendly. This could be due to the fact that STS strategy is full of very interesting activities that learners do carry out in order to get answers to common questions they often ask on the wonders of nature around them.

# CHAPTER FIVE
# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

The purpose of this study was to determine the effects of STS instructional strategy on NCE students' achievement in genetics concepts compared to the traditional (lecture) approach. In this chapter a condensed summary of the rationale, methodology used and the findings are outlined. Conclusions from the study are drawn and recommendations based on the findings from the study are made and presented.

## 5.2 Summary

The study examined the effects of STS instructional strategy on NCE students' achievement in genetics concepts in Federal Colleges of Education, Zaria and Kano. The variables the study was concerned with are: the effects of STS strategy on

(a) Academic Performance;
(b) Gender (male & female).

Fifty study subjects from each school were used, to allow for an in-depth study within the short specified time frame of the study. The study was quasi experimental- control design in nature, involving direct teaching by the researcher of the experimental and the control groups, using STS and the lecture methods respectively. The lessons were planned based on the scheme of work for these concepts as obtained in the NCE Minimum Standard [2005]. A pretest was first administered to both experimental and control groups to determine the equivalence of the two groups before the teaching sessions.

At the end of the study, the following findings were obtained:

1. STS group performed significantly better than the traditional (lecture) group.

2 Male experimental (STS) group performed better than the male control (traditional lecture) group.

3. Female experimental (STS) group performed better than the female control (traditional lecture) group.

4. There was no significant difference in academic performance between male and the female experimental groups. This however, shows that STS teaching strategy is gender friendly.

## 5.3 Conclusions

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

1. STS instructional strategy could effectively enhance meaningful learning of genetics concepts among students in colleges of education and subsequently improve their performances significantly in genetics more than the traditional approach.
2. STS strategy could possibly reduce the fears students entertain in this seemingly hard and dreaded course (genetics) and begin to face it with greater confidence.
3. STS strategy appears to be more gender friendly.
4. STS has the potentiality of enhancing NCE students' academic achievement in genetics as shown in this study. Its gender friendliness could be used by teachers to enhance students' performance in genetics, despite their gender differences.

## 5.4 Recommendations.

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

- Curriculum planners should recommend the use of STS approach in the teaching and learning of genetics concepts. This is because this instructional approach has the material for creating friendly activities that make the learning of dreaded topics like genetics easier and meaningful.
- Conferences, seminars and workshops be organized by professional associations and educational research centres to sensitize the various stakeholders on the need for the adaptation of the STS instructional methods in our colleges of education.
- Science curriculum developers, supervisory bodies of high institutions, educators and teachers should popularize and incorporate STS instructional strategy into the curricula of all levels of education.
- Science curriculum developers and educators should also produce textbooks and teachers guides based on STS model of teaching and learning strategy.
- Examination bodies should introduce STS question models in their examination syllabuses and question papers.
- Teachers teaching at the colleges of education should be trained and retrained through workshops on the use of STS in the teaching of genetics.

## 5.5 Limitations

The study has the following limitations:

1. Only two schools were selected and used for the study, i.e. FCE Zaria and FCE Kano, each containing only 50 study subjects. Other colleges in this zone were not used. It is therefore, difficult to generalize the study to all the colleges of education.
2. The study also used only selected concepts of genetics. It is thus difficult to generalize the study to all biology topics.

## 5.6 Suggestions for Further Studies.

Suggestions made from the study are:

1. Studies on STS teaching strategy could be carried out in other levels of educational institutions such as polytechnics, universities and more colleges of education.
2. This type of study could also be carried out in other difficult topics such as ecology, evolution, microbiology, etc.
3. Similar studies could also be carried out in other subject areas at NCE level, such as chemistry, integrated science, physics, to see what the result will be.

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## APPENDIX A

## ITEM ANALYSIS FOR ACHIEVEMENT TEST.

| ITEM NO | KEY | RU | RL | FI=$\frac{RU+RL}{N}$ | DI=$\frac{Ru- Rl}{½ N}$ |
|---|---|---|---|---|---|
| 2 | A | 5 | 2 | 0.47 | 0.40 |
| 3 | D | 6 | 2 | 0.53 | 0.31 |
| 4 | B | 7 | 4 | 0.73 | 0.53 |
| 5 | B | 6 | 3 | 0.60 | 0.40 |
| 6 | A | 7 | 3 | 0.60 | 0.33 |
| 7 | B | 4 | 3 | 0.67 | 0.53 |
| 8 | D | 5 | 3 | 0.60 | 0.40 |
| 9 | A | 8 | 2 | 0.67 | 0.53 |
| 10 | B | 5 | 2 | 0.60 | 0.40 |
| 11 | C | 5 | 2 | 0.67 | 0.53 |
| 12 | C | 7 | 4 | 0.77 | 0.63 |
| 13 | D | 3 | 3 | 0.40 | 0.45 |
| 14 | B | 7 | 3 | 0.47 | 0.57 |
| 15 | B | 7 | 2 | 0.47 | 0.67 |
| 16 | D | 5 | 2 | 0.67 | 0.86 |
| 17 | C | 8 | 2 | 0.67 | 0.42 |
| 18 | A | 6 | 2 | 0.47 | 0.57 |
| 19 | B | 5 | 3 | 0.57 | 0.47 |
| 20 | A | 6 | 3 | 0.57 | 0.30 |
| 21 | C | 6 | 3 | 0.53 | 0.60 |
| 22 | B | 5 | 2 | 0.47 | 0.39 |
| 23 | B | 7 | 2 | 0.67 | 0.41 |
| 24 | B | 7 | 3 | 0.55 | 0.40 |
| 25 | C | 5 | 4 | 0.77 | 0.45 |
| 26 | B | 5 | 2 | 0.62 | 0.68 |
| 27 | D | 6 | 2 | 0.43 | 0.40 |
| 28 | C | 6 | 3 | 0.60 | 0.67 |
| 29 | A | 8 | 3 | 0.47 | 0.40 |
| 30 | C | 6 | 2 | 0.53 | 0.52 |
|  | C |  | 2 | 0.40 | 0.35 |

**Appendix B:**
**Table of specification of questions .**
**(Test construction analysis for GAT)**

.

| DOMAINS | TOPICS L / CONCEPTS | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | Basic concpt | Mendel 's work | Sex Linkage | Mutation | Human heredity | Applied Genetics | |
| COGNITIVE | 3 | 3 | 3 | 2 | 3 | 3 | 20 |
| PSYCHOMOTOR | - | 1 | - | - | 1 | 1 | 4 |
| AFFECTIVE | 1 | 1 | | 1 | 1 | 1 | 6 |
| TOTAL | 4 | 5 | 3 | 3 | 5 | 5 | 30 |

## APPENDIX C
## LESSON NOTES FOR CONTROL GROUP

| | | |
|---|---|---|
| **LESSON 1** | | WEEK 1 |
| **Mode of teaching** | – | Lecture method |
| **Group** | – | Control |
| **School** | – | FCE Kano |
| **Subject** | – | Biology |
| **Topic** | – | Variations |
| **Class** | – | NCE II |
| **No of Students** | – | 50 |
| **Average age** | – | 20yrs |
| **Time** | – | 1hour |

**Teaching aids** - chalkboard, duster, branches of plants of various types, diagrams of animals of different kinds students themselves.

**Behavioral Objectives** - At the end of this lesson students should be able to:

- Define the term variation.
- Give example of variations found among students and other living organisms.
- Identify the two types of variations we have (continuous and discontinuous variations) and giving examples.
- State the two major causes of variations, among living organisms (genes and environment),
- Mention examples of genetic and environmental or acquired variations.

**Previous Knowledge** - Students see the structural differences that exist among them and other living organisms every day.

**Presentation:**

**Step I**: **Introduction :** The teacher introduces the lesson by asking the students to look around, first, among themselves and tell us the differences they can see. Students to do the same with the branches of plants given to them.

**Step II**: The teacher explains the meaning of the term 'variations', using the teaching aids.

**Step III**: the teacher explains the meaning of 'continuous' and 'discountinuous' variations and give examples of each. Examples of continuous variations are weight, height, color of skin, intelligence etc. for discountinuous variations blood group, sex, tongue rolling etc.

**Step IV**: The teacher states and writes the two major causes of variations among living organisms: - heredity and environment. Teacher gives examples of each above.

| Genetics variations | Acquired or Environmental Variations |
|---|---|
| Skin colour | Bleaching Skin |
| Height | Thick Muscles in weight Lifters |
| Blood group | Dyeing of Hair |
| Sex | Paralysis from polio |

**Step V**: **Evaluation:** The teacher evaluates the lesson by asking Students these question:-

- What do you understand by the term variations?
- Give example of variations among humans, plants and other animals.
- What is continuous variations?
- Give example of continuous variations.
- What is discontinuous variation?
- Give examples of discontinuous variations.
- What are the causes of variations?

- Give example of genetic variations.
- Give examples of acquired or environmental variations.

**Step VI**: **Conclusion:** The teacher concludes the lesson by going over the major points of the lesson.

- Definition of variations
- Continuous and discontinuous
- Causes of variation: heredity (genes) and environment.
- Examples of hereditary variations
- Example of acquired variations.

| | | |
|---|---|---|
| **LESSON 2** | | WEEK 2 |
| **Model of Teaching** | - | Lecture |
| **Group** | – | Control |
| **School** | – | FCE Kano |
| **Subject** | – | Biology |
| **Topic** | – | Basic concepts in genetics |
| **Class** | – | NCE II |
| **No of Students** | - | 50 |
| **Average age** | - | 20yrs |
| **Time:** | - | 1hour |

**Behavioral Objective**: - At the end of the lesson, students should be able to define the following terms : genotype, phenotype, homozygous, heterozygous, alleles, monohybrid and dihybrid crosses, test cross, breeding true pure line, back cross

**Previous knowledge** - Students are familiar with the variations that exist among organisms of same species including humans.

**Teaching Aids:** - (i) Plants of same species that have some slight variations among themselves.
(ii) Charts of animals of same species that show some variations.

**Presentation:**

**Step I : Introduction** The teacher asks the students questions on the variations they observed exist among organisms of same species.

**Step II: Basic Genetic Terms** The teacher gives and writes the definition of the following the following terms: genotype, phenotype, homozygous, heterozygous, alleles, monohybrid, dihybrid cross, dominant, recessive, test cross, breeding true, pure line, back cross. The teacher explains each term with example.

| | |
|---|---|
| **Step III: Evaluation:** | The teacher asks the students the definitions of each term and the examples.<br>What to do you understand by the terms genes, chromosomes?<br>Phenotype, genotype, homozygous, heterozygous, alleles, monohybrid, dihybrid, dominant, recessive. |
| **Conclusion:** | The teacher concludes the lesson by briefly giving the definitions of the basic terms once more. |

| | |
|---|---|
| **LESSON 3** | **WEEK 3** |
| **Mode of teaching** | - Lecture Method |
| **Group** | – control |
| **School** | - FCE Kano |
| **Subject** | – Biology |
| **Topic** | – Mendel's work on peas (Monohybrid inheritance) |
| **Class** | – NCE II |
| **No of Students** | – 50 |
| **Average age** | - 20 |
| **Time:** | - 1 hour |
| **Behavioral Objective** | : At the end of the lesson students should be able to: i)Explain how a single trait is inherited in organisms. ii)State and explain Mendel's First law of inheritance. iii)Explain how Mendel's works on inheritance led to the discovery of chromosomes and genes. |
| **Previous Knowledge:** | Students are familiar with the terms 'genes' and 'alleles'. They are also familiar with traits like 'tall' and 'short', the terms 'genotype', and 'phenotype'. |
| **Teaching Aids:** | Diagrams showing crosses between parent plants, first filial generation, resultant plants – F1 and F2 generations**.** |
| **Presentation:** | |
| **Step I: Introduction** | : The Teacher asks the students questions based on previous knowledge. |
| **Step II** | Monohybrid inheritance: (i) Teacher explains how pollens of a tall plant were robbed on the stigma of a dwarf plant. Seeds were collected and sown. |

Seeds gave rise to tall plants only. i.e.F1 generation. F1 were self – pollinated,

Seeds from F1 gave rise to tall and dwarf plants in the ratio 3:1.

(ii) conclusion from above : Chromosomes and genes occur in pairs, they separate (Segregate) independently during gametes' formation (sperms, eggs, pollen, ovules). Thus a gamete receives only one gene from a pair. This forms Mendel's first law of inheritance, known as "Law of segregation.'

i.e. genes are transmitted singly, T or T and t or t not in pairs.

(iii) Teacher now states Mendel's first law of inheritance (Law of segregation):

This law states that, An organism's characteristics are controlled by internal factors (genes ) which occur in pairs. They separate (segregate ) independently during gamete formation, thus a gamete receives only one gene from a pair'.

The teacher now tells the students that Mendel's work led to the discovery of genes and chromosomes, and also forms the foundation upon which the study of heredity is built.

**Step III Evaluation**: Teacher asks the students the following questions:

(1) What is the product of a cross between tall male and a dwarf female chicken?

(2) What is the ratio of tall to dwarf chicks if the F1 generations are crossed among themselves?

State Mendel's first law of inheritance.

**Step : Conclusion:** The teacher concludes the lesson with a summary of the main points.

| | | |
|---|---|---|
| **LESSON 4** | | **WEEK 4** |
| **Mode of Teaching** | – | Lecture method |
| **Group** | – | Control |
| **School** | – | FCE Kano |
| **Subject** | – | Biology |
| **Topic:** | - | Mendel's work (continued): Dihybrid inheritance. |
| **Class** | – | NCE II |
| **No of Students** | – | 50 |
| **Average** | – | 20 |
| **Time** | | 1 hour |
| **Behavioral Objectives:** | | At the end of the lesson students should be able to: i)explain how two contrasting characters are inherited using crossing and punnet square methods. |
| | - | ii) state Mendel's second law of inheritance. |
| | - | iii) write the ratio of the F2 generation' |
| **Previous Knowledge** | - | Students are familiar with how inheritance takes place in monohybrid cross. |
| **Teaching Aids**: | - | diagrams showing crossing of gametes |

**Presentation:**

**Step I: Introduction:** Teacher asks the students questions based on previous knowledge: Monohybrid inheritance.

**Step II:** Dihybrid inheritance: The teacher explains how Dihybrid Inheritance takes place by using crosses and punnet square.

e.g. color and texture of a seed's surface (green smoothed surface seed and white wrinkled surface seed. Green and smooth are dominant over white wrinkled. Crossing the two shows:

F1 generation all green smoothed seeds.

F2 generation; Green smooth = 9
Green wrinkled = 3
White smooth = 3
White wrinkled = 1
Ratio = 9:3:3:1

Teacher then states Mendel's second law of Inheritance: The two pairs of alleles are transmitted independently from parents to offspring and assort freely. This is called law of independent assortment.

**Step III: Evaluation:** the teacher evaluates the lesson by asking students the following questions:

i) A tall and smooth haired chicken was crossed with a dwarfed and curled haired chicken, the F! generations were all tall and smooth haired chicks.

ii) Using punnet square or crossing, show the genotype of the F1 generation.

iii) Show the genotype and phenotype of the F2 generation when the F1 were crossed among them.

iv) What is the ratio of the F2 generation?

**Step IV: Conclusion:** The teacher concludes the lesson by a brief summary of the major points.

| | | |
|---|---|---|
| **LESSON 5** | - | **WEEK 5** |
| **Mode of Teaching** | – | Lecture method |
| **Group** | – | Control |
| **School** | – | FCE Kano |
| **Subject** | – | Biology |
| **Topic:** | - | Sex determination & sex linkage |
| **Class** | – | NCE II |
| **No of Students** | – | 50 |
| **Average** | – | 20 |
| **Time :** | | 1 hour |
| **Behavioral Objectives** | - | At the end of the lesson students should able to: (i) define a sex chromosome;<br>(ii) define a sex chromosome;<br>(iii) explain how the sex of a child is determined at conception.<br>(iv) describe sex linkage.<br>(v) give examples of sex linkage. |

**Previous Knowledge:** Students are familiar with the terms chromosome and 'sex' of a child; how chromosomes segregate singly into a gamete, and how gametes come together at conception.

**Teaching Aids:** Chalk, chalkboard, diagrams depicting sex chromosomes.

**Presentation**

**Step I: Introduction:** The teacher introduces the lesson by asking students the following questions:-

What are chromosomes?

What are genes?

State Mendel's First Law.

State Mendel's Second Law of inheritance.

**Step II:** **Sex Determination**: the teacher explains how the sex of baby is determined by the XX and XY chromosomes after they have separated and gone into gametes during meiosis or gamete formation. The teacher uses a diagram to illustrate how this happens: X from mother + X from father = XX (Female)

X from mother + Y form father=XY (Male)

Step III: **Evaluation**: the teacher makes brief evaluation of the lesson: (i) What type of chromosomes are found in the gametes of a woman?

(ii) What type are found in the gametes of a man?

(iii) How is a baby boy formed during fertilization?

(iv) How is a baby girl formed during fertilization?

**Step IV:** **Sex Linkage**: the teacher explains what sex linkage means:

- All the genes that are carried on the sex chromosomes. Teacher gives an example of how sex linkage takes place in drosophila. i.e. the inheritance of red eyes.
- How it is only transmitted by an X Chromosome from the father and not the Y chromosome. Draw a diagram.

- Even in humans it's the same. Thus, a male child cannot inherit a sex linked trait from his father because he received only a Y chromosome from his father; this does not carry any sex linked character or gene.

  A female will however inherit a sex linked character from her father because she received an X chromosome from him. She will transfer it to all her children e.g. the inheritance of the red green colour blindness in man.

  A colour blind gene is recessive. A man with it who marries a normal woman will transmit it to his daughters who will not be colour blind because they are heterozygous for that trait (they are carriers.). His sons will not have the recessive allele because they received a Y chromosome and not an X chromosome; their X chromosome is from their mother.

  If the daughter marries a normal man and they introduce a son, the probability is ½ that he will be color blind.

  Their daughter will be phenotypically normal, but probability is ½ that she will be a carrier. As would be expected there are more men than women who are red green color blind.

  Hemophilia is another sex linked disease and operates like color blindness.

**Step V**: **Evaluation: -** The teacher asks the students the following questions:

i. What is sex linkage?

ii. Why will male children not inherit colour blindness from their father?

iii. A colour blind man marries a normal woman. What will be the genotype and the phenotype of: a) His sons b) Daughters

c) Grandson born by his daughter?

iv. A colour blind woman marries a normal man. What is the phenotype of her children?

**Step VI:** **Conclusion:** The teacher concludes the reason with a summary of the main points.

- Defines sex linkage

- Associated mostly with X chromosome from the father
- Examples of sex linkage traits

| | | |
|---|---|---|
| **LESSON 6** | - | WEEK 6 |
| **Mode of Teaching** | – | Lecture method |
| **Group** | – | Control |
| **School** | – | FCE Kano |
| **Subject** | – | Biology |
| **Topic:** | - | Mendel's work (continued):<br>Dihybrid inheritance. |
| **Class** | – | NCE II |
| **No of Students** | – | 50 |
| **Average** | – | 20 |
| **Time :** | | 1 hour |
| **Teaching Aids** | - | Chalk, chalkboard, small plants, seeds,<br>leaves, stems, diagrams of animals, all with abnormalities |
| **Behavioral Objectives**: | | At the end of the lesson, students should be able to: |

i. Define mutation

ii. List the causes of mutations.

iii. State the advantages of mutations

iv. Differentiate between gene and chromosome mutations.

v. Explain how gene and chromosomal mutations take place.

vi. List examples of gene and chromosome mutations in plants, animals and humans.

**Previous Knowledge** - Students have been seeing abnormalities in plants, animals and humans.

- They are also familiar with genes, chromosomes and some of their characteristics.

**Presentation**:

**Step** I: **Introduction:** Teacher introduces the lesson by asking the students questions based on their previous knowledge.

(i) Name some of the abnormalities you see in plants, animals and man.

(ii) Can you suggest the causes of these abnormalities?

**Step II:** **Mutations:** the teacher now groups the abnormalities given by students into two, based on the two main causes: environment and genetic. The genetic abnormalities are as a result of mutations. Two types of mutations: Gene mutations and chromosomal mutations.

**Step III:** **Chromosomal Mutations**:

The teacher explains how chromosomal mutations take place.

- Involve a whole chromosome
- Take various forms: e.g

Deletion

Inversion

Translocation

Duplication

Non – disjunctions or polyploidy

Teacher explains each diagrammatically.

Examples of effects of non – disjunctions in man include: Mongolism (Down's syndrome), Klinefelter's syndrome, Turners syndrome.

**Step IV:** **Evaluation:** the teacher evaluates the lesson by asking the following questions:

(i) What is the different between a child born lame and the child who became lame after suffering polio?

(ii) Name the main groups of mutations.

(iii) List five forms of chromosome mutations.

(iv) Explain each of them (teacher appoints students one by one to explain one each).

**Step V:** **Conclusion:** The teacher concludes by going through the main points once more.

| | | |
|---|---|---|
| **LESSONS 6 (b)** | | **WEEK 6** |
| **Mode of teaching** | – | Lecture method |
| **Group** | - | Control |
| **School** | - | FCE Kano |
| **Subject** | - | Biology |
| **Topic** | - | Gene Mutations |
| **Class** | - | NCE II |
| **No of Students** | - | 50 |
| **Average Age** | - | 20 |
| **Time:** | - | 1 hour |

**Teaching Aids** - Chalk, Chalkboard, small plants, seeds leaves, stems, diagrams and pictures of animals and humans with abnormalities from gene mutations.

**Behavioural Objectives**: - At the end of the lesson students should be able to:

i. explain how gene mutations take place

ii. list types of gene mutations

iii. list effects of gene mutations

iv. differentiate between gene and chromosomal mutations

**Previous Knowledge:-** (i) students have seen the various abnormalities in plants and animals.

( ii ) They know that these abnormalities are caused by genes or chromosome mutations.

( iii) They are familiar with chromosome mutations

**Presentation:**

**Step I:** **Introduction:** The teacher introduces the lessons by asking students the following questions:

i. What are the causes of the abnormalities we see in plants, animals and humans?

ii. How many major groups of mutations do we have?

iii. Briefly explain how chromosome mutations take place.

**Step II**: **Gene Mutations**: The teacher explains how gene mutations take place.

(i) As a result of chemical imbalance in an individual gene

(ii) An alternation in the sequence of nucleotides in that part of DNA molecule to a single gene will change the order of amino acid making up a protein.

(iii) This can have serious consequences on the development of an organism.

(v) Can prevent proper functioning of the protein

(iv) If this results in the death of the organism, the gene is described as lethal genes

(iv) Drastic effects can sometimes be produced by seemingly trivial change in the nucleotide sequence of a gene, e.g formation of abnormal hemoglobin S.

**Step III: Types of gene mutation:**

The teacher explains the various types of gene mutations:

(i) Substitution;

(ii) Insertion

(iii) Deletion

(iv) Inversion

**Step IV**: **Importance of mutations in evolution:**

The teacher lists the importance of mutations in evolution eg:

production of new species of organism;

Hybrid vigor associated with polyploidy;

New hybrid varieties of food crops and animals have been developed to meet the ever – increasing demands of human populations;

This has led to green revolution;

The new varieties display some advantages over the old ones e.g.

i. Stems are shorter, giving dwarf varieties which are less likely to be flattened by wind and rain, thus, can easily be harvested;

ii. Give a higher yield or better nutritional value;

iii. Show greater responsiveness to water or fertilizer;

iv. Give higher photosynthetic performance;

v. Animals grow fatter in a short time and put in more meat;

vi. More resistance to diseases and pests;

vii. Insensitive to daylight and or temperature, with the result that two or three crops can be grown per year;

**Step V: Evaluation**: The teacher asks the students the following questions:

(i) What is the importance of mutations to evolution?

What qualities do the new hybrids have over the old ones?

(ii) Explain how each of these types of gene mutations take place: substitution, insertion, deletion and inversion.

(iii) What is a lethal gene?

(iv) What is the major difference between chromosomal mutation and gene mutation?

**Step VI: Conclusion:** The teacher concludes the lesson by going through the main points once more:

(i) Chromosomal mutations

(ii) Gene mutations

(iii) Importance of mutations

**LESSON 7** - **WEEK 7**

**Mode of Teaching** - Lecture Method

**Group** - Control

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Applied genetics

**Class** - NCE II

**No of Students** - 50

**Average Age** - 20

**Time:** - 1 Hour

**Teaching Aids** - Samples of modified fruits, cereals, legumes,
ink and inkpad

**Behavioral Objectives:** At the end of the lesson students should be able to:

i. list the various areas in which genetics is applied;

ii. name some examples of plants and animals that are produced by applied genetics.

**Previous Knowledge**: Students see and use new species of tomatoes, fruits and some cereals that are introduced into the market these days;
They have been thumb- printing on various documents.

**Presentation**

**Step I: Introduction**: The teacher introduces the lesson by asking students to carry out the following activities:

i. Break open two species of tomatoes and state the differences you can see;

ii. Thumb-print on a plain sheet. Tell us where else are people mandated to carry out such an activity and for what purpose?.

**Step II: Applied Genetics**: The teacher explains what applied genetics is all about and the various ways the science of genetics is used by man to his advantage.

**Step III: Areas of Applications**: The teacher states and explains:

where and how genetics is applied:

forensic Science ( identify and convict criminals and to confirm ownership) ; treat diseases ; production of drugs and gene therapy in treating cancer and cystic fibrosis; alter a plant or animal structure to make it more useful, e.g. to withstand pests, increase yield, resist discoloration and bruise, produce more milk and meat. This leads to the production of new species of organisms.

**Step IV: Evaluation**: The teacher evaluates the lessons by asking them the following questions:

i. What do you understand by the term 'applied genetics'?

ii. List the major areas of application of genetics.

iii. Give specific examples of how genetics is applied in crops, animals, treatment of diseases and production of drugs.

iv. What qualities do new hybrids have over the old ones?

iv. What is the importance of mutations to evolution?

**Step V: Conclusion**: The teacher concludes the lesson by going through the major points of the content.

**LESSON 7 (b)** **WEEK 7**

**Mode of Teaching** - Lecture Method

**Group** - Control

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Human genetic disorders

**Class** - NCE II

**No of Students** - 50

**Average Age** - 20

**Time**: - 1 Hour

**Teaching Aids** - Diagrams of various human genetics disorders.

**Behavioral Objectives** -At the end of the lesson student should be able to :

i. define the terms 'genetic disorder;'

ii. list various genetic disorder;

iii. explain the causes of such disorder.

**Previous Knowledge**: Students have seen genetic disorders such as albinism, sickle cell anemia, etc.

**Presentation**

**Step I:** **Introduction:** The teacher introduces the lesson by asking the students to describe the following conditions if they have seen them before:

i. albinism

ii. sickle cell anemia.

**Step II:** **Genetic disorder:** The teacher defines what genetic disorder is :

Medical conditions caused by an error in a person's genetic material;

There are more than 9,000 genetic disorders;

They may occur before or after birth.

**Step III:** **Types of genetic disorders**: the teacher explains:

(a) those caused by genes: e.g. (i). Huntington disease- uncontrolled movements called chorea. (ii). Cystic fibrosis: build up of thick suffocating mucus in the lungs, it can interfere with digestion of food. .

(iii) Sickle cell anemia (iv) Hemophilia.

( b) those caused by chromosomes: (i) Down syndrome:( one extra Chromosome in the cell); (ii) Klinefelter's syndrome ( failure of an X chromosome to separate during oogenesis, resulting in the individual having XXY ); Affects 1 of 500 males; (iii) Turner's syndrome : affects 1 in 2500 females. Here, an X or Y chromosome is missing, giving a genetic constitution XO. Such females are sterile with immature genitalia.

**Step IV: Evaluation**: The teacher evaluates the lesson by asking the students the following questions:

What do you understand by the term 'genetic disorder'?.

i. Name the two major groups of genetic disorders.

ii. Name the disorders caused by genes, their symptoms and how they are caused by genes.

iii. Name the disorders caused by chromosomes, how they are caused and their symptoms.

**Step V: Conclusion:** The teacher concludes the lesson by going through

the main points: genetic disorders, types and causes, examples in each case.

**LESSON 8** **WEEK 8**

**Mode of Teaching** - Lecture Method

**Group** - Control

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Genetics Counseling

**Class** - NCE II

**No of Students** - 50

**Average Age** - 20

**Time:** - 1 Hour

**Teaching Aids** - Chalk, chalkboard, pictures of pregnant women, families in a counseling session

**Behavioral Objectives** - At the end of the lesson students should be able to:

i. state briefly what genetic counseling is;

ii. list the advantages of genetic counseling.

**Previous Knowledge**: Students have been genetic disorders such as albinism, sickle cell anemia etc.

**Presentation**

**Step I: Introduction**: The teacher introduces the lesson by asking the students to describe the following:

i. What kind of activity takes place when you go to the college counseling master?

ii. How do you feel as you leave the clinic counseling room?

**Step II : Definition of Counseling**: The teacher defines the term counseling' and writes it on the chalkboard.

Advice or guidance, especially as provided by a professional in a given field.

**Definition of Genetic Counseling:**

Medical specialty that helps parents and prospective parents to evaluate and cope with their risk of passing hereditary disorder to their children. It also helps individuals assess the possibility that they will get a medical condition known or suspected to have a genetic basis e.g. Huntington's disease, breast cancer, Alzheimer's disease.

**Step III:** **Who Benefits from Genetic Counseling?** The teacher lists the category of people who benefit from genetic counseling: Prospective Parents,People with family history of disease,ethnic groups at higher risk for disease.

**Step IV:** **Diagnosing a genetic Condition:**

Inheritance Patterns: Educate the clients about inheritance patterns of suspected genetic disorders;

Family medical history: Information about a client's family medical history to determine to whether any inherited disorder exists.

Diagnostic Testing: Genetic counselors may suggest that a client undergoes certain tests that can analyze the genetic information in a person's cell e.g.

i. Career screening: Career screening tests can determine if an otherwise healthy person carries a recessive gene for a disease that is common in certain ethnic groups e.g. toysachs in disease Jews from Eastern Europe. This helps parents to make reproductive.

ii. Prenatal Testing: Done to a pregnant woman to identify health problems in the foetus, so as to provide information about the medical educational needs of the child, should he have heart disorder, or to terminate the pregnancy.

iii. Predictive Testing: e.g pre- symptomatic tests and susceptibility test to identify if a person has one or more altered genes whose effect typically do not appear until later in life.

**Step V:** **Choosing a Course of Action:** After identifying a disease or estimating the probability that a disease will develop, the genetic counsellor helps individuals and their families choose a course of action to cope with the genetic conditions.

This takes individuals varying experiences, social attitudes and religious values into consideration because they influence their thinking about medical issues.

**Step VI:** **Evaluation**: The teacher evaluates the lesson by asking students the following questions:

i. What do you understand by the term genetic counseling?

ii. What categories of people provide genetic counseling?

iii. Who is supposed to attend a genetic counseling session?

iv. List the benefits of attending genetic counseling sessions.

v. State the major areas of diagnosis during counseling sessions.

vi. What is the role of a genetic counselor in the choice of course of action after diagnosis?

**Step VII:** **Conclusion:** The teacher concludes the lesson by going through the major points of the lesson.

**SESSON 9** **WEEK 9**

**Mode of Teaching -** Lecture Method

**Group** - Control

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Biotechnology (Genetic Engineering)

**Class** - NCE II

**No of Students**- 50

**Average Age** - 20

**Time:** - 1 Hour

**Teaching Aids**- Chalk, chalkboard, pictures of special sheep,

some hybrid food crops, pictures of special species of animal brfor same purpose.

**Behavioral Objectives** - At the end the lesson students should be able to:

i. define the terms biotechnology and genetic engineering;

ii. list the various products of genetic engineering;

iii. state the various forms of genetic engineering;

iv. state the advantages and disadvantages of genetic engineering.

**Previous Knowledge**: Students see and use varieties of tomatoe,

oranges, maize, cows e.t.c.

**Presentation**

**Step I:** **Introduction**: The teacher introduces the topic by asking the students the following questions:

i. How many types of tomato do you see on sale?

ii. Are there some that are better than others?

iii. In what ways?

iv. What about other crops like maize and guinea corn; Animals like cows' pigs, sheep etc?

v. Describe their differences.

**Step II**: **Biotechnology:** The teacher tells the students that the varieties of crops and animals they see are produced by a process known as biotechnology or genetic engineering.

The teacher then defines the term 'biotechnology':

Manipulation of biological organisms, biological systems or biological process to make products that benefit human beings and other animals. This process involves genetic engineering which is the alteration of an organism's genetic or hereditary material to eliminate undesirable characteristics and to produce new and desirable ones, e. g, hybridization (in maize and animals), cloning (in bacteria and other animals).

**STEP III**: **Application of Biotechnology:** The teacher explains the areas where biotechnology or genetic engineering is applied.

i. Food Production: New varieties that resist pests or varieties that produce more e.g. more milk and meat from cattle.

ii. Pollution Control: E.g. Genetically altered bacteria to decompose garbage or breakdown petroleum products etc.

iii. Medicine: Production of drugs for diabetic patients, to treat cancer, vaccines for cowpox, hepatitis, influenza, gene therapy to treat, cystic fibrosis, muscular dystrophy etc.

**Step IV: Evaluation:** The teacher asks the students the following questions:

i. What is biotechnology?

ii. What is genetic engineering?

iii. List three areas where biotechnology is applied, citing examples in each case.

**Step V: Conclusion**: The teacher concludes the lesson by going through the major points: Definition, application, examples.

**LESSONS 10** **WEEK 10**

**Mode of Teaching** - Lecture Method

**Group** - Control

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Controversies over Biotechnology

**Class** - NCE II

**No of Students**- 50

**Average Age** - 20

**Time:** 1 Hour

**Teaching Aids**- Two species of soy beans, eggs from home bred fowls, eggs from a modern poultry farm.

**Behavioral objectives**- At the end of the lesson students should be able to:

State the disadvantages of biotechnology/genetic engineering. Give reasons why some people don't advocate for it.

**Previous knowledge**: Students see effects of some products of biotechnology e.g. bleaching creams.

**Presentation**

**Step I: Introduction**: The teacher introduces the lesson by asking students the following questions:

i. What are the effects of some bleaching creams on people's body?

ii. How do children who have never seen their father feel?

**Step II:** The teacher explains the side effects of products of biotechnology/genetic Engineering:

- Use of recombinant genes (DNA) of some pathogens to produce medicines may develop extremely infectious forms that could cause worldwide epidemics.
- Transgenic fish may interbreed with others that have not been genetically altered and cause a change in the characteristics of the wild fish in undesirable ways.
- There are vivid fears that cloning human may create evil beings for evil purposes.
- It is ethically unacceptable to destroy human embryo for harvesting stem cells.
- The birth of Dolly (sheep) through cloning without a father could remove the need for a father in the life of a child.
- Cloning may produce a person with the desired character we want, but if he has strong political powers he may treat humans as he might try for the best breed of cattle.
- Some genetically altered organisms will eliminate existing species, balance of organisms.
- The constant use of creams changes the texture of the skin and makes it unsuitable for some medical operations.
- Transgenic plants may interbreed unwanted characteristics, such as resistance to herbicides e.g. oil seed rape.
- Transgenic plants can transfer allergens to other food crops through genetic engineering e.g. soy beans.

**Step III:** **Evaluation:** The teacher then asks the students one by one to state one disadvantage of biotechnology.

**Step IV:** **Conclusion:** The teacher concludes the lesson by reaffirming that despite the importance of biotechnology in medical and agricultural fields, it is known to cause harm to humans, animals and the environment.

The teacher then briefly mentions a few cases of harm it causes.

## APPENDIX D:

## LESSONS FOR EXPERIMENTAL GROUP

For experimental lessons, the teacher divides the students into 10 groups, each consisting of 5 students.

**LESSON 1 - WEEK 1**

**Mode of teaching** - STS Methodology

**Group** - Experimental

**School** - FCE Zaria

**Subject** - Biology

**Topic** - Variations

**No of students** - 50

**Average age** - 20 yrs

**Time** - 1 hr

**Teaching aids** - chalkboard, duster, branches of plants of various

- types, diagrams of animals of different kinds, students themselves.

.

**Behavioral objectives** - At the end of this lesson students should be able to:

- define the term variation.
- give examples of variations found among them and other living organisms.
- identify the two types of variations we have (continuous and discontinuous variations) and their examples.

State the two major causes of variations among living organisms ( genes and environment ),

- 'give examples of genetic and environmental or acquired variations.

**Previous knowledge** - Students see the structural differences that exist among them and other living organisms every day.

**Presentation:**

**Step I: Orientation phase:** The teacher introduces the lesson by asking the students the following questions:

i. Why do basketball teams prefer tall people to short ones even if the short ones are skillful in the game, to the discomfort of the short ones?

ii. Why do some dark skin women use bleaching cream though they know the medical implications of such an action?

iii. Why do some people prefer a white variety of maize when they find mixture of many colors (red, brown and black) during harvest, against their wish?

**Step II:** **Identification and definition phase**: The teacher asks the students in their various groups to go search for information on the topic and answers to the questions raised above. Students then engage themselves in brain storming and possibly experiment with materials.

**Step III:** **Synthesis phase**: Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV:** **Interaction phase**: Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V:** **Clarification phase**: Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

- The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.
- Social implications of variations: It confers some organisms with some advantages over their mates.
- Scientific concepts: continuous and discontinuous variations, genetic and acquired (environmental) variations.
- Scientific skills needed to be acquired: Ability to identify differences amongst organisms of different species.

**Step VI:** **Action phase**: Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 2 -** | | **WEEK 2** |
| **Mode of Teaching** | - | STS methodology. |
| **Group** | - | Experimental |
| **School** | - | FCE Zaria |
| **Subject** | - | Biology |
| **Topic:** | | - Basic concepts in genetics. |
| **Class** | - | NCE II |
| **No of Students** | - | 50 |
| **Average age** | - | 20 |
| **Time:** | - | 1 hour |
| **Behavioral Objectives:** | - | At the end of the lesson, students should be able to define the following terms: genotype, phenotype, homozygous, heterozygous, alleles, monohybrid and Dihybrid crosses, test cross, breeding true , pure line, back cross |
| **Previous Knowledge** | - | Students are familiar with the variations that exist among organisms of same species including humans. |
| **Teaching Aids:** | - | (i) Plants of same species that have some slight variations among themselves |

(ii) Charts of animals of same species that show some variations.

**Presentation:**

**Step I: Orientation phase:** The teacher introduces the lesson by asking th students following questions:

- What names do people in your place give to various types of abnormalities?
- Why do they give such names?
- When some children grow to know that names given to them have to do with the abnormalities they have, what kind of feelings and characters do they develop?. If the characters they develop are bad, how can this be avoided?

**Step II : Identification and definition phase:**

The teacher asks the students in their various groups to go and search for information on the topic and answers to the questions.

Students then engage themselves in brain storming and possibly experiment with materials. E.g. removing some important material from the cytoplasm of a plant or lower animal embryo (frog).

**Step III: Synthesis phase:**

Students come back to the class and prepare charts, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

- The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.
- Social implications: A child always have the tendency to behave in the way the society looks at him. If he is given a name that connotes something negative, he behaves negatively, if positive, he behaves and develops good manners.

  In most cases such names are misinterpretation of the abnormal situation i.e. having a wrong concept of the situation.
- Scientific concepts: the researcher now explains the meaning of each basic genetic concepts; dominant, recessive, allele, gene, chromosome,

homozygous, heterozygous, haploid, diploid, zygote, phenotype, genotype gamete.

Scientific skills needed to be acquired: Ability to interpret phenomena scientifically, laboratory techniques on embryo.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 3** | | **WEEK 3** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Zaria |
| **Subject** | - | Biology |
| **Topic:** | - | Mendel's work on peas (Monohybrid inheritance) |
| **Class** | - | NCE II |
| **No of Students** | - | 50 |
| **Average** | - | 20 yrs |
| **Time:** | - | 1 hour |
| **Behavioral Objectives:** | | At the end of the lesson students should able |
| | - | explain how a single trait is inherited in organisms. . |

- State and explain Mendel's First law of inheritance.
- Explain how Mendel's works on inheritance led
- to the discovery of chromosomes and genes.

**Previous Knowledge:** Students are familiar with the terms 'genes' and 'alleles'. They are also familiar with traits like 'tall' and' short', the terms 'genotype', and 'phenotype'.

**Teaching Aids:** - Diagrams showing crosses between parent plants, first filial generation, resultant plants - F 1 and F2 generations.

**Presentation:**

**Step I: Orientation phase:** The researcher introduces the lesson by asking the students the following questions:

- A tall man found a short woman with compatible manners but is hesitant to marry her because he does not want his children to be short. How would you convince him that his children are not likely to be short?.

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions.

Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.

- Social implications of monohybrid inheritance:

  The fear of producing a character we do not want can sometimes blind our eyes to the good aspects of the organism entirely. If only we know that there may be a way of correcting the bad characters, we would not take a step that makes us miss out in the whole struggle.

- Scientific concepts: dominant and recessive characters, gametes ratio, F I generation, F 2 generation. Mendel's first law of inheritance (Law of segregation).

- Scientific skills to be acquired: Ability to pollinate plants or fertilize animals artificially.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 4** | | **WEEK 4** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Kano |
| **Subject** | - | Biology |
| **Topic:** | - | Mendel's work (continued) : - Dihybrid inheritance. |
| **Class** | - | NCE II |
| **No of students** | - | 50 |
| **Average age** | - | 20 |
| **Time:** | - | 1 hour |

**Behavioral Objectives -** At the end of the lesson students should be able to:

- explain how two contrasting characters are inherited using crossing and punnet square methods.
- State Mendel's second law of inheritance.
- write the ratio of the F2 generation'

**Previous Knowledge-** Students are familiar with how inheritance takes place in monohybrid cross.

**Teaching Aids:** - diagrams showing crossing of gametes.

**Presentation:**

**Step I: Orientation phase** : The researcher introduces the lesson by asking the students the following questions:

- Two species of maize have just been brought from Spain, one has the potential of yielding much but cannot withstand any slight drought, while the other can stand drought but cannot yield as much as the first one. People are confused as to which one to choose, looking at the conditions of our rainfall here and the high demand for food by our ever growing population. What is the solution?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go and search for information on the topic and answers to the questions.

Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions

raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

The researcher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic:

- Social implication of Dihybrid inheritance: Lack of knowledge of how to produce food crops with two desired characters can make people to suffer the consequences of any bad character for a long time.
- Scientific concepts: pure breeding, Dominant characters, ratio 9:3:3:1 Fl generation, F2 generation.
- Scientific skills that need to be acquired: Ability to blend two characters in order to have a species that does not have an undesirable trait.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 5** | | **WEEK 5** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Kano |
| **Subject** | - | Biology |
| **Topic:** | - | Sex determination & sex linkage. |
| **Class** | - | NCE II |
| **No of students** | - | 50 |
| **Average age** | - | 20 |
| **Time:** | - | I hour |
| **Behavioral Objectives:** | - | At the end of the lesson students should able to: |

(i) Define a sex chromosome;

(ii) Name the two types of sex chromosomes;

(iii) Explain how the sex of a child is determined at conception.

(iv) Describe sex linkage.

(v) Give examples of sex linkage.

**Previous Knowledge:** Students are familiar with the terms chromosome and 'sex' of a child; how chromosomes segregate singly into a gamete, and how gametes come together at conception. .

**Teaching Aids:** - Chalk, chalkboard, diagrams depicting sex chromosomes.

**Presentation**

**Step I: Orientation phase:** The teacher introduces the lesson by asking students the following questions: -

- Many men blame their wives for giving birth to only female children. Many of such men either divorce their wives or they themselves desert the family and, in some cases, marry a second wife who, as they think, will give them male children that will inherit them. Who is to blame in this case?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions.

Students then engage themselves in brain storming and possibly experiment with materials. .

**Step III:** **Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV:** **Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written report

**Step V:** **Clarification phase :** Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic:

Social implications of sex determination and sex linkage: It has led to broken homes and social ills. Many women and children have suffered innocently for what was not their making.

Scientific concepts: X chromosome, Y chromosome, XX =

female, XY = male. X and Y chromosome from male

determine sex of a child.

Skills needed to be acquired: Ability to create conducive environment for the meeting of X and Y chromosomes to bring about a male child.

**Step VI:** **Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 6(a)** | **-** | **WEEK 6** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Kano |
| **Subject** | - | Biology |
| **Topic** | - | Chromosomal Mutations |
| **Class** | - | NCE II |
| **No of students** | - | 50 |
| **Average age** | - | 20 |
| **Time:** | - | 1 hour |
| **Teaching Aids** | - | Chalk, chalkboard~ small plants, seeds, leaves, |

Stems, diagrams of animals, all with abnormalities.

**Behavioral Objectives**: - At the end of the lesson, students should be able to:

(i) Define mutation

(ii) List the causes of mutations.

(iii) State the advantages of mutations.

: (iv) Differentiate between gene and chromosome mutations.

(v) Explain how gene and chromosomal mutations take place.

(vi) List examples of gene and chromosome mutations in plants, animals and humans.

**Previous knowledge** - Students have been seeing abnormalities in plants, animals and man.

- They are also familiar with genes, chromosomes and some of their characteristics.

**Presentation:**

**Step I: Orientation phase: -**

The teacher introduces the lesson by asking students the following questions:

Many people suffer heavy loss of their soy beans and cowpea in the farms whenever they fail to harvest them in good time as a result of tight schedules or illness. How can this loss be avoided when one is not opportune to harvest it as at when due?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions.

Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.

Social implications of mutations: It can lead to the development of unwanted traits in plants and animals, but when done artificially, it leads to the production of desired characters.

Scientific concepts: gene mutations, chromosome mutations, mutagenic agents, mutants, mutation frequency, deletion, inversion, translocation, duplication, non-disjunction, polyploidy, syndromes.

Scientific skills that need to be acquired: Ability to induce mutation to get the desired trait.

**Step VI:** **Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

**LESSON 6(b)** - **WEEK 6**

**Mode of teaching** - STS

**Group** - Experimental

**School** - FCE Zaria

**Subject** - Biology

**Topic:** - Gene Mutations

**Class** - NCE II

**No of students** - 50

**Average age** - 20

**Time:** - 1 hour

**Teaching Aids** - Chalk, chalkboard, small plants, seeds, leaves, stems, diagrams and pictures of animals and humans with abnormalities from gene mutations.

**Behavioral objectives**: - At the end of the lesson students should be able to:

(i) explain how gene mutations take place.

(ii) list types of gene mutations.

(iii) list effects of gene mutations

(iv)differentiate between gene and chromosomal mutations.

**Previous knowledge:** (i) Students have seen the various abnormalities in plants and animals;

(ii)They know that these abnormalities are caused by genes or chromosome mutations.

(iii) They are familiar with chromosome mutations.

**Presentation:**

**Step I: Orientation phase:**

The teacher introduces the lesson by asking students the following questions:

Many families suffer many sleepless nights as a result of having sickle cell anemia child. How can this be avoided?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions.

Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports. .

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic Social implications of gene mutations:

It leads to regrets of having married your present wife or husband.

It gives rise to birth of a sickle cell case, a drastic effect. However, it produces desired characters when induced.

Scientific concepts: lethal genes, hemoglobin S. Sickle cell anemia, substitution, insertion, deletion, inversion.

Skills that need to be required: Ability to induce mutation to get the desired trait.

**Step VI:** **Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 7(a)** | **-** | **WEEK 7** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Zaria |
| **Subject** | - | Biology |
| **Topic:** | - | Applied genetics |
| **Class** | - | NCE II |
| **No of students** | - | 50 |
| **Average age** | - | 20 |

**Time:** - 1 hour

**Teaching Aids** - Samples of modified fruits, cereals, legumes, ink and inkpad

**Behavioral objectives** - At the end of the lesson students should be able to:

(i) list the various areas in which genetics is applied;

(ii) name some examples of plants and animals that are produced by applied genetics;

**Previous knowledge -**

(i) Students see and use new species of tomatoes, fruits and some cereals that are introduced into the market these days.

(ii) They have been thumb printing on various documents.

**Presentation:**

**Step I: Orientation phase-**

The teacher introduces the lesson by asking students the following questions:

We have a problem of insufficient power supply in this country; as a result, we have difficulty in preserving our vegetables, especially tomato. What is the solution to this problem of short life span of tomato?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions. Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher.

The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic:

- Social implication of applied genetics: It can be used for destructive purposes, e.g. chemical weapons used on humans, transfer allergens from transgenic crops to wild ones, and environmental hazards. However, it produces desired characters when induced.
- Scientific concepts: Gene therapy, biotechnology, genetic engineering, biological and chemical weapons.
- Scientific skills to be required: microbiology techniques.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 7 (b)** | | **WEEK 7** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Zaria |
| **Subject** | - | Biology |
| **Topic:** | - | Human genetic disorders. |
| **Class** | - | NCE II |
| **No of students** | - | 50 |

**Average age** - 20

**Time:** - 1 hour

**Teaching Aids** - Diagrams of various human genetic disorders.

**Behavioral Objectives** - At the end of the lesson students should be able to:

(i) define the term 'genetic disorders'.

(ii) give examples of various genetic disorders.

(iii) explain the causes of such genetic disorders.

**Previous knowledge** - Students have seen genetic disorders such as albinism, sickle cell anemia, hemophilia etc.

**Presentation**

**Step I: Orientation phase:**

The teacher introduces the lesson by asking the students to carry out the following activities:

(i) We see in television how albinos have formed an association to protest discrimination against them in the society. How do we solve this problem?

(ii) Women who get married and cannot get pregnant get worried and are sometimes threatened by their husbands.

How do we solve this problem?

(iii) There are few men with slight learning problems, usually infertile, with small testes and slight breast development.

How can this problem be avoided?

(iv) Some people bleed profusely when they get a fresh wound. This sometimes necessitates blood transfusion, but the scourge of HIV and its

associated stigma is making people feel reluctant to either accept or donate blood. What is the way out?

**Step II: Identification and definite phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions. Students then engage themselves in brain storming and possibly experiment with materials.

**Step III:** **Synthesis phase:** Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV:** **Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V:** **Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher. The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.

Social implications of human genetic disorders:

- Most barren women feel very inferior among their mates that have children. This is because it is not easily known who has the problem of infertility between a man and his wife.
- Hemophiliacs always entertain fear of death whenever they see themselves loosing too much blood.
- Scientific concepts: clotting factors, polyploidy, hemophilia, cystic fibrosis, Down syndrome, Huntington's diseases, chromosome 21.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

| | | |
|---|---|---|
| **LESSON 8** | | **WEEK 8** |
| **Mode of teaching** | - | STS Methodology |
| **Group** | - | Experimental |
| **School** | - | FCE Zaria |
| **Subject** | - | Biology |
| **Topic:** | - | Genetic counseling |

**Class** - NCE II

**No of students** - 50

**Average age** - 20

**Time:** - 1 hour

**Teaching Aids** - Chalk, chalkboard, pictures of pregnant women, families at a counseling session. .

**Behavioral Objectives** - At the end of the lesson students should be able to:

(i) State briefly what genetic counseling is all about.

(ii) List the category of people that provide genetic counseling services.

(iii) list the category of people that are supposed to attend genetic counseling.

(iv) state the benefits of attending genetic counseling sessions.

(v) state major areas of diagnosis during a counseling session.

**Previous knowledge**: students have been attending counseling sessions at the college counseling department when they have academic problems.

**Presentation**

**Step I:** **Orientation Phase**:

The teacher introduces the lesson by asking the students to describe the following questions: Most people with social and medical problems either feel shameful to disclose them or are ignorant of how to go about their problems. How would you help these category or people?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions. Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher. The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.

Social implications of genetic counseling:

Most people mistake counseling sessions for a forum that only seeks to know one's secretes, and so would not open up. However, counseling helps one to avoid any possible inherited disease. It solves the problem of misunderstandings between couples by revealing the real with the problem.

Scientific concepts: Hereditary diseases, inheritance patterns, career screening, prenatal testing, predictive testing, presymptomatic tests, symptomatic tests, etc.

Scientific skills required: Counseling techniques.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

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**LESSON 9** **WEEK 9**

**Mode of teaching** - STS Methodology

**Group** - Experimental

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Biotechnology (genetic engineering)

**Class** - NCE II

**No of students** - 50

**Average age** - 20

**Time:** - 1 hour

**Teaching Aids** - Chalk, chalkboard picture of 'Dolly' the cloned sheep, some hybrid food crops, pictures of special species of animals bred for some purpose.

**Behavioral Objectives** - At the end of the lessons students should be able to:

(v) define the terms 'biotechnology' and 'genetic engineering';

(vi) list the various products of genetic engineering;

(vii) state the various forms of genetic engineering;

(viii) state the advantages and disadvantages of genetic engineering.

**Previous knowledge**: Students see and use varieties of tomatoes, oranges, maize, cows etc every day.

**Presentation:**

**Step I: Orientation Phase:**

The teacher introduces asking the students the following questions:

- How does a child who has not been told who his father is feel and behave?
- How comes that chickens lay eggs without meeting with the male counterpart these days?
- The new plants introduced of recent e.g. mango, paw-paw and some cereals, do not grow tall, begin fruiting earlier and produce bigger, sweeter and more fruits in abundance, why?

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions. Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the researcher. The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic.

Social implications of biotechnology:

- There are ethnical issues attached to it.
- Some of the products have side effects on people, animals, plants and the environment.
- Scientific concepts: genetic engineering, transgenic plants, cloning, hybridization, gene therapy.

Scientific skills to be acquired: hybrid techniques.

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

**LESSON 10** **WEEK 10**

**Mode of teaching** - STS Methodology

**Group** - Experimental

**School** - FCE Kano

**Subject** - Biology

**Topic:** - Controversies over biotechnology..

**Class** - NCE II

**No of students** - 50

**Average age** - 20

**Time:** - 1 hour

**Teaching Aids** - Two species of soy beans, eggs from home bred fowls, eggs from a modern poultry farm. .

**Behavioral Objectives** - At the end of the lesson, students should be able to:

(i) state the disadvantages of biotechnology/genetic engineering.

(ii) give reasons why some people don't advocate for it.

**Previous knowledge:** Students see effects of some products of biotechnology e.g. bleaching creams.

**Presentation**

**Step I: Orientation phase:**

The teacher introduces the lesson by asking students the following questions:

- Should we continue with biotechnology? Debate it.

Groups 1-5 for YES.

Groups 6-10 for N0.

**Step II: Identification and definition phase:**

The teacher asks the students in their various groups to go search for information on the topic and answers to the questions. Students then engage themselves in brain storming and possibly experiment with materials.

**Step III: Synthesis phase:**

Students come back to the class and prepare chats, graphs or write ups for presentation as possible solutions to the questions raised in phase I.

**Step IV: Interaction phase:**

Students organize a mock public meeting in the class and present their findings for sharing ideas in a cooperative manner. This could be oral or written reports.

**Step V: Clarification phase:**

Students come together collectively and cooperatively to identify possible solutions or answers to the searching questions in phase I with the teacher. The teacher explains the social implications of the topic, skills needed to be acquired, scientific concepts and facts about the topic and re-emphasizes scientifically correct ideas about the topic

Social implications of controversies over biotechnology:

- It may stop further research on looking for solutions to some diseases e.g. cancer, AIDS, sickle cell etc.
- It may also stunt the growth of the green revolution it is bringing to our ever growing population.

- Scientific concepts: Recombinant genes, pathogens, epidemics, allergens, herbicides, transgenic plants, human cloning, biological and chemical war.

  Scientific skills to be acquired: Ability to present concrete evidence on the good and bad sides of biotechnology .

**Step VI: Action phase:**

Students make decisions and take action based on the information gained from classroom interaction with mates and researcher.

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**APPENDIX E (i): REQUEST FOR VALIDATING A RESEARCH INSTRUMENT**

Department of Biology,
Federal College of Education,
P .M.B 1041, Zaria.

Dr. Adamu Kasim,
Department of Biological Sciences,
Ahmadu Bello University,
Zaria.

Dear Sir,

**VALIDATING A RESEARCH INSTRUMENT**

I have developed a research instrument designed to generate data for my M.Ed thesis on teaching of genetics in our Colleges of Education. The instrument titled 'Genetics concepts Achievement Test' (GAT) consists of 40 multiple choice items drawn from the NCCE minimum standard reviewed in the year 2000. It is to be used as both pre-test and post-test.

As an experienced biology lecturer in genetics inputs from you would certainly improve the quality of the instrument. I would like you to please examine the items with respect to the following.

i. Do the items relate to genetics concepts expected of NCE students?
ii. Are the items readable, appropriate and of standard?
iii What general criticisms and suggestions can you give for the improvement of the instrument?

I very much thank you and appreciate your assistance please.

Yours truly
Dambana B. Tete

**APPENDIX E (ii): REQUEST FOR VALIDATING A RESEARCH INSTRUMENT**

Department of Biology,
Federal College of Education,
P .M.B 1041, Zaria.

Mr. Suleiman O. Jimoh
Department of Biological Sciences
Federal College of Education,
Zaria

Dear Sir,

**VALIDATING A RESEARCH INSTRUMENT**

I have developed a research instrument designed to generate data for my M.Ed thesis on teaching of genetics in our Colleges of Education. The instrument titled 'Genetics concepts Achievement Test' (GAT) consists of 40 multiple choice items drawn from the NCCE minimum standard reviewed in the year 2000. It is to be used as both pre-test and post-test.

As an experienced biology lecturer in genetics inputs from you would certainly improve the quality of the instrument. I would like you to please examine the items with respect to the following.

i. Do the items relate to genetics concepts expected of NCE students?
ii. Are the items readable, appropriate and of standard?
iii. What general criticisms and suggestions can you give for the improvement of the instrument?

I very much thank you and appreciate your assistance please.
Yours truly

Yours truly,

Dambana B. Tete

**APPENDIX E(iii): REQUEST FOR VALIDATING A RESEARCH INSTRUMENT**

Department of Biology,
Federal College of Education,
P .M.B 1041, Zaria.

Dr. I.S. Mari
Science Education Section,
Faculty of Education
Ahmadu Bello University,
Zaria.

Dear Sir,

**VALIDATING A RESEARCH INSTRUMENTs**

I have developed a research instrument designed to generate data for my M.Ed thesis on teaching of genetics in our Colleges of Education. The instrument titled 'Genetics concepts Achievement Test' (GCT) consists of 40 multiple choice items drawn from the NCCE minimum standard reviewed in the year 2000. It is to be used as both pre-test and post-test.

As an experienced biology lecturer in genetics inputs from you would certainly improve the quality of the instrument. I would like you to please examine the items with respect to the following.

i. Do the items relate to genetics concepts expected of NCE students?
ii. Are the items readable, appropriate and of standard?
ill. What general criticisms and suggestions can you give for the improvement of the instrument?

I very much thank you and appreciate your assistance please.

Yours truly
Dambana B. Tete

**APPENDIX F : GENETICS ACHIEVEMENT TEST (GAT)**

1. Which of the following is not an example of discontinue variation?

   a. Ability to Smell

   b. Blood group

   c. Body weight

   d. Tasting of P. T.C

   e. Tongue rolling

2. Which of the following pollutants can cause mutation?

   a. Agricultural waste

   b. Industrial waste

   c. Nuclear fallout

   d. Chlorofluorocarbon

   e. Untreated sewage

3. A text cross is carried out to determine an Organism's

   a. Phenotype

   b. Dominant game

   c. Blood group

   d. Genotype

   e. Sex

4. When two carriers of sickle cell gene marry what percentage of their

$F_1$ generation will be carriers?

   a. 50%

   b. 35%

c. 60%

d. 75%

e. 125%

5. Which of the following determines a normal male offspring?

a. X

b. Y

c. XY

d. YY

6. What is the theoretical probability that a normal male child will be born

a. 1/2

b. 1/4

c. 1.3

d. 1

e. 2/3

7. Which of the following statements is correct about variation?

a. Offspring's are different from their parents only;

b. Offsprings from the same parents look alike;

c. Offsprings differ from their ancestors but look like their immediate parents;

d. Offsrpings differ from their ancestors and from each other;

8. Which of the following statement about sex determination is correct

at fertility?

a. The probability of male to female offspring is 1/2;
b. The Y chro of the father decreases the probability of having a male child to 1/2;
c. In XX chro of the mother deceases the probability of having a female child to 3/4;
d. The vapour of either parents determines the sex of the offspring;

9. The genotypic ratio of 1:2:1 in the offspring of a hybrid cross illustrates the law of:

a. Use and disuse
b. Dominance
c. Segregation
d. Linkage

10. Which of the following traits may not be important in marriage counseling?

a. Sex-determination
b. Sickle-cell factor
c. Rhesus factor
d. Colour of skin

11. Which of the following in <u>not</u> a type of finger-print

a. Whorl

b. Compound

c. Simple

d. Arch

12. Which of the following is the precise location of the gene?

a. Chromosome

b. Contresouce

c. Centriole

d. Ribosome

e. Endoplasmic reticulum

14. How many chromosomes are found in the human ovum?

a. 46

b. 23

c. 33

d. 13

e. 43

15. If a black guinea pig of genotype BB, is crossed with a white guinea pig of genotype bb, what will be the phenotype of Fl generation?

a. Half would be white, while half would be black

b. All would be black

c. All would be grey

d. 1/3 would be black, while 2/3 would be white.

16. Hereditary variation is best described as:

a. Xters transmitted from generation to generation.

b. Traits acquired from disease. .

c. Xters that show up due to social conditions.

d. Traits acquired from habits and environ condition

e. Xters that result from physical injuries.

17. An individual with blood gp AB can receive blood from those in blood group

a. AB only

b. A andB

c. B only

d. AB and 0 only

e. A,B, AB and 0

18. Which of the following is NOT a reason why offspring looks different from its parents

a. Random re-organization of chromosomes during genetic formation

b. Existence of multiple alleles in organism

c. Formation of chaismata in chromatides during meiosis

19. The pair of genes expressed in a heterozygous individual is described as:

a. Allele

b. Chromatin

c. Dominant gene

d. Centrosome

e. Chromomere

20. An example of a sex-linked trait is

a. Ability to roll the tongue

b. Ability to test PTC

c. Boldness

d. Blindness

e. Blood group

21. The genetic composition of an organism is termed

a. an allele

b. a cross

c. a genotype

d. a phenotype

e. a hybrid

22 Which of these allelic pairs represent a homozygous dominant trait?

a. TT

b. Tt

c. tt

d. Bb

e. bb

23. When both alleles in a heterozygous individual are fully expressed in the phenotype of the F 1 generation this phenomenon is described as

a. Co-dominant

b. Dominant

c. Incomplete dominance

d. Mutation

e. Recession

24. The genotype of species with respect to particular traits can be .

determined by carrying out.

a. a backcross with a pure stock known to be recessive for that trait,

b. a cross between two F 1 generation that are heterozygous for the trait,

c. a testcross with a pure stock

d. In-breeding among the members of the species.

e. Out-breeding with an exotic variety of the species.

25. The segregation of factors into different types during meiosis is called

a. Monohybrid

b. Morphogenesis

c. Random inheritance

d. Independent assortment

e. Incomplete dominance

26. The significance of the first meiotic division is to:

a. Produce DNA

b. Re-arrange genes

c. Reduce the chromosomes to haploid

d. Double the number of chromosomes

e To produce spindle fibre

27. Albinism in mice is due to

a. A recessive gene

b. Incomplete dominance

c. Multiple genes

d. Test cross

e. Sex-linkage

28. Hemophilia is an example of

a. Blood group

b. Sex-linkage

c. Incomplete dominance

d. Rhesus factor

e. Genotype

29. Which of these are controlled by multiple alleles?

a. River blindness

b. Haemophilia

c. Blood group

d. Down syndrome

e. Sickle anemia

30. Which of these is not a cause of variation?

a. Independent assortment

b. Cross over

c. Mutations

d. X - rays

e. Low temperature

31. Which of the following male animals is not heterozygous?

a. Drosophila 2n = 6 + x ¯1

b. Pheasant 2n = 14 + xx

c. Grasshopper 2n = 16 + xo

d. Man 2n= 4 + xy

32. Which of the following sentences best describes a dominant factor?

a. The expression of the factor is masked by is partner;

b. The factor occurs in three times as many fertilizations as its partner;

c. The expression of the factor masks its partner;

d. The expression of the factor is more noticeable than its partner.

33. In rabbits, black hair B is dominant to while hair b and short hair S is dominant to long hair s. The cross BbSs X bbss results in 1 black short: 1 black long: 1 white short: 1 white long.

Which of the following crosses would also produce the result?

a. BBSs x bbss

b. Bbss x bbSs

d. Bbss x Bbss

34. In meiosis, how many chromatids are found in each bivalent?

a. 1

b. 2

c. 3

d. 4

35. A sex-linked allele cannot be passed from a

a. Woman to her daughters?

b. Man to his grandsons?

c. Man to his sons?

d. Woman to her grand daughter

36. Which one of the following is the advantage of using pea plants over fruit flies as material for experimental work in genetics?

a. Self-fertilization possible

b. Easier to keep

c. Less space needed

d. Shorter generation time

37. In fruit flies, the female sex is determined by the chromosome XX and the male XY. The effect of a recessive mutation in the X chromosome of a male parent could appear in the phenotype of a

a. Female in the F 2 generation

b. Male in the F 2 generation

c. Female in the F 1 generation

d. Male in the F 1 generation

38. Which of the following is not necessary for chromosome replication?

a. ATP

b. Ribosome

c. Nuclear enzymes

d. A DNA template

39. The sugar found in DNA molecules is

a. Sucrose

b. Ribose

c. Ribulose

d. Deoxiribose

40. Continuous out breeding in a population leads to

a. Increase in variation

b. Decrease in variation

c. Increase in mutation rate

d. Evolution of the population

**APPENDIX G : GAT MARKING SHEME.**

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

3.