Error Analysis in practical biology of Senior Secondary School students in Zaria and Sabon Gari Local Government Areas of Kaduna State

By

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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous application for a higher degree. All quotations are indicated by quotation marks or indentation, and the sources of information are specifically acknowledged by means of references.

F.K. Lawan (Mrs)

CERTIFICATION

This thesis entitled, "Error Analysis in Practical Biology of Senior Secondary School Students in Zaria and Sabon Gari Local Government Areas of Kaduna State by Falilatu Kike' Lawan (Mrs), meets the regulations governing the award of the degree of Masters in Education (M.Ed) in Science Education of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my late parents Alhaji Badamasi Alabi and Madam Rabiatu Alabi (May their souls rest in peace). Also to my children.

Ahmed
Abdul Malik
Mohammed Nasir
Halimatu Sadiatu

I love you All.

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ABBREVIATIONS, DEFINITION OF TERMS AND SYMBOLS

In the course of this study, some words have been abbreviated because of their frequent use, and terms have been used in special ways. The abbreviated words and specially defined terms are listed below:

ABBREVIATION:

A.B.U. - Ahmadu Bello University, Zaria, Kaduna State.

SSCE - Senior Secondary Certificate Examination. This examination is taken by students who have completed the three years of their Senior Secondary School Education.

WAEC - West African Examination Council, the body responsible for the drawing of examination the examination leading to the award of the SSCE Certificate.

Error Analysis - This is the definition and categorization of the errors found in the students practical examination scripts, for the purpose of drawing some inferences.

Error Types - These are the common errors made by a number of students.

Frequency of Occurrence of Error Types - This is the number of times an error occured.

Errors - A deviation from that which is standard. In order words the failure of a student to solve a problem correctly will constitute an error.

et al. - and others.

I.A.R. - Institute for Agricultural Research

NISTEP - Nigerian Integrated Science Teacher Education Project.

ABSTRACT

This study determined the nature of errors secondary school students commit in practical biology and the effect of such on academic achievement. The study went on to determine any difference in error types between schools, as well as the effect of gender on errors committed.

The four null hypotheses stated for the study reflected the research problems outlined above. Two instruments, the practical WAEC selected questions and the possible error types also selected, from WAEC regulations, and in-line with the questions selected, were used for data collection. The data collected from 317 Final Year biology students in Zaria and Sabon-Gari Local Government Areas of Kaduna State were analysed using the statistical package for the Social Sciences, available at A.B.U. Computer Centre.

The results showed that:

1. there was a significant difference in error types between schools;
2. the order in which errors are committed, differ from one school to the other.
3. there is a significant relationship (<0.05) between errors committed and achievement of each of the subjects. The more the error the poorer the

achievement.

4. Error committed was gender-related.

On the basis of these findings, recommendations were made as regards the possibility of reducing errors committed by biology students in practicals, thereby improving their achievement in the paper.

Chapter 1

BACKGROUND TO THE STUDY

1.1 Introduction

The importance of the sciences as a requirement for scientific and technological development cannot be over-emphasized in this nation. The Revised National Policy on Education (NPE) 1981 stressed the teaching and learning of science subjects in Nigerian schools. Under Secondary education, one of the broad aims of this National Policy is "to equip students to live effectively in our modern age of science and technology..." In line with this, science subjects are among the core subjectas being taught in the Senior Secondary Section in Nigerian Schools. Also, all newly established Federal and State Universities are oriented towards science and technology, with a basic entry requirement of credits or distinction in science subjects.

According to Abubakar (1972), Fafunwa (1974), Yoloye (1982), Ogunniyi (1982) and Bajah (1984), Nigerians are living in a world where science and technology have become an integral part of the world's culture, and any country that over-looks this significant truism, does so at the risk of remaining backward in a technological fast moving world.

Biology is one of the science subjects many students like to read both at the secondary and tertiary levels of education. The fact that this subject is particularly required for medical (human and animal) and agricultural disciplines in the University stimulates the learning of the subject at the secondary school level. Students are expected at the end of the three year senior secondary course to sit an examination (Senior Secondary Certificate Examination, SSCE) made up of theory, multiple choice and practical.

Practical work in biology or any other natural science is of great importance. This is supported by Fatubarin (1984) and Aramide (1985), when they wrote in their work that practical biology techniques like other skills are of great importance in the learning of biology. Bajah (1984) also stated that research reports support the view that practical work aids learning and makes learning even easier.

An examination of the enrolment in biology at the school certificate level confirms its relative popularity among other school subjects, (Olaniyi, 1985; Turton, 1991). Yet students' performance in SSCE is depressingly poor. This can be seen in Turton's (1991) analysis of the Senior Secondary Certificate Examination results (see Table on Appendix VI), that despite the fact that biology had the greatest number of students enrolment for the year 1988-1990 (when compared to other science subjects), it had the greatest percentage of failures. The low percentage passes in biology has been attributed to the use of ineffective learning strategies and lack of appropriate learning environment under which biology teaching takes places, (Kumari and Aliyu, 1985).

Aramide (1985) in his study on assessment of practical biology and what examiners look for, observed that most errors made in practical biology are as a result of the teachers' inability to include enough practical work in their teaching scheme and lack of qualified and experienced teachers to handle biology.

A number of research work, Ogbo, 1976; Onah, 1977; Sorunke, 1980; Soyinbo, 1982; Jegede, 1986; and Eshiet, 1987, carried out to determine factors responsible for poor academic performance of students in WASC biology revealed the following factors:

a. Inavailability of qualified and experienced teachers

b. Lack of laboratory facilities, textbooks, library, etc

c. Students attitude to the subject, in the fact that they think biology is easy

e. Lack of a good knowledge of Mathematics

As a result of students' poor performance in biology and other sciences at the SSCE level, the number of students being enrolled for science and technical courses is limited. No wonder Aghenta (1982), found in his study that only 25% out of 529 SSCE students were qualified for university entry.

Sex differences have also been noted in a number of research work in science. Graybill (1975), reported the existence of sex differences in intellectual development and problem solving abilities of pupils. According to him boys were better than girls in tasks that require manipulation. The reasons that have been advanced for the observed sex differences were largely social and biological (Teitelbaum, 1976).

In Nigeria, Ogunyemi (1973) and Fakuade (1979), worked on the effect of gender on academic achievement in science. They found that boys tended to achieve higher than girls in Mathematics and Science Projects. On the other hand, Jegede (1981) in his own study, found that there is a significant sex difference in achievement in Integrated Science, with boys achieving higher than girls.

The problem of sex differences in secondary schools in Zaria Metropolis as it affects the nature and magnitude of errors committed in practical biology was investigated in this study.

For Nigeria as a developing country to meet its high manpower needs as well as make a break through into science and technology, it must re-examine and improve its science education and redress the sex differences.

It is the aim of this study to make a proper analysis of biology practical scripts of SSCE students in secondary schools in Zaria Metropolis in order to find out the nature of errors they make, that contributes to their poor performance.

Error-pattern analysis which is the intended method to be used in this study, is a form of evaluation in which the evaluator is out to find what part of the subject is posing a problem to the learner, how much they have learnt and how much they are yet to learn.

In this study, a critical analysis of the written examination scripts of students is made. Errors they have committed which leads to them failing are classified and grouped according to the lists of error types identified by the West African Examination Council's (WAEC) Practical Biology Regulations 1985/86 (see 3.5.2 Pp 45). This list of error types should be of great value to the teacher when he prepares his future lessons, and the learner, as he prepares his learning materials. In support of this, Olayemi (1980) observed that error-analysis based on adequate data would reveal common and individual weaknesses that call for special attention. This view was also held by Wyatt (1973), Akonobi (1976), Etherton (1977) and Isa (1990).

From the foregoing statement one might be tempted to conclude that error-pattern analysis is one of the practical ways in which a conscientious teacher can find out students area of difficulty. Nevertheless, Olayemi (1980) claimed that this would lead to what might be called the student's built-in syllabus.

The analysis of errors made by senior secondary students of biology should be of great interest and concern to students themselves, teachers of biology, curriculum planners and science educators.

It is the researcher's hope that this work would expose the types and nature of errors made by students and how the teachers can help to prevent such errors. It is thought that a good knowledge of students' error-patterns would help to determine the nature of remedial measures to adopt.

1.2 The Problem

The role of practical work in biology cannotbe over-emphasized. This is particularly stressed in the development of psychomotor or manipulative skills, as well as enhancing better understanding of the products and processes of science. To this end an attempt was made to identify areas constituting problem thus resulting in poor performance in practical biology. This was carried out by analysing the various errors committed by students in some selected secondary schools in Zaria.

Practical in biology represents about fourty percent (40%) of the examination at the SSCE level with theory and multiple choice being thirty percent each (30%). This confirms the importance attached to practicals in biology.

Biology practical with its unique nature, deals with accuracy in representation of observations and data. As such wrong spellings of technical terms, wrong representation of views, wrong magnification and careless or dirty representation of drawings, would usually end in errors being committed.

To remedy such, science educators are of the view that understanding why learners experience difficulties, hence commit errors, should underpin any discussion on improving teaching and learning. (Corder 1967, Akonobi 1976, Olayemi 1980, Otuka 1986, Akpan 1989 and Olabisi 1990).

In this study an attempt has thus been made to answer the following questions:

1. Do the error, types committed by biology students in practical biology differ from school to school?
2. Does the order of error types differ from school to school?
3. What is the relationship between the frequency of error types and students' overall achievement in practical biology.
4. Do boys and girls differ in terms of the frequency with which they commit each error type?

1.3 Assumptions

The following assumptions are made in undertaking this study:

1. That the scheme adopted for classification of error types covers most of the possible errors students may commit.
2. That the categories of error types are recognised by biology educators, science educators and the WAEC, in the marking and grading of students' examination scripts.
3. That the students' answer scripts are a true reflection of what they know and do not know.

1.4 Hypotheses

The following four hypotheses form the basis if this study:

1. There is no significant difference in error types between schools.
2. There is no significant difference in the order of error type between schools.
3. There is no significant relationship between the frequency of occurrence of error types and students' overall achievement in practical biology.
4. There is no significant difference in the frequency of error types committed by boys and girls in practical biology examination.

1.5 **Justification of the study**

The need to undertake this study stem from the general concern felt among biology teachers in secondary schools, Colleges of Education and the University over the poor performance in the practical aspect of biology exams conducted by WAEC. (Fatubarin, 1984; Kumari and Aliyu, 1985; Aramide, 1985; Asun, 1986; Bichi, 1988; Jegede, 1990 and Turton, 1991).

Etherton (1977) asserted that error analysis based on adequate data:

a. Would highlight the common weaknesses with which leaners need help, as well as

b. Serve as basis for self evaluation to the teacher, by highlighting those areas where the teacher's instruction has not been effective. The ability of a learner to learn from his mistakes be it personal, social or academic raises him above other animals (Etherton 1977).

So far in Nigeria only very few studies (Sorunke and, Olafimihan 1988, Soyinbo 1992), analysed the nature of errors committed in practical biology. None of these studies focused on secondary school students. The present study is significant for its contribution in highlighting the type of errors secondary school students commit during practical biology exams. The findings could be of great value to the students and teachers of biology, science educators, curriculum planners and the WAEC. If students are aware of the types of errors that could lead to poor performance, they would learn to avoid such in future. Suggestions from the study would also help the teacher to be aware of the aspect of practical biology posing problem to the leaner.

The analysis of errors committed by students in an exam is an indirect way of consulting learners to find out their needs for purpose of curriculum planning (Corder 1967). Thus for the curriculum planners and science educators in general, awareness of students' common error patterns is desirable in designing curricula, writing instructional materials and training of science teachers.

The WAEC on the other hand would be expected to take cognizance of the findings and recommendations of the study in the setting of practical biology questions.

Finally, it is hoped that this study would contribute ideas for improving teaching and learning of biology in the secondary schools, as well as being of value to various bodies engaged in scientificand technological policy formulation and development in the country.

Chapter 2

REVIEW OF RELATED LITERATURE

2.1 Introduction

In this chapter relevant literature concerning processes and skill development and their relation to the knowledge of practical techniques are discussed. The highlights of the chapter is as follows:

a. Practical biology and problems associated with its teaching in Nigerian secondary schools.

b. Processes of science and scientific skills in relation to practical biology.

c. Error analysis in practical biology.

2.2 Practical Biology and Problems Associated with Its teaching in Nigerian Secondary School.

The nature of science, biology inclusive, has changed considerably over the past several decades. Theories of instructions, the design of curricula and views on the nature of science teaching have experienced a variety of modifications. However, throughout this period there has remained unanimous agreement that learning of science is likely to be more effective, if the learner is involved in first hand direct manipulative experiences. This concern for active learner participation in the learning experience was advocated for long ago by some educationists like Dewey and Montessori as sited by Usman (1992). In more recent years, with reference to biology, a lot of emphasis has been placed on this by experimental science curriculum projects such as Biological Science Curriculum Project (BSCS), Science A Process Approach (SAPA), at the international level. At the local level are the Comparative Education Study and Adaptation Centre (CESAC), Science Teachers Association of Nigeria (STAN), Nigerian Educational Research Council (NERC), etc. All these projects gear towards the teaching of science as both content and process.

It is in line with this that the WAEC syllabus (1985) clearly enumerated the objectives of practical biology in Nigerian secondary schools as follows:

1. Ability to observe.
2. Ability to relate forms with functions.
3. Ability to represent observation by illustration.
4. Ability to recognise general characteristics of plants and animals.
5. Ability to interpret data which illustrates known biological principles.
6. To develop the ability to perform simple experiments and draw inference from results obtained.

Based on the recent objectives of science teaching, a greater emphasis has been placed on practicals and along with it is the development of science skills. Practical work in science has been described as very crucial in the understanding of the nature of science. A number of science educationists have enumerated the need for practical work in science. They include Head (1966), Ndu (1980), Bently and Watts (1989). Many science teachers also place great value to practicals in science. The practical nature of a subject is commonly regarded as an important source of pupil motivation (Bryce and Robertson, 1985).

Others howerver view it as having little value to learning. Infact from records, practical work in science is often described by critics as being too expensive in terms of space and equipment, too dangerous for pupils in Junior Secondary Schools and time consuming (Hempstead, 1973).

Pickerry (1979) on the other hand stated that laboratory work in science provides students the opportunity to actually learn science as opposed to theoretical learning about science. He added that laboratory work motivates and trains the learner in the science processes, thus learning of science is made concrete and real rather than abstract.

Although laboratory exercises are important, integral part of science teaching. Abdullahi (1982) claimed that it is used mainly when:

1. Needed as a means of verifying scientific principles, laws or theories already known to students.

2. As a means of obtaining and learning scientific information.

3. To match the textbook and other learning activities.

Pella (1961), on his own noted that the value of the laboratory work depends upon the position assumed by the science teacher during the science lesson. He said, if the teacher assumes the position of a dispenser of knowledge, he uses laboratory only to drill or verify concepts as noted above. On the other hand, if he assumes the position of a guide to learning, he makes use of laboratory as a place where students discover knowledge. From experience students learn the later role of the teacher. Various studies on the methodolody of science teaching such as inquiry, discovery and process approach, have shown that students learn more from science lesson by doing rather than mere observation (Betty and Woolnough, 1982).

Another important feature of the laboratory technique is that it erases the artificial distinction between the mind and the hands. Schwab and Batten (1962) described laboratory experiences as participation in a series of experimental, observational and demonstrative activities. This they wrote provides the learner the opportunity to develop and understand practical and theoretical concepts by making use of problem-solving approach.

Drawing is an important aspect of practical biology.

According to Lysek (1981), drawing is practised in biology as a necessary skill. Furthermore, he added that it is used whenever imagination, memory or interpretations of data need to be expressed visually. It allows for alterations such as the stressing of interesting structures in a more complex object, or its simplification to improve understanding. Finally, it can be used in the development of an organism in sequence of pictures.

There is of course no arguement about the value of drawing in practical biology. Drawing is needed by the teacher as well as by the students. For the teacher, drawing an object or a structure rather than using a slide or another ready made illustration, allows the development of this structure to be shown step by step. Starting first with a simple basis and subsequently adding to it the various details. Thus the complex structure of a plant cell is often explained by drawing the cell wall first, then adding thevarious organelles one by one. This breaks up the cell for the student into smaller parts which are easier to understand.

On the other hand, drawing is used by the students to acquire knowledge and experience in biology. In addition to give practice in observational skills. It also helps to fix the observed object in the mind in such a way that the student becomes thoroughly familiar with the material. As Lysek (1981) claimed that any observation which is not fixed in the mind by sketching or drawing tends to be readily forgotten. Also beneficial effect of drawing is increased when the student prepares the objects by themselves. Lysek (1981), thus concluded by saying that drawing is an integral part of biological education. It is withthis consideration in mind that the WAEC stresses emphasis on drawing in practical biology in SSCE (objective three above). This is to develop drawing and representation skills and not artistic training in the learner.

Fowler and Brosius (1968) conducted a study on the value gained in practical work. They dissected four types of animals - earthworm, crayfish, frog and pearch. This was done along with viewing of film of similar dissections. They found that the two methods (dissection and film viewing) were equally effective in improving the student's understanding of the methods and aims of science. In addition they also found an improvement in skill in manipulation of the implements.

Milson (1979) also evaluated the effect of laboratory oriented science curriculum materials, on the attitude of students with reading difficulties. He tried to determine whether the use of laboratory - oriented science curriculum materials would have any significant effect on the attitudes of students with reading difficulties. In his study, he used three experimental classes and three control classes. Teachers teaching the experimental class received brief introduction to the curriculum materials selected for the study. Teachers instructing the control group were requested to continue with their normal textbook oriented presentation. The students were taught for six weeks. Over 50% of instructional time was spent in laboratory oriented activities requiring manipulation of equipment. Approximately 30% of instructional time involved in the reading of directions and preparation of laboratory reports, the remaining time devoted to reading about science teacher instruction and classroom management activities. Pretest was administered to both group, after a period of 40 instructional days post test was administered.

The analysis of the prestest showed an initial level of attitude not statistically significant. But the result of the post test showed a significant difference in the attitude of the two groups, towards science class and science laboratory. The experimental group developed improved attitude towards science. This findings further strengthened the importance of an activity oriented method of teaching in science.

Purser and Renner (1983), conducted a study on two tenth-grade biology teaching procedures. The research was carried out to find the influence of teaching methods upon content achievement. The two teaching methods used were concrete instruction (the learning cycle) and formal instruction (exposition). In the exploration phase of the learning cycle, students were usually provided with concrete materials and written directions for their use in gathering data about the concept to be learned. The second group were taught using the method of taking notes from textbock, studying and memorising a vocabulary list of concepts from the text chapter and listening as the teacher explained in more details those concepts they judged to be more difficult to understand. They were both taught for a period of eight weeks. 68 students of the 9th and 10th grade biology classes were taught concretely. The control group of 67 students from same school were assigned to classes receiving the exposition instruction of same content. All the sampled subjects were taking biology I for the first time and attended at least 80% of the class session.

The findings showed no difference in the intellectual development of the pretest. But they found that the mean of the exposition instruction group post test to be significantly greater than the other group. For content achievement, the group taught using exposition method developed deeper understanding of biology concepts than the other group. The findings therefore showed clearly that students taught using concrete materials developed better intellectually and deeper understanding of biology concepts than those taught using normal traditional method of teaching.

All these studies showed clearly the importance of practical work in the development of scientific attitude and achievement in biology.

Practical work in science have also been seen as very necessary for proper understanding of a concept. A number of educationalists including Green (1965), UNESCO (1976), Otuka (1978), Jegede (1982), Soyinbo (1982), Fido and Gayford (1982), Nwokedi (1983) and Bichi (1988), similarly, Ango and Silas (1985) believed that:

> Practical experience in any science subject is crucial for the real understanding of the principles and application of the knowledge ingrained in that subject for cognitive growth and technological orientation and advancement.

In additon, Aramide (1985) believed that practical work provide opportunity for students to learn various skills as well as stimulates interest in the subject.

In the teaching and learning of biology, both practical and theory are equally important for proper understanding of the subject. No wonder Aramide (1985) wrote that practical work helps in the meaningful understanding of science concepts.

Anderson and Koutnick (1972) claimed that teaching science processes demands the teaching of concepts inseparable from process. Sund and Trowbridge (1973) categorically stated that it is essential for a science teacher to make his students learn the principles and theories of science, by giving students constant perceptual experiences, building concepts that are necessary to understand principles. Infact Good (1974), brought together content and process of science and compared it to fabric, in which process is the "warp" and content the "woof".

Despite the amount of effort put in by educationists and scientists, on the importance of learning the content and process of science together. It is however disheartening to note that science teachers, most especially biology teachers in Nigerian secondary schools still revert to the use of "chalk and talk" or traditional method for teaching, rather than the process and enquiry method.

Osenuga (1981), Soyinbo (1982), Abijo (1982), Baja (1984), Aramide (1985), all came up with a number of factors militating against the teaching and learning of biology. These include the followings:

1. Poor teaching methods
2. Lack of qualified and experience Biology teachers in most of the schools.
3. Lack of confidence in handling science equipment and apparatus.
4. Lack of adequate professional preparation during the pre-service years.

5. Lack of technical know-how on improvisation of science equipment.
6. Lack of elementary background knowledge of Physics and Chemistry.

Another major problem teachers of biology are faced with is, what proportion of the available time should be given to practical and theory work? Green (1965), suggests approximately twice as much time as the theory in the teaching of biology.

A number of research work has been carried out to answer this question. Notably among them are Beaty and Woolnough (1982). According to them, most elementary science teachers in England spent 40 to 80 percent of their time on practical work. This they claimed is an activity that developed practical skills, in particular accurate observation, description and deductive logic.

Bichi (1988), in his study, looked into the practical course content of course B161, Biological Techniques. This is a first year under-graduate course on Practical Biology, at the Biological Science Department, A.B.U. Zaria. He found that every one hour of theory lesson is followed by a three hour practical sessionin all under-graduate courses.

Alabi (1980), however reported in his work that more time was allocated to theory than practical in Advance Level Chemistry in one Post-Secondary Institution in Zaria. Alabi's finding is a typical characteristics of science teaching (biology inclusive), in most Nigerian secondary schools. This Ali (1986) rightfully stated in his own study were he found that science teachers revert to the traditional method for teaching. A method Ali claimed do not encourage to any extent the learning of method and content of biology.

Ileoje (1981) however wrote that the performance of a student in his practical examination paper, often determines his success as a whole in the subject. If this is so, there is therefore the need for biology teachers in Nigerian secondary schools to change their present method of teaching to the process and enquiry method. As this would help to reduce errors learners make in biology, as well as convey biology as both content and method. In addition, develop inthe learner scientific attitude which is needed for a technologically developing country like Nigeria.

2.3 Processes of Science and Scientific Skills in Relation to Biology

Recently, tremendous emphasis in science education has centered on developing teaching strategies which will successfully instruct students in scientific skills and processes. This is in order to establish in the learner capabilities that will be of lasting usefulness.

Hanks (1979), describe skills as practical knowledge in combination with ability, cleverness, expertness. Winfield (1988) sees skills as any series of mental or physical acts executed in such a way as to demonstrate complete control by the executor. Complete control, he continued, depends on the building up of co-ordinated activities involving different senses.

Tomera (1974), on his own part, described skill development as an element in science education that holds promise in allowing students to autonomously generate knowledge and solve problems. Tomera (1974), further said that learning scientific processes would influence an individual's behaviour immediately and in future in whatever situation this skill can be used. No wonder Winfield (1988), wrote that skills are very importance and it is that part that remains even when a catastrophe occurs, like taking away our oil, energy resources and trades. The skills and abilities remained and this can only be shared, he mentained.

According to Good (1974), teaching of science as a process was introduced by the Commission on Science Education of the American Association for the Advancement of Science (AAAS). The purpose of which is to stimulate improvement of Science Education at all educational levels. The processes according to the commission are as follows:

The ability of the child to be able to observe, classify, measure, communicate using numbers, using space/time relationship defining operationally, controlling variables, interpreting data and experimenting, (Victor, 1967).

Scientific skills on the other hand is one of the desirable outcomes of science. Vaidya (1976), described scientific skills as a visual behavioural change in a learner.

Educationists like Green (1965), Good (1974), Vaidya (1976) and Bajah (1984), all stressed the need for the development of scientific skills in the learner. This according to them can be achieved when the content of science is learnt along with the process. Good (1974) concluded by saying, when science is taught as a process, the scientific skills are learnt and developed along with it.

Vaidya (1976) went on to enumerate the various abilities and skills that can be developed through science teaching which include:

a. General skills, language skills, i.e reading and writing.
b. Communication skills, e.g. speaking, listening including dramatization.
c. Social skills, e.g. to get on with people, respect for others and their property, self

competition, working effectively in groups, co-operation and emotional stability, etc.

d. Library skills, e.g. finding various and varied reference and consulting them.

e. Laboratory skills, e.g. experimental skills needed in the laboratory to set up apparatus, make observations, record observations, plan for experiment, improvise apparatus and develop preservation skills.

f. Mathematical skills, e.g. computation, graphing, ranking, averaging, approximating, geometrical drawings, dealing with symbols and reading tables.

g. Aesthetic skills, e.g. artistic sensitivity and the physical ability to prepare charts, models, instructional and illustrative materials.

h. Safety skills, e.g. avoiding accidents and the ability to do first-aid whenever needed.

i. Abstract, e.g.

  i. ability to recognise and classify things on the basis of common characteristics;

  ii. ability to analyse simple and complex problems situations;

  iii. ability to check evidence;

  iv. ability to verify one's idea;

  v. ability to judge absurdities, irrelevancies and fallacies;

vi. ability to set up control experiments and thereby to distinguish between relevant and irrelevant variables and development of insight into the nature underlying assumptions and proofs.

Sund and Trowbridge (1973) went on to classify scientific skills into five. These are:

1. Acquisitive skills, i.e. listening, observing, searching, inquiring, investigating, gathering data, researching.
2. Organisational skills, recroding, comparing, contrasting, classifying, organising, outlining, reviewing, evaluating, analysing.
3. Creative skills, planning ahead, designing, inventing, synthesizing.
4. Manipulative skills, using instruments, caring for instruments, demonstrating, repair, construction, calibration, etc.
5. Communication skills, asking questions, discussions, explanation, reporting, writing, critism, graphing, teaching, etc.

The above lists of skills by Vaidya and Sund and Trowbridge are all relevant skills that students of biology should acquire, which should be of immense benefit in learning the subject.

Bichi (1988), used the content course of course B161, Biological Techniques, a first year under-graduate course in biology practical at the Department of Biological Science, A.B.U. Zaria. He examined and analysed the course content, from where the required skills were identified and listed out. 20 skills were identified and then condensed to the eleven listed below:

1. Keen observation that arouse interest.
2. Orderliness in the conduct of practicals.
3. Following procedures.
4. Record keeping skills.
5. Controlling variables.
6. Familiarity with the common laboratory equipment.
7. Biological drawing skills presenting biology diagrams satisfactorily.
8. Safe handling of laboratory equipment.
9. Operating skills of ordinary light microscope.
10. Dissecting a small animal to trace the alimentary canal satisfactorily.
11. Communicating experimental results to audience satisfactorily.

The above skills identified by Bichi (1988), though are for under-graduate course, there is no doubt that they have a direct relationship with the WAEC objectives of practicals in Nigerian secondary schools, as already stated earlier on.

Bichi's identified skills like others (Vaidya's 1976; Sund and Trowbridge's, 1973), all describe the necessary skills required in any science practical work, its value to the learner in whatever situation cannot be over-emphasized.

A number of research work has been done in the area of the importance of process skills to achievement in science. These include Gabel, et al (1977), Ryan and Schroeder (1974); Macbeth (1974); Fowler and Brosius (1968); Winfield (1988) and Ali (1986).

Gabel, et al (1977) in their study on the effect of early teaching and training experiences on Physics achievement, found that students achieve more academically. In addition, students attention on the process skills helps them become competent in the skills.

Ryan and Schroeder (1974) compared the effect of the different teaching methods on the attitude of sixth form grade students towards science. The three teaching situations he compared were:

1. Students taught by a traditional textbook method.
2. Students taught in a combination texbook and supporting laboratory activities and
3. Students taught in activity centered open-ended enquiry situation.

He found that students who interacted with concrete materials developed significantly more positive attitude than those studying similar subjects matter from a textbook. This results therefore suggests that teachers interested in the development of positive scientific attitude of their students towards science, should teach science as a process. This Ryan and Schroeder (1974) claimed required the use of concrete materials to work with.

Macbeth (1974), carried out his research on the effect of manipulating materials on the attainment of process skills in elementary science. Two groups of kindergarten in a small University community were used for the study. The first were taught using the Science A Process Approach Programme (SAPA). They were exposed to a lot of materials and permitted to actively use them in the manner specified for the exercise. The second group had none of the exercise materials for manipulation, that is they were not permitted to touch or handle any of the physical objects of the exercise. They were all differently taught for a period of 14 weeks. They observed that the SAPA group performed better as their mean score was larger than the mean score for the non-manipulative group.

Although the experiment was conducted on kindergarten children, and shows the need for manipulation in the learning of process skills. There is no reason to believe that the findings do not have implications for learning and development of process skills in the secondary school learner.

From the foregoing reviews, it could be gathered that when the content and process of biology (a science subject), is taught to the learner in the appropriate manner, necessary skills are developed along with the knowledge of the principles and products.

2.4 Error Analysis in Practical Biology

An analysis of the written examination gives the teacher not only a fair idea of the progress of the students, but also indicates which part of the course were not well understood. Infact, a properly kept record of all types of errors will be of value when the teacher prepares his future lessons. In support, Olayemi (1980) claimed that:

> Error analysis may show a teacher the areas where his teaching has not been effective enough, and error analysis can provide data for the preparation of teaching materials when extensive error analysis is replicated.

Corder (1967), enumerated the following to support why an error analysis of students' work should be carried out:

1. It is an indirect way of consulting the learner, to find out his needs for purpose of planning his curriculum.
2. It provides evidence of the language that the learner is using.
3. It reveals to the teacher how far towards the goal his students have progressed, and what remained

for them to be learned.

Corder (1967), added that the errors were indispensible to the learner since the learner learned through his errors, and discovers the acceptable from the unacceptable.

Etherton (1977), on his own part stated that error analysis based on adequate data would shows:

a. Common weaknesses with which pupils need help.
b. Inadequacies in an official syllabus, faulty sequence of units or omission of essential materials.
c. Weaknesses or errors which may be entirely new to the teacher or of which he may be only dimly aware.
d. Problems which are unknown to some textbook writers.
e. Can be a form of self-education to the teacher, as the errors may show a teacher areas where his teaching has not been effective.

Wyatt (1973), claimed that an error analysis may be undertaken in an attempt to find out the final remedial work that would be necessary before an end-of-course examination.

To Etherton (1977), errors could be caused by simultaneous exposure to regional varieties, and the constant change in the status of a subject. This could be brought about by lack of textbook, qualified teachers and lack of motivation on the part of the students. This study however does not intend to evaluate the effect of Etherton's list on biology in Nigerian secondary schools. But his suggestion that such errors be sympathetically treated is noted.

Akonobi (1976), claimed that psychologically the learner could be a source of error. This is true where a learner is unable to represent correctly what is observed, or identify correctly any specimen given. The effect of these on the learner are faulty representation.

The present study agrees with Akonobi's (1976) view that contrastive analysis has its needs and values. Also the analysis of the learners written examination reveals the learners weaknesses and strength. The aim of this type of analysis is to provide the students with a curriculum that best suits them at that particular time.

Backman in Suydam (1985) classified errors into five distinct categories. They are:

1. Random errors.
2. Errors related to sequencing steps within procedures.
3. Errors related to conceptual learning.
4. Errors related to selection of information or procedure.
5. Errors related to recording work.

Etherton (1977) observed that the classification of errors varies from individual to individual. For present study the WAEC objectives of practical work and ideas of Sorunke and Olafimihan (1988) were used to classify the possible error types, in relation to biology practicals.

Practical biology being an area for development of psychomotor skills, provides proper understanding of the content of the subject. An error analysis of work done by the learner can be carried out, and its findings can be of great value to the teacher and the learner. No wonder Bryce, et al (1983) and Sand (1981), wrote that error analysis can be used as a method of assessing students' practical work. The assessment they advocated could be carried out externally or internally.

Bryce, et al (1983) and Sand (1981), went on to distinguish between externally devised and internally controlled practical assessment. They said, the distinguishing factor is the role the teacher plays. In the former, the teachear has little involvment during the examination. He may however be required to assess the end-product of an investigation, e.g. dissection. This is usually followed with a marking scheme supplied by the examining body, e.g. the WAEC. In the later, the teacher will be involved in the design of the examination as well as participate actively during the actual examination (e.g. observing and assessing practical skills as they are performed by students).

The internal method has been reported to be satisfactory and more appropriate than the external practical examination method (Sand, 1981). The following are the advantages of internal method of practical assessment outlined by the Schools Council (1973):

1. Increased freedom on the part of students and teachers to choose their own objectives, subject matter and activities.
2. Direct observation by teachers extends the range of student attributes which can be assessed on written evidence alone.
3. It encourages teachers to clarify their objectives and provides an opportunity for them to assess the achievement of those objectives with a view to adjusting their own teaching.

A number of research work has been carried out on error analysis of students examination scripts in areas of English Language, Chemistry, Mathematics and a few in Biology. These include Olayemi (1980), Alabi (1980), Wyatt (1973), Etherton (1977), Bello (1988), Isa (1990) and Soyinbo (1992).

Sorunke and Olafimihan (1988) also conductaed a similar study in the area of practical biology. 64 science teachers were used at a meeting of STAN (Science Teachers Association of Nigeria). They were adminsitered with two types of leaves of two different plantas, Dalbergia Sp,

.ceplant (variegated leaf), a fruit of <u>Parkia</u> <u>clappertonia</u> and <u>Tilapia</u> fish. They were to draw and label fully. The scripts were marked and errors classified according to the criterion below:

1. Proportion.
2. Broken lines.
3. Shading.
4. Nature of lines.
5. Accuracy of drawing.
6. Spelling of labels.
7. Accuracy of labels.
8. Headings.
9. Guidelines touching parts.
10. Lettering.

The present study is similar to Sorunke and Olafimihan's in that it also tries to identify the types of errors students make in biology practicals. It is however different in that the present study uses the learner while the other made use of the teachers. In addition, Sorunke and Olafimihan's study limited their study to the drawing and labelling aspect of practical biology alone, while the present study looks at biology practical at the Senior Secondary Certificate level. The present study however borrows the criteria used for analysis of the error types to analyse the different types of errors.

A similar study was carried out by Soyinbo (1992) on pre-service teachers of N.C.E. and B.Sc. Ed., 50 N.C.E. and 60 B.Sc. Ed. students were used for the study. The instrument used was developed by the researcher. It consisted of five labelled diagrams, which typified wrongly labelled diagrams containing wrongly labelled parts mixed up with correctly labelled parts. Also another diagram displayed situations where one structure is labelled as two and where label lines pointed to empty space. Soyinbo found in the study that, the knowledge of the three categories of errors in biological diagrams, in the pre-service teachers was poor. This he concluded could be traced back to their poor background knowledge of practical work at the secondary school level.

Soyinbo's work like Sorunke and Olafimihan's looked at only the aspect of drawing and labelling in Practical Biology. The present study goes a step further to look at other aspects of practical biology and the drawing as well.

At the international level, Etherton (1977), in his study on error types, used a written composition scripts of students to determine the types of errors they make. Although his field of study was English, his idea of written examination scripts of students to determine errors is used in the present study, to determine the types of errors students make in practical biology.

In addition, Etherton (1977) suggests that to make an error analysis a teacher requires among other things including an extensive teaching experience at the level concerned. This has been taken care of since the present researcher has continuous eight years teaching experience and three years experience in marking WAEC practical biology. This experience according to Etherton (1977), makes the location and classification of errors easier and more accurate.

Lock (1985), conducted a similar study on error types. He compared three approaches to getting notes into pupils exercise books and from there determine the types of errors they made. He also found which method had the most errors. For his study, Lock (1985) used two sets of third year biology students ages 13-14 years, in a co-educational comprehensive school. One set consisted of higher ability pupils and the other set composed of low ability group. Both set were taught biology syllabus by same teacher. After the teaching of the topic,the students were asked to copy a passage from the board. For the second assignment, they were to compose their own notes in answer to the questions given. And thirdly, they were to write down some dictation from the teacher. The notes were then all collected and analysed according to the following error types:

1. Spelling errors.
2. Punctuation errors.
3. Presentation errors.
4. Morphological errors.
5. Factual errors.

Lock (1985) found in his study that performance of the high ability group was better in all the three methods of copying notes. That means, they made less errors than the low ability group, and that the graduation of errors was from dictation to broad-copied to self-composed notes.

Lock's (1985) analysis of errors was on the theory aspect of Biology. The methods he used has advantages to the learner; the broad copying allow pupils to get a holistic grasp of the piece. Dictation on the other hand adds good intonation and aids comprehension and aural pronounciation. The present study however is out to identify the common errors biology students make in their practical not theory. The effect of these on the achievement as well as the development of certain process skills would also be discussed.

Finally, according to Ghadessey (1989), errors can serve as indicators of progress and success. As such a systematic analysis of errors of this nature would lead to improved teaching method and a greater awareness of the nature and causes of the mistakes learners make.

Summary of the Review

A lot of the studies reviewed in this chapter testified to the importance attached to practicals in biology.

The review focused on three aspects, which included problems associated with the teaching of practical biology, processes of science and scientific skills and error analysis in biology. Most of the experts' views gathered, (Fatubarin 1984, Aramide 1985, and Kumari and Aliyu 1985) supports the fact that practical activities play an important role in biology teaching, as well as in the acquisition of scientific process skills. Some however disagreed with this, for the fact that practical work does not affect students' theoretical knowledge. They believed practical is too expensive, time consuming and without adequate effective uniform criteria both in the conduct and mode of assessment.

The literature reviewed on the problems associated with the teaching of practical biology, (Soyinbo 1982, Bagah 1984, Aramide 1985, Ali 1986), highlighted a number of problems the teachers are confronted with. This ranges from inavailability of materials, lack of cooperation on the part of the administration, lack of technical know-how on improvisation of science equipment to lack of knowledge of what available time should be alloted to practicals.

A number of the literature reviewed on analysis of errors committed by learners, agreed that error analysis of learners' work is valuable. This they believe would help reveal common and individual weaknesses, that calls for special attention. (Wyatt 1973, Akonobi 1976, Etherton 1977). Finally the procedure used for identifying errors by a number of researchers in various disciplines was discussed. The ideas and procedures were adapted and used in identifying the errors in the test used in the present study. The details of the methodology and procedure are reported in the next chapter.

Chapter 3

DESIGN AND PROCEDURE

3.1 Introduction

In this chapter, the population and sample selected for the study, as well as the procedure for their selection are discussed. The development of the questions, marking scheme and error types used for the data collection and analysis are discussed below.

3.2 Design of the study

This study is a correlational study, in which an attempt was made to establish the extent to which error committed by secondary school students in practical biology is dependent on:

i. the school attended

ii. the achievement of the subject in the test and

iii. the gender of the subject.

In carrying out this investigation the following steps were employed namely:

a. the development of the instrument.

b. the development of the error types.

c. the preliminary study.

d. the preparation of specimens required for the practical and data collection.

These steps are discussed in subsequent sections in this chapter.

3.3 Population of the study

The population from which the sample of this study was selected is the final year students, offering biology in secondary schools in Zaria (SS III, final year students), at the time of data collection (May 1993). At the time of this study there were a total of 46 secondary schools in this area. Of this number 13 had final year biology students, the others were junior secondary schools or with classes only up to SS I and SS II. For the purpose of this study, secondary schools that has been approved by the WAEC and have presented candidates for the Senior Secondary Certificate Examination (SSCE) in biology were used. This was to ensure that such schools are adequately established in the area of biology teaching. The estimated population of the final year biology students in the thirteen schools was 2,879.

3.4 Samples and Sampling Technique

For the purpose of sampling, these thirteen schools were stratified on the basis of sex of students in each school population. This gave a total of seven boys' schools, five girls' schools and one co-educational school. The only co-education school was selected. In selecting the boys and girls schools, their geographical locations were also considered. The schools were stratified and selected according to the local government area. The two local government areas Sabon Gari Local

Government Area and Zaria Local Government Area. Two schools each were selected, one boys' and one girls' from each of the two Local Government Areas, using the table of random numbers (Kerlinger, 1973). This was to ensure adequate geographical representations. On the whole, 5 schools were selected, two girls', two boys' and one co-educational school. The selected schools are:

1. Government Girls Secondary School, (GGSS) Samaru.
2. Government Girls Secondary School, (GGSS) Kofan Gayan.
3. Government Secondary School (GSS) Barewa.
4. Government Secondary School (GSS) Chindit Barracks.
5. Demonstration Secondary School (DSS) A.B.U. Zaria.

In the case of GGSS Samaru, GGSS Kofan Gayan, Barewa and DSS A.B.U. Zaria, each of which had 5 arms of classes of final year students offering biology, two classes each were randomly selected. In Chindit Barracks, there were seven classes of final year students, two were randomly selected too. The sample size represented a minimum of 30% of all the students in the final year in each of the school selected. In support of this Borg and Gall (1979) agreed that 30% from any population can be considered as adequately representative of such a population.

In each school, the test instruments were administered to all the students present in the selected classes at the time of test administration. This was in order to avoid undue disruption of the schools' programmes as well as enable students to take the tests in a normal practical classroom situation.

The actual number of students in the study sample selected from each school as well as some other relevant information is summarised in a table, thus:

Table 3.1: SUMMARY OF SECONDARY SCHOOL SAMPLES

S/No	SCHOOLS	NUMBER IN POPULATION	NUMBER TESTED
1.	GGSS Samaru (G)	130	74
2.	GGSS Kofan Gayan (G)	125	48
3.	GSS Barewa (B)	163	63
4.	GSS Chindit Barracks (B)	315	71
5.	DSS, A.B.U. Zaria (Co-Educ)	207**	61*
	Total	940	317

G - Girls; B - Boys; Co-Educ. - Co-educational
** 1) 207 = 132 boys and 75 girls
* 2) 61 = 33 boys and 28 girls
Total number of boys in the sample = 167
Total number of girls in the sample = 150

3.5 Instrumentation and Study Instrument

Instruments used for the purpose of data collection and analysis are:

1. West African Examination Council (WAEC) questions and marking schemes.
2. Error types from West African Examination Council Regulations 1985/86.

3.5.1 <u>Development of the test items and Marking Scheme</u>

For data gathering purpose, practical biology examination test questions of WAEC (1988-1992) ordinary level SSCE questions were randomly sampled. The test consisted of two sections; section A made up of short answer questions, and section B made up of long answer questions requiring the use of certain instruments, drawing, etc. A total of ten short answer questions were selected for section A, out of the total 49 short questions. For section B, three long answer questions were selected, they were randomly selected out of the 15 long answer questions. These 10 short answer questions, the three long answer questions and marking schemes were selected in line with the WAEC number of questions set. The questions were selected in a way that the error types selected were reflected. The questions along with the marking schemes were however not validated, since they were WAEC questions, it is assumed they were already validated. The test items and marking scheme are presented in appendix I and II.

3.5.2 <u>The Error Types</u>

For the purpose of analysis of data collected, a list of error types in SSCE biology practical (WAEC, 1985/86 Regulations) were selected in line with the questions set. The error types are as follows:

I. **Drawing Errors** - This is further classified as follows:

a. Magnification - must be correctly stated and proportionality counts too.

b. Label Lines - These are also called guidelines, they must be straight with no arrow head, not crossing each other and must touch the part they are representing.

c. Labels - parts labelled must be written horizontally and accurate.

d. Drawing Lines - drawing lines must not be wooly, wavy and broken. Thick lines are not accepted. If double lines are drawn as are represented for cut surfaces, they represent. They are not expected to merge.

e. Shading - shading is not allowed as they are likely to misrepresent structures.

f. Accuracy of Drawing - essential details of biological significance must be included, as this helps in the identification of specimen.

g. Spelling - spelling of parts labelled must be correct, e.g. 'Peak' instead of 'beak' conveys different meaning.

h. Title - correct title must be given to drawings, e.g. Transverse section of an orange fruit.

II. **Spelling of Technical Terms** - Technical terms must be correctly spelt most especially where it is just a one word answer, e.g. Hepatic portal vein, variegated leaf, etc.

III. **Inability to Follow Instruction Accurately** - This occurs where a student fails to follow instructions given systematically, e.g. where cross-section of a fruit is required, the student draws longitudinal section.

IV. **General Neatness of Drawing** - Smudges and dirty marks are not acceptable, drawing must be neat.

V. **Technique of Answering Questions** - Answers must be direct and accurate. The student may have the idea, but have no technique of answering the question.

VI. **Identification and Classification of Specimen** - Specimen must be correctly identified and classified where necessary.

VII. **Inability to Observe Parts Identified** - Parts identified where necessary features of biological significance should be clearly stated, e.g. webbed hindlimb of toad for swimming in water.

VIII. **No knowledge of the Subject** - Here completely wrong answers are given by the students (wrong idea).

IX. **Inability to Compare and Contrast** - Here where students cannot draw a simple table to show similarities and differences between specimen (e.g. fruits) provided.

X. **Poor Knowledge of Mathematics** - Where student cannot add, subtract and compute simple figures to come out with simple interpretations.

Table 3.2. is a breakdown of how these errors are tied up to the marking scheme.

3.5.3 **Validity of the error types**

During the selection of the error types, several steps were taken to ensure validity. The first of this steps was to select the error types in such a way that they are reflected by the questions selected. In order to realise this, the researcher made reference to an authoritative source (WAEC 1985/86 regulations). Also the questions selected along with the ten criteria of errors, were forwarded to a number of biology educators who had been teaching and or marking SSCE practical biology. They were to match all the possible error types that may be associated with each question.

The specific instruction given to the validators are contained in Appendix III. Table 3.2 is the final errors associated with each of the questions and the marks alloted to each of the questions.

Table 3.2 Error types associated with each question and marks awarded.

Question Number	Error type	Marks
1 (a)	II, VIII,	1
(b)	II, VIII,	1
2.	V, VIII	1
3.	II, V, VIII	3
4 (a) i	V, VIII	1
ii	II, VIII	1
(b) i	V, VIII	1
ii	V, VIII	1
5(a)	II, VIII	1
(b)	V, VIII	2
6(a)	V, VIII	2
(b)	V, VIII, IX	2
7(a)	II, VIII	1
(b)	V, VIII	1
(c)	VIII	1
(d)	II, V, VIII	2
(e)	V, VIII	1
8	II, VI, VIII	2
9	V, VIII	2
10(a)	II, VI, VIII	1
(b)	II, VII, VIII	1
(c)	II, VI, VII, VIII	1
11(a) i	II, VI, VIII	3
ii	I, III, IV	8
iii	II, V, VIII	3
(b) i	II, V, VIII	4
ii	II, VIII	2
(c)	III, VIII, IX	4
12 (a)	II, VI, VIII	4
(b)	II, V, VII, VIII	4
(c) i	II, III, VI, VIII	1
ii	II, III, VII, VIII	1
iii	I, III	8
13(a) i	V, X	1
ii	V, X	1
iii	V, X	1
(b)	VIII, X	1
(c)	V, VIII, X	3
(d) i	V, VIII	1
ii	V, VIII, X	1
iii	V, VIII	1
Total mark		82
Maximum score		80*

* This maximum mark score, is in-line with the WAEC regulations.

3.5.4. **Reliability of the Test item**

The questions set were administered to a sample of students similar to the sample to be used, but not the same. This was to establish its reliability, as well as researchability of the test items. A test-retest was conducted. The test was administered to the group on the first occasion and re-administered to them after two weeks interval under the same condition. The school used was government secondary school Basawa. The total number of students in the class was 47. Only 36 of the subjects sat for the test in the two occasions. The results of these 36 students were then used for the computation. On each occasion of the test administration, two hours was given for the subjects to complete the test. Marking of the scripts was also undertaken. (Here only the achievement of each of the subjects was sortted for.)

The reliability co-efficient of the test-retest was then computed using Pearson product moment correlation. This gave co-efficient of $r = 0.97$ at 0.05 level of significance. This value of 0.97 showed that the test is reliable and as such would test what it is out to test. The table in appendix VIII represents the scores of the students.

3.5.5 <u>Preparation of Specimens for Data Collection</u>

A total number of seven different specimens were needed for the data collection. They are as follows:

Specimen A - Mango/Oil Palm/Coconut (fruit)

B - <u>Tridax/Emilia</u> (chick weed/goat weed)
C - Tomato/Guava (fruit)
D - Earth-worm
E - Cockroach
F - Fish
G - Toad

For specimens A and C, Mango and Tomato were used, and they were highly available as such were collected on the spot for the test. For specimen B, <u>Tridax</u> sp. was used (a wind dispersed fruit). This was collected about four months before data collection. It was preserved in a dry specimen bottle by the researcher. This is because the specimen is available around the end of rainy season after which it becomes difficult to come by. Specimens D - G were collected about a week to the period of data collection, as some of the schools had no such specimens preserved in their laboratory. They were collected and preserved in 30% carbon tetrachloride, until they were needed. The questions based on these specimens are shown in appendix I. All these specimens were kept away by the researcher and shown to the subjects only on the day of test administration. This was to ensure that subjects had not seen the specimens prior to the time of test administration.

3.6 **Data Collection Procedure**

The test was administered to each of the study samples directly (face contact) by the researcher with the aid of a research assistant. The test was administered to the subjects in the month of May 1993 just before the SSCE examination began. The test instrument was administered to all students present in the selected classes at the time of data collection. This was to avoid undue disruption of the schools' programmes, and ensure that subjects take the test in a normal classroom situation.

Two visits were made to each of the schools by the researcher, the first visit was to seek for permission to administer the test from the Principal of the school, (with the help of the letter from the zonal Director). Appendix IV & V. In addition too, to talk to the Head of Department of Biology or the Biology teacher, teaching the final year students. This was necessary as there was the need for the laboratory to be used, and such a place needed to be prepared. The second visit was for the test administration. The schools all co-operated and this enabled the successful administration of the test to all the study samples. In all cases, this researcher was allowed enough time during the normal school hours to administer the test item to the subjects. This was an advantage to the study since the subjects took the tests in normal classroom environment which enabled them to put in their best in answering of the test items.

The researcher and the research assistant (a Biology teacher) went round and ensured that all the subjects were responding to the test questions in accordance with the instruction. At the end of the tests, the answer scripts and test question papers were collected. The answer scripts were then marked by the researcher using the marking scheme. A colleague of the researcher who is also a biology teacher was asked to check the scripts to ensure that mistakes are not made in the marking, scoring and summation of the scores.

3.7 **Treatment of Data and Analyses**

The responses of the subjects were scored based on the marking scheme. Section A, carried a total of 30 marks. Section B had three long answer questions each, with marks 24, 18 and 10 respectively. Overall total mark is 82 and maximum obtainable score is 80. (This is in line with WAEC manner of setting questions) see Appendix I & II. These marks obtained by the subject represents the student's achievement.

For the errors made, each of the scripts was taken and each question analysed to see why the subject failed in cases were they have failed to obtain a score. The error made is thus recorded for each question. Failure by subject to obtain a score for a particular number is marked as wrong with a tallying mark against the criterion concern (the ten criteria is set out in Page 42. The total number of errors in each of the 10 criteria for the error types was then added up to give the total errors for each student. Also the total number of errors on each criterion for the total number of the students in each school was then calculated. The table that follows illustrates the mode of analysis.

Table 3.3 <u>CRITERIA FOR ANALYSING ERROR TYPES IN BIOLOGY PRACTICALS</u>

S/No	ERROR TYPES										TOTAL ERROR	MARK OBTAINE
	I	II	III	IV	V	VI	VII	VIII	IX	X		
TOTALS												

The above table was made for each of the schools. The sum total of errors made by each subject in each school was added up and recorded along with the marks obtained as indicated in the table above. Also the sum total of each error type in each school was also added up. These were further fed into the computer. The data collected were then analysed in chapter four.

Chapter 4

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter contains the analyses of data, results and discussion of the data collected for this present study. For the purpose of data collection two instruments were used. These were:

1. Biology practical questions, which were selected from the SSCE practical biology questions (1988-1992) along with the marking scheme and
2. Possible error types which were also selected, in-line with the SSCE practical questions set in (1) above. These were adopted from WAEC (1985/86 regulations).

Four null hypotheses were stated for the study. The subjects were tested and the test scripts were marked to obtain their overall achievement in the practical examination. Each of the scripts were further analysed to obtain the nature of errors committed. These informations were used to test the hypotheses. A probability level of less than or equal to 0.05 was considered to be significant.

The findings of this study and their implications are discussed in subsequent sections in this chapter.

4.2 Hypotheses Testing

The results of the analysis, mean scores and standard deviations of each of the error types by schools are indicated in the table below (4.1).

TABLE 4.1: MEAN SCORES AND STANDARD DEVIATIONS OF ERROR TYPES BY SCHOOL

SCHOOL	ERROR TYPES									
	I	II	III	IV	V	VI	VII	VIII	IX	X
A {74}	10.19	3.97	0.04	0.86	6.78	3.62	2.82	6.12	0.72	1.39
	(2.94)	(1.94)	(0.2)	(0.78)	(2.64)	(2.24)	(2.20)	(3.2)	(1.26)	(0.86)
B {48}	8.73	3.19	0.79	0.77	3.52	3.44	3.6	8.0	2.85	1.6
	(2.66)	(1.45)	(0.41)	(0.78)	(1.82)	(1.50)	(1.99)	(4.05)	(1.05)	(1.45)
C	9.05	2.30	0.37	0.90	3.3	4.33	3.92	9.95	2.33	2.02
{[illegible]3}	(3.59)	(1.83)	(0.55)	(0.73)	(2.14)	(2.16)	(2.24)	(5.3)	(1.87)	(1.57)
D	11.46	3.25	0.76	0.87	3.08	3.23	3.48	13.62	2.13	1.73
{[illegible]1}	(2.48)	(1.36)	(0.43)	(0.88)	(1.67)	(1.19)	(1.54)	(4.99)	(1.72)	(1.32)
E	10.10	2.45	0.03	0.35	1.47	2.42	3.33	10.55	1.15	1.87
{[illegible]0}	(2.87)	(1.41)	(0.18)	(0.66)	(1.74)	(1.32)	(2.34)	(4.89)	(1.99)	(1.77)

*Figures in bracket ( ) are standard deviation and { } are number of subjects in each school.

The values in the table were used in subsequent analysis. Each of the hypothesis formulated was tested and results obtained are contained as follows:

Hypothesis 1

There is no significant difference in error types between schools. To test this hypothesis, a one-way analysis of variance was used (of 5 schools and 10 error types). This statistics was used because all the five schools were drawn from the same parent population. The results obtained are as shown in Table 4.2 below.

TABLE 4.2: SUMMARY OF ONE-WAY ANOVA FOR DIFFERENCE IN ERROR TYPES BETWEEN SCHOOLS

Source of Variation	SS	df	Ms	F
SSb	506.9	9	56.3	
SSw	59.5	40	1.48	*38.0
SSt	566.4	49		

*F calculated was found to be 38.0
F critical at df1 = 9, df2 = 40 is 2.88 at 0.05 level of significant.
df1 = 9 df2 = 40

From the results, the F calculated value is greater than F critical at 0.05 level of significant (Fcal > Fcri). Thus the relevant null hypothesis was rejected. It can therefore be concluded that there is a significant difference is error types between schools.

Hypothesis 2.

There is no difference in the order of error types between schools.

To test this hypothesis, the prevalent errors were first ranked and after ranking Krushkal-Wallis test was applied. The formula used is in appendix VII (a)

Calculated value of H was 42.98. The degrees of freedom (K-1) which was 10-1=9 was used at .05 level of significant.

The critical value of X^2 for df 9 at 0.05 level of significant was found to be 16.92 from the table (where K is the number of the error types). Since the critical value is less than the calculated value, the relevant null hypothesis is rejected. This has shown that there is a significant difference in the order of error types between the schools. The order of errors in the schools are indicated in Table 4.3.

TABLE 4.3: ORDER OF ERRORS BY SCHOOLS

SCHOOL	Error Type (Order)									
A	I	V	VIII	II	VI	VII	X	IV	IX	III
B	I	VIII	VII	V	VI	II	IX	X	III	IV
C	VIII	I	VI	VII	IX	V	II	X	IV	III
D	VIII	I	VII	II	VI	V	IX	X	IV	III
E	VIII	I	VII	II	VI	V	V	IX	IV	III

The above table is a clear indication that each school has its own order with which the errors were committed. Since there are no any two schools with the same order.

Hypothesis 3.

There is no significant relationship between the frequency of occurrence of error types and student's overall achievement in Practical Biology.

To test this hypothesis, Pearson Product Moment Correlation Coefficient was used. The formula used is as presented in Appendix VII (b). The result obtained is shown in Table 4.4.

TABLE 4.4: RESULT OF CORRELATION OF ERRORS AND SCORE OF SUBJECTS

EX	EY	EXY	EX2	EY2	r*
12036	6936	251826	488793	196652	0.71*

Significant, $P<0.05$
EX = Sum of errors
EY = Sum of scores

The value (r = 0.71) is significant at 0.05 level. Hence we reject the null hypothesis. r can further be converted to r^2 (coefficient of determination), in this case it is 0.504 which is 50.4%

Hypothesis 4

There is no significant difference in the frequency of error types committed by boys and girls in Practical Biology examination.

To test this hypothesis, chi-square statistics was used. The results of the frequency counts were used, the chi-square analysis employed was to determine the dependency of frequency of errors committed by students by gender. The results obtained are as follows (Table 4.5).

TABLE 4.5: ERROR TYPES BY GENDER

GENDER	ERROR TYPES										
	I	II	III	IV	V	VI	VII	VIII	IX	X	TOTAL
Male	1711 (1753)	457 (534)	79 (66)	132 (133.7)	488 (660.6)	590 (602.7)	595 (597)	1986 (1716.8)	320 (290.8)	301 (295.5)	6659
Female	1463 (1420.7)	510 (432.8)	41 (53.7)	110 (108)	708 (535)	501 (488)	486 (483.9)	1122 (1391)	221 (242)	234 (239.5)	5396
Total	3174	967	120	242	1196	1091	1081	3108	541	535	12055

Figures in bracket ( ) are expected cell frequencies

X^2 value obtained by calculation = 233.5.
With df 9 (P = 0.05)
X^2 critical from table was found to be 16.92.

From the results critical value for X^2 is less than the calculated value. The null hypothesis of no significant difference in frequency of errors committed by male and female subjects was rejected. Using the contingency coefficient table, the value of X^2 can further be simplified using the formula presented in Appendix VII(C). Q = 0.65.

Ability of a subject to commit error therefore appears to be sex-related; with the females committing less errors than their male counterparts in most of the error types.

4.3 Discussion

This study was designed to determine the nature of errors students commit in practical biology, as well as the effect of such errors on achievement in practical biology in senior secondary school.

The data collected from the test administered was analysed by employing the one-way analysis of variance. The result of the one-way analysis of variance showed a significant difference in error types between schools, at $P<0.05$ as shown by table 4.2 above. The hypothesis which thus stated that there is no significant difference in error types between schools was rejected. The significant difference found between schools was likely to be as a result of the fact that students were not adequately taught, or they were not exposed to enough practical work. If the students were properly taught and exposed to the same amount of practical lessons, there would not have been any difference between the schools. This therefore is an indication that practical lessons as well as a prior knowledge of error types by a learner in senior secondary school are both very important for effective learning and acquisition of process skills. This result confirms earlier conclusions made by Soyinbo (1992), on the relevance of practical lessons in biology, for the development of skills required to answer the final examination questions in practical SSC examinations.

The Krushkal-Wallis test applied on the order of error types between schools, indicated a significant difference in the order with which the schools committed each of the error types. The siginificant level was placed at 5% (P<0.05). Table 4.3 showed the order by which each of the schools committed the error types. No two schools committed the errors with same order. The greatest number of errors for school A and B were error one, which has to do with drawing and labelling of specimen while in schools C, D and E, the greatest were error VIII which was, giving completely wrong answer to the questions asked (wrong idea). This also can be as a result of the differences in the teaching method, teaching experiences as well as the fact that they might not have been taught the subject properly. Earlier findings of Osenuga (1981) and Soyinbo (1992), also confirms this. The result clearly showed too, that certain aspect of the practicals that pose a great problem to some schools, thus resulting in high frequency of errors committed do not infact pose same to another. In this respect Wyatt (1973) is of the view that the knowledge of the frequency with which learner commit errors, hence resulting in poor performance can be used to make a final remedial work.

The Pearson Product Moment Correlation Coefficient conducted on the frequency of occurrence of error types and student's overall achievement, indicates that there is a significant relationship at $P<0.05$ level. This showed, that there is a significant relationship between the frequency of occurrence of errors and achievement. The results showed that the more the errors committed the less the achievement. The value of the coefficient of determination $r^2 = 0.504$ (50%), further explains that 50% of the achievement is accounted for by errors committed. Thus it can be concluded that frequency of errors has depressing effect on achievement in practical biology. This finding is in agreement with Ileoje (1981) who stated that the performance of a student in Biology Practical is directly related to how well the learner can represent his observations.

The present study therefore reveals that the more the errors committed by a subject the less is the overall achievement of the learner in the subject. For maximum achievement therefore, learner needs to be guided from committing errors. Also possible types of errors be brought to the attention of the learner and the learner's knowledge of such errors could help guide against such. This is in line with the statement made by Ethertone (1977), Olayemi (1980), Bello (1988), Isa (1990) and Soyinbo (1992).

The influence of gender on errors committed was also investigated. The result of the chi-square analysis showed a significant difference. The results suggests that error committed by subjects was gender related with the females committing less errors than their male counterparts. This therefore means that the achievement of females is higher than that of the males as earlier stated. Although this finding disagreed with Usman's (1992), whose work dealt with theoretical aspect of science, however the study of Ameh (1980), on process skills, supports the present study. Ameh (1980), found that girls achieved better than boys in tests that require the use of process skills. The reason given being that the Nigerian culture encourages the use of hands, eyes and ears in girls than in boys. Such cultural practices according to Ameh, enhanced achievement in areas that require the use of process skills.

Chapter 5

SUMMARY, CONCLUSION, IMPLICATION, LIMITATION AND RECOMMENDATION

This chapter contains the summary, conclusion of the procedure and findings of the present study. The implications, limitations and problems encountered during the conduct of this study are discussed. Some recommendations on how to improve on the teaching of Practical Biology in Senionr Secondary Schools are made.

5.1 Summary

This study was an attempt to establish the nature of errors final year Biology students commit as well as the effect of such errors on their achievement in Practical Biology.

The subjects were 317 final year Biology students, from 5 Secondary Schools in Zaria Metropolis. Participation in the study was limited to those students who were present in school on the day the schools were visited. The study was undertaken to seek answers to the specific questions and hypotheses stated in chapter one.

For the purpose of data collection and analysis, two instruments were used. Biology practical questions and marking scheme which were selected from SSCE practical biology questions (1988-1992); and possible error types selected in line with the questions set. These error types were used to determine errors made by the subjects. The practical questions consisted of two sections, Section

A which had 10 short answer questions, while Section B consisted of 3 long answer question requiring drawing and labelling of parts in two of the 3 questions. The Section B of the test measured the subjects' ability to draw and label correctly biological specimens as well as identify features of biological significance. It also measured the subjects' ability to calculate and interprete calculated data. The questions set were not validated since they were WAEC questions and assumed to be already validated. The error type associated with each question was however validated, the test were administered for reliability. The reliability coefficient calculated for the test was 0.97 ($P<0.05$).

The scores of the subjects were recorded and that represented the achievement of each of the subjects. The analyses of each of the scripts also gave results of errors committed and the frequency with which each was committed. The results obtained as a result of the analyses of the error types suggested the existence of a strong relationship between the overall achievement in the practical test and the frequency with which errors were committed. The correlation coefficient between achievement and error committed ($r = 0.71$) as moderately significant. Similarly, the analysis of error types between schools showed a significant difference (F calculated > F critical) at the 0.05 level of probability. Thus the first hypothesis was rejected. The order with which each of the schools committed errors also showed a significant difference (F critical < F calculated) ($P = 0.05$).

When the error committed by boys and girls was considered, the X^2 value obtained was also significant ($X^2 = 283.5$ at $P < 0.05$) with contingency coefficient value of 0.65. Thus the null hypothesis of no significant difference was rejected. The result indicated that error committed by a subject is gender related, with the females committing less errors than their male counterparts.

5.2 Conclusions

Within the limitation of the present study, the following conclusions could be made:

1. The subjects of this study generally commited all the 10 groups of error types with a high degree which lead them to perform poorly in the test as a whole.
2. The order with which each of the error types was committed differ from school to school.
3. The frequency with which the errors were committed differ between schools. These can be related to the difference in the qualification and teaching experiences of the teachers handling the subject in the different schools.

4. The degree by which errors were committed by the subjects was found to be gender-related. The female subjects in this study appear to commit less errors than the males. This also means that they achieve better than their male counterparts.

5.3 Implications of the study

The problems that initiated this research is the poor academic performance of students in biology at the Senior Secondary School Examination. This poor performance has been attributed to so many factors, one of which is the rate at which errors were committed in practical biology, due to its unique nature.

The results of this study have shown the nature of errors committed and the frequency with which these errors were committed by the subjects. It is therefore important for biology teachers to take note of these error types and take all necessary precautions to guide students against making such, as we have seen that the errors are directly related to performance. For an improved performance, these errors should be avoided as much as possible. The teachers of biology at the secondary schools should also improve on their approaches towards practical work. This they can do by making sure they organise and conduct practical lessons. Also they should mark students' practical work, pointing out errors made in representations and other aspects of the practical. If these steps are taken by the teachers in each of the practical lessons, the learner would learn to avoid committing the errors as well as acquire the skills they needed to answer the final examination questions.

Science educators should be aware of the erro types in practical biology, as this would be of immense value in the training of the teachers to be. For effective learning on the part of the learners parents should provide all the necessary practical materials such as drawing book, HB pencil, ruler, eraser, dissecting kits, etc. This will go a long way to motivate the learner to work. The school authority should also provide the learning environment, the learning materials needed to conduct practicals as well as allow their staffs to participate in marking WAEC examinations. This would encourage as well as develop the teacher in his work. Finally, the curriculum planners should state clearly the nature of practical work to be carried out in practical biology. This would help the teachers in setting and conducting their class practicals. If the above mentioned steps are taken, it will in turn lead to the production of better future science students, who will consequently help in producing competent scientists needed for technological development and advancement.

5.4 Limitations of the Study

During the conduct of this study, a number of problems, particlarly those associated with the data collection procedure were noted.

1. It was not possible to reach all the final year biology students in Zaria Metropolis. At the time this study was conducted, there were about 46 secondary schools in this area. Of this number thirteen had final year biology students, the others were Junior secondary schools or with classes only up to SS I and SS II. The estimated population of the final year Biology students in the thirteen schoolss, (as shown by the record kept at the Zonal Education Office, Zaria), was 2,879 students. Since the study was limited by fund and time, this population was considered too large for an efficient study. In addition, about two hours was required for the completion of the test which was used for data collection. This implied that three periods on the time table were required for testing the students. Hence only those students who were present in the school on the day the researcher visited their schools for data collection, participated in the study. The number of students who participated in the study was 317. This represented only 11% of the student

population and thus limits generalising the findings of this study.

2. At the time of data collection, (May 1993), some of the schools especially the girls schools were preparing for their final examination in Practical Home Economics, as such their attentions were diverted on the materials they were carrying for their Practical Home Economics. Their lack of full concentration could possibly affect the subjects' performance in the test.

3. Students who submitted blank scritps or who did not attempt questions on the sections requiring drawing or the mathematical aspects were judged as committing errors in those aspects. This is explained by the fact that students are usually asked to leave out whatever they do not know in examinations. However it may also be that those students were lazy or uninterested in the instrument. In which case their scores in the test and the errors they have committed might not be indicative of their ability.

5.5 Recommendations

The findings of this study revealed that secondary school students generally commit a number of errors in practical biology, which also affects their performance in the practical examination and hence the subject as a whole. The result obtained from the first hypothesis showed that there was a difference in errors committed between the schools. The second hypothesis revealed the order with which each of the schools committed the errors. The findings showed a difference in the order with which each of the schools committed the errors. In order to reduce the error committed and thus improve students' achievement, it is therefore recommended that:

1. Biology teachers should teach the possible errors to the students, as students awareness of these errors will help them to guide against committing them.
2. Practical class should be handled as practical lessons, teachers of biology should teach biology as both content and process, rather than the present "chalk" and "talk" method operating in most of the schools, (Aramide 1985). As this method does not help, develop in them necessary scientific skills they require to answer the final year type of questions.
3. Drawing in practical biology is very important as Lysek (1987) rightfully pointed out. He wrote that it is a necessary skill, as it is used whenever imagination, memory or interpretation of data are needed to be expressed visually. The findings of this study showed that it is an area

of the practical where most errors were committed. Drawing in practical biology does not require artistical knowledge. It is mear representation of observations. The ability to make such representations can only be developed through constant practice. If the teachers of biology are dedicated to their job, conducting practicals regularly, marking the practical book as well as pointing out to the learner the errors associated with their work. The learner would committ less errors and this would in turn improve achievement.

4. Teacher trainers should themselves try to develop such abilities in the teachers to-be, so that these teachers could transfer same into their regular classroom practices.
5. Teachers already in the teaching should be sent on in-service training and workshop to improve their teaching approaches.
6. WAEC should endevour to organise workshop for biology teachers on-the-service to educate them better.
7. In order to solve the problem faced by biology teachers on what percentage of the time available should be used for practical work in biology. Curriculum planners should state out

clearly the hours required for the practical lessons and that for the theory lessons. This will go along way to solve problems a number of the teachers in the secondary schools are presently faced with.

If the above recommendations are taken into consideration, there may be some improvement on students' academic achievement in our Senior Secondary Certificate Examination as regard to biology.

For further studies

1. It is recommended that the effect of varying amount of practical work on the errors committed by learner be investigated, so as to determine whether varying amount of practical work has any effect on error committed and achievement.
2. A study of this nature can also be carried out in other science subject areas like chemistry and physics.
3. Since the present study was limited to secondary schools in Zaria, it is recommended that further studies extend the population to educational institutions in other parts of Nigeria, so as to improve the generalizability of the findings of this study.

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APPENDIX I

SENIOR SECONDARY SCHOOL BIOLOGY PRACTICAL, QUESTIONS

TIME: 2 Hours

SECTION A:

Answer all the questions in this section. Write your answers in your answer booklets. You are advised to spend 30 minutes in this section

1. a. What would you observe if a filament of spirogyra is immersed in 0.1 molar sodium chloride solution for about one hour?

   b. Name the process which occured during the immersion of the spirogyra filament in the 0.1 molar sodium chloride solution.

   (2 marks)

2. What is meant by the term endospermous seed?

   (1 mark)

3. State three methods of preserving food generally.

   (3 marks)

4. a. i. State one function of plastids to plants
   ii. Name one plastid found in plants

   b. State one function each of:
   i. Mitochondria
   ii. Chromosome

   (1 mark each = 4 marks)

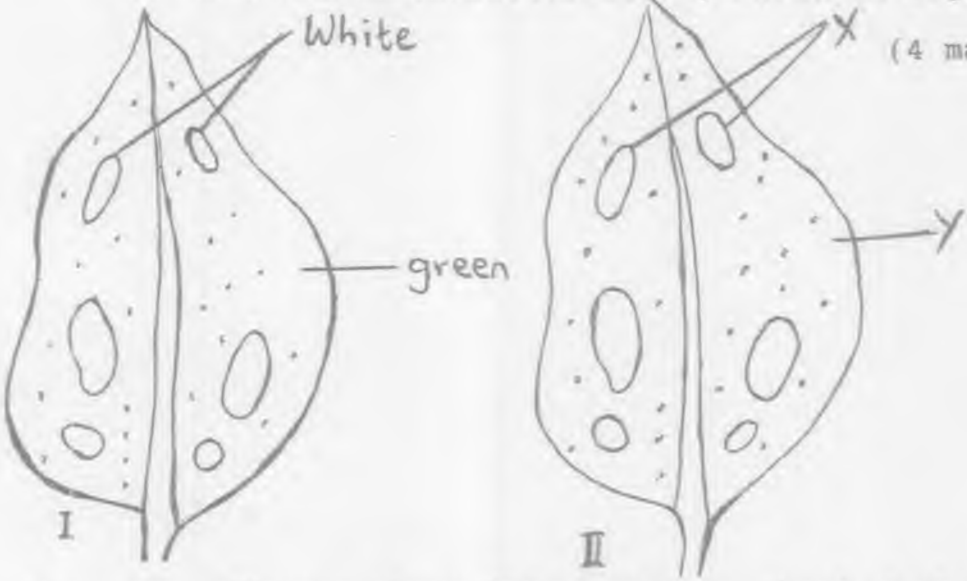
5. a. Name the vessel that carries blood from the wall of the small intestine to the liver.

   b. State two similarities in structure between the transport system in plants and animals.

6. List:

a. Two plant characteristics.
b. Two animal characteristics, found in Euglena.

(4 marks)



7. The diagram above illustrates a leaf before and after an experiment stated below. The leaf shown in diagram I was detached from a potted plant which had been exposed to sun-light for 4-5 hours while diagram II showed the same leaf after the test for starch.

a. Name the type of leaf used for this experiment?

b. Why is this type of leaf most suitable for this experiment?

c. State one precaution that should be taken in carrying out this experiment.

d. What would be the colours of the part labelled X and Y, after the test for starch?

e. Suggest the aim of this experiment.

(6 marks)

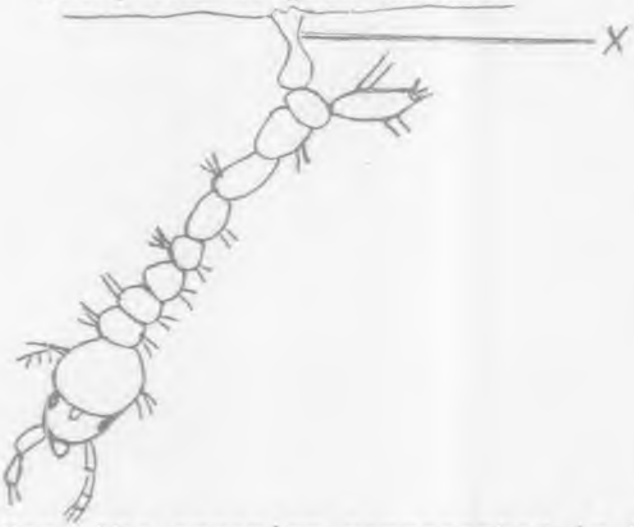
8. State two main components of the axial skeleton of mammals.

(2 marks)

9. State two functions of the mammalian white blood cells.

(2 marks)

10. Study the diagram below:



a. Name the organism represented in the diagram above.
b. Name the structure labelled X.
c. Into what stage would the organism develop?

(3 marks)

SECTION B:

Answer all the questions in this section. Use both sides of your answer sheets for writing and drawing.

You are advised to use sharp pencils for your drawing. Do not shade or colour.

Great importance is attached to accuracy of all drawings and observations. You are advised to spend 1hr. 30 minutes on this Section.

11. a. i. Identify specimen A, B, C without reasons.
ii. Cut a transverse section through specimen A and make a labelled drawing 6-8 cm wide to illustrate the essential features of the cut surface only.

iii. What type of fruit is it? Give two reasons for your answer.

b. i. State two features each which contribute to the dispersal of the seeds of specimens A and B.

ii. Name one agent of dispersal for each of specimen A and B.

c. Cut a transverse section through specimen C. State two similarities and two differences in structure in tabular form between A and C.

12. a. Identity specimens D, E, F and G without reasons.

b. Name one respiratory organ found in each of specimens D, E, F and G.

c. i. State one habitat each of specimen E and F.

ii. Examine the limbs of specimen G. List two ways by which specimen G is adapted to its habitat.

iii. Make a labelled drawing 10-12 cm long of specimen D.

13. Study the table below. It shows the record obtained during a period of field work undertaken by a class of pupils on an uncultivated piece of land. The land was 20 cm long and 15cm wide. It was divided into twelve quadrats of 5cm by 5cm each. The class was divided into twelve groups (A to L) and each group counted the numbers of animals (black ants, red ants, grass hoppers, spiders and beetles) in its plots. The table below shows the record of the counts made by all the twelve groups.

Population study by direct counting.

Types of Animals	Number of Animals in each Plot											
	A	B	C	D	E	F	G	H	I	J	K	L
Blacks Ants	30	25	6	7	20	26	10	4	27	11	30	20
Red Ants	25	2	17	5	0	4	4	23	4	61	45	25
Grass Hoppers	8	3	2	9	2	7	3	6	11	8	12	5
Spiders	1	1	2	1	1	1	2	6	1	3	12	4
Beetles	0	0	0	2	2	0	0	2	0	0	0	1

a. From the above data calculate:

i. The total area of the study plot.

ii. The population of black ants in total plot.

iii. The population of grass hoppers in the total plot.

b. Which of these animals has the highest population of its kind on the plot.

c. In six months the population of the organisms in this area will have changed. Give any three reasons for such a change.

d. State one use of each of the following instruments:
   i. Rain gauge
   ii. Sweep net
   iii. Thermometer

APPENDIX II
MARKING SCHEME

1. a. Shrinkage of the cell/shrink.

(1 mark)

b. Plasmolysis.

(1 mark)

2. - Seed that contains a seed leaf for nutrition of the embryo.

- A seed that contains nutritive tissue that surround and nourishes the embryo (Any one).

(1 mark)

3. - Heating - Chemical application/treatment
- Freezing - Smoking
- Salting - Iradiation/sun drying

(Any 3 1 mark = 3 marks)

4. a. i. Storage/formation of substances which are important in the metabolism of the organism.

(1 mark)

ii. Chlorophasts.

(1 mark)

b. i. Energy - production.

(1 mark)

ii. - Carry heredity factors of the cell called genes.

- Guide development and natural organisation of the organism.

(Any 1 x 1 mark = 1 mark)

5. a. Hepatic protalvein.

(1 mark)

b. - They both have special vessel for transportation.

- They both branched to different parts of the organism

- They both operates in a system of tubes.

(Any 2 x 1 mark = 2 marks)

6. a. Plant characteristics:

- Possess chloroplast/chlorophyll.
- Nutrition is holophytic, produce foood by photosynthesis.

b. Animal characteristics:

- Outer covering is a flexible pellicle, no rigid wall.
- Moves from place to place by flagella and (pellicle).
- Possess contractile vacuole (for osmoregulation).
- Possess a gullet and reservoir.
- Possess an eye spot (stigma)/(a light sensitive organelle).

(Any 2 x 1 mark = 2 marks)

7. a. Variegated leaf (ice plant).

(1 mark)

b. - A part of the leaf (green) contain chlorophyll while a part is white and does not contain chlorophyll.

- You can use the same leaf to test for starch and have its control at the same time.

(Any 1 x 1 mark = 1 mark).

c. You can allow the plant to stand in sun-light for at least three hours to allow starch to be formed.

(1 mark)

d. X - will not turn blue black.
Y - will turn blue black.

(Any 1 x 1 mark = 1 mark)

e. - To find out if chlorophyll is necessary for photosynthesis.

- To find out if starch is formed during photosynthesis.

(Any 1 x 1 mark = 1 mark)

8. Axial Skeleton - Skull
- Vertebral column (backbone)
- Ribs
- Sternum (breast bone)

(Any 2 x 1 mark = 2 marks)

9. - Destroy bacteria by ingesting them.
- Secrete chemicals called antibodies.

(2 marks)

10. a. Larva of mosquito/Larva of culex mosquitor.

(1 mark)

b. X - breathing tube/(Siphon).

(1 mark)

c. Pupal stage.

(1 mark)

TOTAL = 30 MARKS)

<u>SECTION B</u>

11. a. i. Specimen A is mango/oil palm/coconut fruit
Specimen B is tridax/emilia
Specimen C is tomatoe/guava

(3 marks)

ii. Drawing of specimen A:

<u>Quality of drawing:</u>
M - Magnification (X half - X1)

(1 mark)

S - Size (6-8 cm) (1 mark)

C - Clarity of lines (half allowed)

(1 mark)

<u>Details</u>

DL - Double lines for cut surface
ED - Hard endocarp shown
MS - Soft mesocarp shown

(3 marks)

<u>Labels</u>

Epicarp, mesocarp, endocarp, seed.

(2 marks)

iii. Drupe

- Hard endocarp
- One seed

(3 marks)

b. i. Specimen A - hard endocarp
- succulent mesocarp
- bright colour

(Any 2 x 1 mark = 2 marks)

Specimen B - hariy parachute
- light (easily carried by wind)

(2 marks)

ii. Specimen A - man
Specimen B - wind

(2 marks)

c. Similarities:

Mango (A)	Tomatoe/Guave (C)
- Seed present	- Seed present
- Contain 3 layers epicarp, mesocarp and endocarp	- Same
- Succulent mesocarp	- Same

(Any 2 x 1 mark = 2 marks)

Differences:

Mango (A)	Tomatoe/Guava (C)
- One seed	- Many seed
- Hard endocarp	- Soft endocarp
- Placentation marginal	- Axial placentation

(Any 2 x 1 mark = 2 marks)

TOTAL = 24 MARKS)

12. a. Specimen D - Earthworm
Specimen E - Cockroach
Specimen F - Fish
Specimen G - Toad

(4 marks)

b. Specimen D - Skin (moist)
Specimen E - Spiracle/Trachea
Specimen F - Gills
Specimen G - Lungs (pulmonary)/mouth (Bucal)/ cutaneous (skin)

(4 marks)

c. i. Habitat of E - Dark cupboard/drawer and darkened rooms in small cracks (Terrestrial)

ii. Habitat of F - (Equatic) - ponds/lakes

iii. Drawing of Specimen D:

Quality of drawing:

M - Magnification (X half - X1)
(1 mark)

S - Size (10-12 cm)
(1 mark)

C - Clarity of lines (half alllowed)
(1 mark)

Details

CL - Clitellum
CH - Chaetae (setae)
SG - Segment
(3 marks)

Labels:
Head, mouth, prostomium, peristomium, chaetae (setae), clitellum, segment, sperm grove, reproductive openings.

Any 4 x .5 mark = 2 marks)

TOTAL = 20 MARKS

13. a. i. Total area = Length x Breath
20 x 15 sq. m.
= 300 sq. m
(1 mark)

ii. Population of black ants in plot H = 4
(1 mark)

iii. Population of grass hoppers in the total plot
8 + 3 + 2 + 9 + 2 + 7 + 3 + 6 + 1 + 8 + 12 + 5 = 66
(1 mark)

b. Animal with the greatest number of the individual of its kind is the black ants, total 316 individuals.
(1 mark)

c. - Reproduction
- Death
- Emigration
- Immigration
- Regulation by themselves one animal feeding on another (all these could be in sentences).

(Any 3 x 1 mark = 3 marks)

d. i. Rain Gauge - Used to measure amount of rainfall that falls at a time.

(1 mark)

ii. Sweep Net - To catch flying insects such as butterfly or grass hoppers. Insect name may not be mentioned.

(1 mark)

iii. Thermometer - To measure the temperature of the surrounding.

(1 mark)

TOTAL = 10 MARKS

OVERAL TOTAL = 82

MAXIMUM SCORE = 80

APPENDIX III

Department of Education
Ahmadu Bello University
Zaria.

Dear Sir/Madam,

I am undertaking a research study on error patterns in Senior Secondary Students' Biology Practical Examination scripts. This is for my M.Ed. Thesis in Science Education Department, Ahmadu Bello University, Zaria.

Attached are:

1. Questions set.
2. Marking Scheme
3. Possible types of errors in Biology SSCE Practical Examination Scripts.

I will be very grateful if you can help match the various errors types that may be associated with each question.

Your comments and critisms are sincerely welcomed. Thank you for your anticipated co-operation.

Yours faithfully,

K. F. LAWAN (MRS)

APPENDIX IV

Department of Education
Ahmadu Bello University
Zaria
29th March, 1993

The Zonal Director
Ministry of Education
Zaria-Zone

Dear Sir,

COLLECTION OF RESEARCH DATA

The bearer Mrs K.F. Lawan is conducting research in Science Education for a degree in M.Ed (Science Education) Biology.

The title of the research is **Error Analysis of practical Biology in Senior Secondary Schools in Zaria.**

The Department of Science Education will be grateful if you could permit her to collect data at the following schools.

1. Government Girls Secondary School Kofan Gayan
2. Government Girls Secondary School Samaru
3. Government Secondary School Chindit Barracks
4. Government Secondary School Barewa.

Thank you for your continued co-operation with us.

Yours sincerely

Supervisor

APPENDIX V

Faculty of Education
Ahmadu Bello University
Zaria
29th March, 1993

The Principal,

Dear Sir/Madam

Request for permission to meet with SS III Biology Students

The bearer of this letter is Mrs K. F. Lawan, an M.Ed candidate in Science Education. She is currently carrying out research for her M.Ed thesis under my supervision.

Her research is geared ttowards common errors students make in their practical Biology that could make them achieve low marks.

I shall be most grateful if you could kindly permit her to meet with the above students at a convenient time.

Any assistance you can give in this matter will be highly appreciated.

Thank you.

Yours sincerely

Supervisor.

APPENDIX VI

ANALYSIS OF RESULTS IN SELECTED SUBJECTS AT THE SENIOR SCHOOL CERTIFICATE LEVEL 1988 - 1990

(From West African Examinations Council, Yaba, Lagos (1991) Senior School Certificate Examinations - June 1988 and Nov/Dec 1989-90
Nigeria Statistics of Entries and Results)

Subject	Year	Candidate	Percent Grades 1-6	Percent Grades 7&8	Percent Grades F9	Remarks
	1988	62 712	30.8	25.9	43.3	
Agric.	1989	63 690	20.0	40.5	39.5	
Science	1990	150 587	25.1	39.3	35.6	
	1988	89 342	9.3	16.3	74.4	
Biology	1989	87 710	11.8	22.3	65.9	
	1990	190 386	15.7	30.8	53.5	
	1988	34 508	20.7	24.6	54.7	
Chemistry	1989	35 702	10.8	26.7	62.5	
	1990	80 059	4.1	20.8	75.1	
	1988	26 297	31.5	15.3	53.2	
Physics	1989	28 524	9.5	26.9	63.6	
	1990	63 161	20.1	32.2	52.3	
	1988	93 657	11.0	28.3	60.7	
Mathematics	1989	91 142	8.8	30.0	61.2	
	1990	195 133	10.6	37.3	52.1	
	1988	92 529	7.7	20.2	73.1	
English	1989	91 665	9.0	18.3	72.7	
	1990	195 840	6.3	21.6	72.1	
	1988	33 194	18.5	25.3	56.2	
Hausa	1989	38 826	34.8	19.8	45.4	
	1990	46 848	24.3	24.0	51.7	
	1988	26 833	44.7	34.2	21.1	
Igbo	1989	25 845	60.0	30.0	10.0	
	1990	45 254	41.0	30.2	28.8	
	1988	230	67.8	15.2	17.0	
Yoruba	1989	625	46.0	20.4	33.6	
	1990	30 907	35.4	25.6	38.7	

APPENDIX VI (contd.)

Subject	Year	Candidate	Percent Grades 1-6	Percent Grades 7 & 8	Percent Grades F9	Remarks
	1988	26 985	21.5	33.3	45.2	
History	1989	22 183	31.1	20.2	48.7	
	1990	37 227	33.6	24.7	41.7	
	1988	47 539	29.6	10.0	60.4	
Geography	1989	50 914	29.0	18.0	53.0	
	1990	115 213	39.6	15.5	44.9	
	1988	25 931	36.9	14.3	38.8	
Government	1989	24 837	45.1	28.7	26.2	
	1990	69 611	41.4	34.8	23.8	

APPENDIX VII

a. The formula used for Krushkal-Wallis is

$$\text{Krushkal-Walls, } H = \frac{12}{N(N+1)} \, E\frac{Ti^2}{ni} - 3[N+1]$$

where N = total number of observation in the analysis.
Ti = Sum of ranks in each group
ni = Number of observations in each group.

b. The formula used for Pearson Produc Moment Correlation Coefficient is

$$PPMC = \frac{XY - \frac{(EY)\,(EY)}{N}}{\left[EX^2 \frac{(EX)^2}{N}\right]\left[EY^2 - \frac{(EY)^2}{N}\right]}$$

where X = total errors
Y = total mark obtained
N = total number of subjects.

c. $$Qc = \frac{X^2}{X^2 + N}$$

Where Qc = Coefficient of determination
X^2 = Chi-Square value
N = Number of Subjects

APPENDIX VIII

TABLE Test-Retest Results Analysis

STUDENTS	TEST A	TEST B	Input Column
1	19.00	20.00	
2	3.00	6.00	
3	30.00	28.00	
4	5.00	10.00	
5	24.00	35.00	
6	9.00	10.00	
7	2.00	3.00	
8	8.00	10.00	
9	22.00	13.00	
10	3.00	4.00	
11	4.00	10.00	
12	16.00	20.00	
13	11.00	13.00	
14	5.00	9.00	
15	6.00	10.00	
16	7.00	7.00	
17	2.00	6.00	
18	5.00	6.00	
19	7.00	6.00	
20	16.00	25.00	
21	22.00	23.00	
22	3.00	3.00	
23	8.00	1.00	
24	8.00	0.00	
25	6.00	8.00	
26	6.00	8.00	
27	3.00	5.00	
28	.6.00	24.00	
29	50.00	62.00	
30	60.00	65.00	
31	7.00	9.00	
32	10.00	13.00	
33	12.00	18.00	
34	45.00	48.00	
35	13.00	18.00	
36	9.00	15.00	

Correlation Matric

	Test A	Test B
Test A	1.000	.971
Test B	.971	1.000

36 observations were used in this computation.