RELATIVE EFFECTS OF SELECTED COMMUNICATIONAL STRATEGIES IN SOME BIOLOGY TEXTBOOKS ON HIGH SCHOOL STUDENTS' LEARNING IN BIOLOGY

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ABSTRACT

Textbooks have consistently been accepted as an important companion of science teachers and students. With apparent inadequacies of laboratory equipment and facilities, coupled with the unwillingness of science teachers to explore their environment sufficiently, most science teachers had struck faithfully to textbooks as an easily accessible instructional aid in shaping their knowledge in science. Today, textbooks have been seen as a critical component of courses than contact with actual living material. In addition to their roles as an instructional aid, textbooks have for sometime remained as a source of information. In many developing countries, particularly in Africa and Asia, science has been largely held as a foreign knowledge whose understanding can best be appreciated and understood only by reading textbooks.

This great dependence on books places a premium on the value, quality and significance of textbooks in impacting scientific knowledge and understanding. The pertinent and crucial question is, "To what extent should textbooks serve as facilitators of scientific knowledge and learning in terms of effective incorporation of desirable communicational

strategies?" This study had attempted an answer to this complex and multi-faceted issue.

In seeking an answer, an attempt was made in identifying desirable communicational strategies expected in a biology textbook. Further efforts were also made to find out if four commonly used biology textbooks in Nigeria are indeed within the comprehension level of students. Having identified the various communicational strategies in the four textbooks, the relative effects of selected strategies on secondary school students' learning was consequently focussed upon. Formm four secondary school students (N = 154) drawn from three (two for experimental, and one for control groups) selected schools in Oyo State, Nigeria were involved in the study.

In addition, 50 people (which included teachers, students, education officials, publishers and authors) were involved in a survey relating to desirable communicational strategies in a biology textbook. For the experimental setting, cognitive achievement in biology, the level of development of scientific attitudes and the level of acquisition of practical skills were the dependent variables of the study. The independent variables included the textual communicational strategies, age and sex of the subjects. The Solomon-3 design was used for the data gathering. All the subjects were pretested, treated for six weeks and post-tested on all dependent measures.

The result of the study revealed the following:

1. There were significant differences in the number of factual, leading, probing and terminal questions in the four biology textbooks examined.

2. There were significant differences in the number of technical terms defined at; first occurrence, immediately after occurrence, later in the text and those not defined in the four biology textbooks examined.

3. There were significant differences in the number of local and non-local specimens, labelled/ unlabelled diagrams, labelled and unlabelled pictures contained in the four biology textbooks examined.

4. There were significant differences in the number of evolutionary, ecological, economic importance, inquiry, historical and knowledge themes in the four biology textbooks.

5. There was no significant differênce in the number of traditional world-view themes represented in the four biology textbooks.

6. There were significant differences in the number of simple, specific, general and challenging practical exercises contained in the textbooks examined.

7. There were significant differences in the views of authors, teachers, publishers, ministry officials and students in their preferences for questioning styles, specimens, pictures/diagrams, practical exercises, major themes and physical characteristics of biology textbooks.

8. There were significant differences in the cognitive, affective and psychomotor performances of the experimental and control group subjects with respect to questioning styles, technical terms, specimens, pictures/diagrams, major themes and practical exercises.

On the basis of the findings, the following recommendations were made;

1. To promote cognitive, affective and psychomotor performances in biology, teachers should identify the merits of communicational strategies in biology textbooks, and make these textbooks available for teachers' and pupils' use. They should also use in planned sequence, identified strategies in their teaching.

2. Authors and publishers should make use of a variety of communicational strategies in the preparation of biology textbooks. They should be conscious of the comprehensibility of the learning material they are presenting. A constant review of published textbooks should be made along identified merits.

3. Ministry officials should involve practioners in the education sector in the selection of textbooks for students' use.

4. School libraries could be supplemented by the location of community/district libraries for a number of schools that do not have libraries.

5. A regular forum (Seminars, workshops) should be organised for officials, publishers, authors, teachers and students where exchange of ideas on the merits of identified communicational strategies in textbooks can be discussed.

DEDICATION

Two individuals have consistently given me joy and inspiration - my son, Adefemi Adesanya Adelekan and my father Samson Adegbenro Adelekan. To 'Femi who on many occassions stayed behind while I am working till late in the night - calling Daddy, and my father for his implicit confidence in education as a vehicle of social mobility, I lovingly dedicate this work.

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CERTIFICATION

I certify that this work was carried out by Mr. A.I. Adelekan in the Department of Teacher Education, University of Ibadan, Ibadan.

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ABBREVIATIONS

The following abbreviations have been used in the text of this thesis:

C	-	Control group
C.S.S.	-	Communicational Strategies Survey
E_1	-	Experimental Group 1
E_2	-	Experimental Group 2
N. S.	-	Not Significant
R. I.	-	Readability index
S	-	Significant
S.A.T.	-	Students' Achievement Test
S.A.T.T.	-	Students' Attitudinal Test
S.E.P.A.	-	Science Education Programme for Africa
S.P.A.I.	-	Students' Psychomoter Assessment Inventory
S.P.T.	-	Students' Psychomoter Test
S.S.T.	-	Subjects Selection Test
STAN	-	Science Teachers Association of Nigeria
T.B.A.	-	Textbooks Analysis
W.A.E.C.	-	West African Examinations Council
$>$	-	Greater than
$<$	-	Less than

DEFINITIONS OF TERMS

In this study a number of terms have been used which require operational definitions.

They are as follows:

Communicational Strategies: A process, method or ways of planning, executing and giving information by verbal and /or non-verbal activities sufficiently meaningful to a recipien in a way to elicit maximum response from the recipient.

Contextual Questions: Are those questions used within the meaning of the subject-matter being discussed or the textual material.

Inquiry Theme: Is concerned with the attempt directed at finding out more about a phenomenon, object, event or situation presented in a textual material or learning episode.

Leading Question: These are questions that are concerned with guiding or directing the reader to an answer given later on in the text.

Pictures and Diagrams: Are the illustrative two-dimensional drawings, sketch representation, photograph or visual images of an object, process or system used in the textbooks.

Practical Exercises: These are practical exercises involving casual observation, setting up of an experiment by a student, group of students or the teacher in order to demonstrate a highly specialised knowledge or skill.

Probing Questions: These are questions that require the reader to give free expressions, personal opinions or an evaluative judgement.

Specimens: These are foreign or locally available organisms, which may be either preserved or living.

Technical Terms: Are biological terminologies which may be defined in the text or left undefined.

CHAPTER ONE

INTRODUCTION

Background to the Study

Researchers in education have acknowledged the important role that books can play in the dissemination of knowledge. Books are indispensable to most teachers and their students. This is because books serve as the very point of contact between the curriculum proper and the actual learning materials. In other words, books are means to an end in the process of disseminating information in any particular field. Since the documentation in 1932 of, "The teaching of general science", by the Science Masters Association of Britain, there has been major reforms of science curricular materials in many European, Asian and African countries.

A cursory review of the history of science teaching in Africa would reveal a general awareness of the need to make science functional and relevant to the growing and challenging needs of developing economies. Ogunniyi (1978) identified that in the earlier stages in most African countries, the science curricula was in the form of syllabuses of the different science subjects developed for examination purposes. It was assumed that certain aspects of the curriculum would grow, while others would die a natural death - a phenomenon akin to natural selection in the evolutionary process. The immediate consequence of this strategy, was the clustering of the curricula with materials that presented an inadequate view of science.

With the attainment of self-government and the concormi-nant realities and challenges in the 1960's, many African countries began to examine the place of science and science teaching in the overall manpower development process. To tackle the problem of shortage in scientific manpower, several ministerial conferences were held. These include among others those held at Tenanarive (1962), Addis Ababa (1962) and Lagos (1974). A UNESCO Report (1974) of the Yaounde (1967) symposium acknowledged the efforts of many African governments at science planning, decision-making and co-ordination (Ogunniyi, 1986).

Cessac's (1963) survey of the status of science teaching in tropical Africa showed shortages in virtually every area of science teaching. The facilities were grossly inadequate. The laboratory assistants were in short supply. The laboratory conditions including the availability of electricity, water, gas, apparatus etc. were below expectation. Apart from this broad survey, reports from various countries showed that sci science teaching in these countries was of a poor quality (Weaver, 1964; Kalamanathan, 1970;

Gilbert and Lovegrove, 1972; Taibo, 1975; Ogunniyi, 1977; Orisaseyi, 1977). All these studies showed that the type of science being taught in Africa could not prepare students adequately for future careers in science. The implications of this state of affairs in a continent aspiring for scientific and technological development are self-evident and may not require further comments.

Recently, Yoloye and Bajah (1981) found that despite the significant efforts made at improving the status of science teaching, most African countries had not attained the ambitious target set at the 1961 Addis Ababa conference.

Ogunniyi (1982) has adduced some reasons for the deplorable status of science teaching in Africa. These include among others:

(i) the rapid increases in students population;

(ii) the acute shortage of funds and laboratory facilities characteristic of most consumership economy;

(iii) the shortage of trained science teachers and laboratory assistants;

(iv) the rapid transfer rate of teachers from one school to another or outside the classrooms;

(v) the negative effects of external examinations, and

(vi) the rapidly changing socio-political and educational policies.

In spite of the sorbid state of affairs sketched above, various attempts have been made to improve the quality of science teaching in the schools. The present poor status of schools. science is a product of several decades of lack of curriculum planning. As stated earlier, the science curriculum was not perceived beyond the examination syllabuses. Therefore, the overall aim of science education was totally missing. But from the 1960's efforts, the picture begun to change for the better.

According to Yoloye and Bajah (1981), the process of curriculum development is perhaps the most remarkable change that has taken place in the educational system of many African countries. However, the 1960 conference in Rehovolt, Israel - "The Curriculum Development of New States", and the 1961 conference at the Massachusettes Institute of Technology, U.S.A. served as the catalyst to curriculum development efforts in Science and Mathematics in African countries. It is generally accepted, however, that the 1965 conference in Kano, Nigeria which gave birth to the African Primary Science Programme could be regarded as the real watershed of curriculum development efforts in science in African countries.

In addition, it is worthy to note that several organisations like UNESCO, African Curriculum Organisation (A.C.O), Ford Foundation and Rockefeller Foundation have taken active part in the development of new science curricula in Africa. Other bodies that have aided the development of science curriculum process in Africa include: the International Council of Associations for Science Education (ICASE), World Confederation of Organisations of the Teaching Profession (WCOTP), Commonwealth Fund for Technical Cooperation (CFTU), International Council of Scientific Unions (ICSU) and USAID. The World Bank has provided aids ranging from financial assistance, supply of laboratory equipment, textbooks and teaching aids, to that of trained teachers and instructors (Ogunniyi, 1986).

A significant aspect of science curriculum development in Africa has been the emergence of educational development units and centres. These have been the generating focus of science curricula, textual materials, supportive instructional and teaching aids. Also, the role of national and international teachers association in science curriculum development has been significant. These various bodies include, the African Association for the Advancement of Science and Technology (AAAST), West African Association of Science Associations (WASA), West African Association of Science Teachers (WAAST), Forum of Africa Science Educators (FASE) and Science Teachers Association in various countries (Nwana, 1980).

It is crucial to emphasize that the revolution in science curriculum development in the United Kingdom and U.S.A. has had a significant impact on science curriculum development in Africa. A comparison of the general principles and products of science curricula in these countries with those in Africa would easily reveal obvious similarities. Balogun (1978) and Ogunniyi (1986) have provided summaries of the said similarities between the science curricula developed in the West and those developed in Africa.

As a result of curricular reforms in science, the Examining Bodies have begun to set questions compatible with newly developed science curricula. For example in Nigeria, a request was made in 1968 by the West African Examination Council (WAEC) to the Science Teachers Association of Nigeria (STAN) for assistance in the review and improvement of WAEC science syllabuses. Prior to this period, members of STAN had identified (STAN Newsletter, 1970) that if science subjects are taught with an enquiry approach, science would be able to contribute to the nation's socio-economic development.

The direct consequence of various major curriculum reforms alluded to above and the changes in the methods and the content of science that followed, have brought into focus the need for teachers to acquire new instructional skills and strategies. For instance, individualised instruction and learning, resource-based learning and mixed ability classes, demand that materials be used effectively by individuals or groups for the maximum benefit of individual pupils. Consequently, researches in education have turned their attention to the form, content, communicational strategies, presentation, storage and retrieval of acquired scientific knowledge.

Uche (1979) observed that the most important means of obtaining vicarious experiences in science at the secondary school level was by reading. As students make progress, the learning and reading tasks become more challenging, diffused, complex and abstract. With the tremendous increase in students population in Africa - especially Nigeria, and the attendant problems, it has become imperative to provide an adequate science education for a greater number of students rather than a selected few.

With the gradual emergence of textbooks as a predominant teaching aid, it is still possible and increasingly desirable for different teachers to approach their subjects in a creative manner. A close association of textbooks, schools and teachers can provide a dinstinct measure of freedom for individuals to choose and decide on the value and quality of instructional materials. Consequently, a relevant question is, "What are desirable qualities of a science textbook?" This study has been designed to attempt an answer to the crucial dimension of examining the effects of communicational strategies in some biology textbooks on high school students learning.

Lewy (1977) asserts that textbooks must be prepared to meet and suit the needs, interests and abilities of a defined student population. McAllister (1971) had observed that in most novels, the themes chosen are largely too mature, the style too comtemplative, too philosophic and necessarily weighted with description. Priare (1970) had however accordingly pointed out that it is important for writers and authors to identify the concepts, images and language that students best understand when conceptualising on a work meant for an age grade.

One of the challenges facing educational practice, is how to meet the individual student's needs, aspirations and capacities. Bailey (1962), observed that a textbook is usually judged on the basis of the facts it contains, the clarity of its exposition to beginners, the validity and the enthusiasm with which it presents results of science to students. In the same way, Major and Collete (1961) had indicated that textbooks should be written to the comprehension level of students for whom they are intended. In ascertaining the ingredients for a functional education, Thomas (1978) pointed out that the needs of students should be identified in line with the learner's capacities, interest and inherent differences.

In Nigeria, students rarely have a say in the choice of textbooks being used in the school. In such a setting, it is imperative to note the warning by McAllister (1971) when he pointed out that textbooks selection should be based on the fact that adolescents do not have the same perspective and experiential background as the adult. This is a crucial factor that has to be considered when a textbook is to be adopted for students.

According to Evans (1976), most teachers and students had come to regard printed words as infallible. In most classroom interactions, many teachers rely almost exclusively on textbooks to shape their instruction in science (Piltz, 1961). Consequently, as Gould (1977) pointed out, textbooks have remained an indispensable teaching aid. Textbooks have been accepted as critical components of courses than contact with actual living materials, and they have successfully remained valuable sources of information for illustrations and as a descriptive guide.

The situation in most developing countries as Ogunniyi (1982) observed, is an over-dependence on textbooks. He ascribed this dependence to acute scarcity of laboratory facilities, the need to cover examination syllabuses and the fact that teachers are not sufficiently motivated to explore their environment.

With the great premium placed on textbooks as an indispensable facilitator of learning, there has been recent efforts in the examination of biology **textbooks used in Nigerian** secondary schools (Balogun, 1978; Ogunniyi, 1982). These studies have complimented other research efforts on textual materials analysis (Wahome, 1970; Yoloye, 1975; Uche, 1979; Jegede, 1982; Okpalla, 1982). These studies have concentrated on the survey of biology textbooks in terms of their popularity and types in secondary schools. The findings of the studies warrant the need to determine empirically the quantitative effects of identified communicational strategies on students' learning.

Need for the Study

In the development of relevant and viable scientific knowledge, researches in science education have focussed on curriculum reforms and changes in the methods and the content of school science. Other areas of interest include analyses of the quality and merit of textbooks and classroom textual reading materials as effective teaching aids (Priare, 1970; McAllister, 1971; Lewy, 1977; Uche, 1979).

All these studies on textbooks have only isolated the qualitative merits of the materials in terms of their suitability, rather than their quantitative impact on student learning. In other words, they have been concerned largely with the researchers' point-of-view of the comprehensibility and adequacy of classroom reading materials rather than their direct effect on student achievement in science.

Researchers in science education have also identified the need to have textbooks that are relevant to the needs, interest, experience and capacities of the individual child (Bailey, 1952; Major and Collete, 1961; McAllister, 1971; Thomas, 1978). Although the need for acceptable resource materials has been recognised, there seems to be an equal need to ascertain emperically the advantages and difficulties associated with such resource materials.

Studies on science textbooks have isolated a number of factors critical to the quality or suitability of such textbooks. These include the length of the sentences, the type of style, questions, pictures, diagrams and other aspects of communication (Piltz, 1961; Evans, 1976; Gould, 1977; Balogun, 1978; Ogunniyi, 1982). There is no doubt that all these studies have provided useful information about the quality of good biology textbooks. However, they have neglected the vital area of the direct impact of such textbooks on student achievement. This study has been designed to provide some information in this area.

The Problem

The aim of this investigation was to examine the relative effects of selected communicational strategies in some biology textbooks on high school students' learning. In pursuance of this objective, answers were sought to the following questions:

1. Are there differences in the frequency of questioning styles, technical terms, major themes, diagrams and pictures, specimens and practical exercises used in the four biology textbooks involved in this study?
2. Are there differences in the cognitive, affective and psychomotor performances of three groups of high school students relative to certain communicational strategies viz: style of questioning, defined terms, local specimens, labelled diagrams and pictures, an inquiry method and challenging practical exercises?
3. Are there differences in the readability indices of the four biology textbooks: Mackean, Ewusie, Stone and Cozens and STAN Biology used for this study?

Research Hypotheses

In seeking answers to these questions, the following Null hypotheses were posited for testing:

Hypothesis 1 (Ho_1): There is no significant difference in the frequency of questioning styles, technical terms, major themes, diagrams and pictures, specimens and practical exercises used by the four biology textbooks involved in the study.

Hypothesis 2 (Ho_2): There is no significant difference in the cognitive, affective and psychomotor performances of high school students exposed to selected communicational strategies such as styles of questioning, defined terms, local specimens, labelled diagrams and pictures, an inquiry method and challenging practical exercises and those not so exposed.

Hypothesis 3 (Ho_3): There is no significant difference in the readability indices of the four biology textbooks: Mackean, Ewusie, Stone and Cozens and STAN Biology used for the study.

Scope of the Study

The study was limited to class Four biology students in secondary schools located in Ibadan. It involved an emperical determination of textbooks readability indices, an analysis of communicational strategies in the selected biology textbooks, and the relative effects of the strategies on students' learning. The study did not examine the effects of mediating variables such as sex, home environment and teachers personality.

The main focus was to examine the relative effect of selected communicational strategies in four biology textbooks on the affective, cognitive and psychomotor domains of the students learning.

The survey on communicational strategies involved in the study was limited to producers and consumers of biology textbooks. All the respondents were resident in Ibadan.

The textbooks used in the study were limited to four: Mackean, Ewusie, Stone and Cozens, and STAN Biology. The first three were chosen on the basis of Balogun (1978) study that they were the most popular Biology textbooks in use among secondary schools in Oyo State. STAN Biology was the fourth textbook used in the study, because of the national popularity and acceptability of STAN Integrated Science earlier published by STAN, and the likelihood of this textbook becoming a very popular one in Nigerian schools.

Assumptions

In carrying out this study, it was assumed that:

1. The identified communicational strategies used in the experimental setting, will elicit the same responses from the students as those strategies contained in the textbooks examined.

2. The students involved were representative of class four students in Oyo State.

3. The textbooks are still or will be (as in the case of STAN Biology) popular in Oyo State secondary schools.

4. The viewpoints of respondents involved in the communicational strategies survey are reflective of the respective groups involved in the study.

5. The practical lessons observed are reflective of the practical lessons in Oyo State secondary schools.

Significance of the study

In an increasingly technological conscious society as ours, the need to find ways and means of equipping the learner with necessary scientific knowledge, skills and attitudes has become a matter of urgent necessity. To cope with the challenges, researchers have focused on the determination of minimum scientific knowledge, needed for a functional and scientific conscious citizen (Ivowi, 1983; Ogunniyi, 1983; Abdullahi, 1983; Okebukola, 1984;

Olarinmoye, 1983; Shuaibu, 1983; Obanya 1983).

Researches in science education have been greatly involved in determining the place of such things as the teaching methods, classroom organisation and interactional patterns, teachers and students attitudinal disposition, and psychomotor development, including examination of the relative effects of instructional facilities amongst others in the learning of science.

Good as many of these studies have been however, very little attention has been paid to the place of textual materials in the learning of science. This is not to say that researchers are not aware of the importance of textbooks to learning in an environment with scarce facilities, but rather that such awareness has not resulted in detailed empirical studies. Till date, only a few studies have been carried out in the area (Ogunniyi, 1982; Guthrie, 1972; Wahoure, 1979; Jegede, 1982; Okpalla, 1972). This study is a follow-up of earlier studies. It is an attempt to examine in detail, different aspects of the communicational strategies used in textual materials which hitherto have either not been examined at all, or have been treated rather superficially.

Balogun's (1978) determination of the relative popularity of biology textbooks, and Ogunniyi's (1982) analysis of the communicational strategies used in some biology textbooks, have provided the necessary stimulus and inspiration for this study.

An important aspect of the present study was to determine the adequacy of selected biology textbooks in terms of the level of readability and comprehension for the intended readership. This entailed a critical analysis of the content and communicational strategies used to dissiminate the content.

It is hoped that the viewpoints of the producers and consumers of the biology textbooks would shed some light on vital factors that make a textbook relevant and popular. It is also hoped that the findings of this study would provide useful information for teachers and researchers with respect to the relative values of the selected communicational strategies - especially as they affect learning in biology. Similarly, authors and publishers might find the outcomes useful and informative in the development of new biology textbooks in Nigeria.

Limitations of the study

The study had the following limitations:

1. Within the six weeks experimental period, only a single teaching unit -NUTRITION- was taught. This of course places some constraints on the generalizability of the findings.

2. Because of the complexity of the communicational strategies involved in the experimental setting, the number of items selected for each strategy in the SAT, SATT and SPT was limited.

3. With inadequate laboratory facilities and acute shortage of biology teachers, the school authorities were unwilling to distrupt class schedules for experimental purposes. Invariably, the study was limited to intact classes.

4. The participating teachers for the treatment and the control groups had an initial difficulty following the designed notes of lesson. To these teachers, the notes placed some limitations on their individual style of teaching, methodology, strategy and presentation.

5. The participating teachers also had the difficulty of applying the Practical Test Assessment Inventory (PTAI) during the collection of pretest data on practical skills. The difficult arose from the limitations posed to the individual teachers ability to assess the criteria laid out in the instrument.

CHAPTER TWO

THEORETICAL FRAMEWORK AND REVIEW OF RELATED LITERATURE

Introduction

This investigation deals with the relative effects of selected communicational strategies in some biology textbooks on high school students learning. In this chapter, an attempt has been made to discuss the studies within a theoretical research context. For most empirical studies, this is largely not only a convention, but also a desirable format in which a proper perspective can be easily discerned.

For this study, the temptation exist for one to see the study as an investigation of instructional strategy per se. However, this study was concerned with determining the quality and the potential of a group of biology textbooks for meaningful study of biology. Another aspect of the study was to examine the relative effects of the communicational strategies employed by the textbooks on achievement in biology.

For more than two decades, science educators had established that science teaching can be most effective within the framework of a process of inquiry method (Gagne, 1965; Scott, 1966). With this awareness, researchers have been working on factors that can assist enquiry behaviour. Schwab (1962) and Suchman (1965) primarily ascertained that questions and questioning are good facilitators of an enquiry behaviour. Consequently, science educators have identified a dynamic relationship between questioning and inquiry behaviour (Bossing, 1962; Scott, 1966; Scheriber, 1967).

As evident today, one of the current emphasis in science education is the presentation of school science as a forum of enquiry (Schwab, 1962; Ogunniyi, 1982). In other words, the enquiry approach has become a central theory of instruction.

Related to an enquiry approach and sometimes used interchangebly is the discovery approach in science teaching. However, researchers have been greatly divided as regards the communicational strategy that can best promote discovery teaching. In a rather general perspective, Wilson (1969) played safe when he observed that the art of questioning can generally be said to be the essence of discovery teaching.

What sort of questions normally envince enquiry behaviour?

Although there is no general consensus about this, most researchers agree that contextual, leading and probing questions facilitate enquiry behaviours (Stevens, 1912; Gall, 1970; Rowe, 1974; Ogunniyi, 1981; Carrick, 1982).

Research efforts have also yielded some results in ascertaining the merits and the demerits of other communicational strategies such as technical terms, specimens, diagrams, themes and practical exercises in the effective dessimation of scientific knowledge (Kerr, 1963; Evans, 1976; Ogunniyi, 1982; 1983).

It is generally accepted that effective communication is an important factor in a teaching-learning situation. Central to this factor is the issue of understanding and comprehension. These include such parameters as value, nature and merit of a teacher's personality, his experiences, qualification and competence. In addition to this are such factors as the instructional methods, learning environment and pupils attitudes.

But while the teaching method is crucial to learning, the varying and divergent instructional aids that compliment verbal and nonverbal interactions are also essential.

The learning aids play complimentary roles in supporting other instructional strategies in ensuring that materials to be learned are made more meaningful, relevant and practicable than they would have otherwise been.

With the realisation that books are easily the most common, accessible and readily available instructional facility, it is crucial that we determine their potentials to the teaching-learning process. It is not enough to know that textbooks are in abundant supply, but also to determine emperically that they are contributing to learning. The implication is that we would be concerned not only with the quantity, but also the quality of reading materials available to the teachers and learners.

Fry (1964) was concerned about this issue. He stressed that the selection of the right reading materials for pupils is one of the most crucial jobs of the teacher. If a teacher gives his students a reading material which are found difficult or incomprehensible, the students would soon become bored and lose interest in the reading material.

Some attempts have been made by a number of investigators to determine the readability of certain science textbooks.

The assumption here is that a book with a **high readability** index is likely to constitute a problem to the reader. In spite of the notable efforts made in this area, the results have been inconclusive. The disparity of viewpoints one encounters in the literature is a pointer to the need for more investigations in the area.

Apart from readability issues, there is the need for more investigation on those parameters that have direct bearing on the desirability of textbooks as an instructional tool. Some of these parameters have been identified to include the use of pictures and diagrams; intellectual competence, interest, values and previous knowledge of learners; classroom interactional patterns; features of print and the level of the language used. We shall examine these in order to identify areas needing further investigation.

Questions and Learning

In most developing countries, there has been major curriculum reforms and changes in the educational system which has made it imperative for science teachers to consider viable alternative forms of classroom organisation and communication. Individual learning, resource-based instructional modes and mixed ability classes warrant that learning materials be used in such a way that will benefit the learners.

An area that has received increased attention is the quality of questions used in the instructional process. As in Nigeria where many teachers rely almost exclusively on textbooks to shape their instruction (Piltz, 1961), the importance of textbooks as pointed out by Evans (1976) becomes even more obvious when one realises that both teachers and pupils regard printed words as infallible. With the awareness of textbooks as a predominant teaching aid, it has become possible for teachers to approach their subjects in a variety of ways and to **exploit** the communicational strategies used in the textbooks to the advantage of science teaching (Uche, 1979).

Textbooks have grown to be accepted as critical components of courses than contact with actual living materials. Textbooks have become identified as the greatest source of information for illustrating as well as providing a descriptive guide in its role as an indispensable aid in teaching and learning. As Gould (1977) indicated, textbooks are essential components of classroom interactions, and are important facilitators of scientific knowledge. The seeming over-dependence on textbooks demand that science educators examine closely the values and merit of textbooks in promoting science teaching.

Questions have been recognised as an important integral component of science teaching. Balogun (1974) in his investigation of the topography of learning control in a science subject, examined the use of questions as an orienting stimuli which create a set of inspection behaviour, self testing, self prompting in addition to other mediating process in learning. He further examined the location and frequency of questions as can be identified in some text-books and enrichment books. From his findings, he reached the following conclusions:

(i) That adjunct questions in written instructional materials facilitate learning.

(ii) That adjunct questions when used in the management of learning has to operate within traditional problems of learning, individual differences, learning rates and motivation.

(iii) That textbooks are a significant part of instruction.

These assertions indicate that questions as facilitators of learning has to operate within the usual framework of personal and environmental variables.

Generally speaking, the use of questions as communicational strategies is as old as the Socratic method of teaching. Gall (1970) identified the classification systems on questions developed by Bloom (1956), Ascher (1961), Garner (1963), Adams (1964), Clements (1964), Gallagher (1965), Moyer (1965), Sanders (1966), Guzak (1967), Pate and Bremer (1967) and Schreiber (1967). Using these systems, he provided a schema which shows the common cognitive elements between the various categories of questions in the system. He, however, found Bloom's (1956) questioning category to be the most appropriate for science teaching out of all the categories analysed.

Broadly speaking, there are two main functions for questions in the educational process. First, we use them to create perceptual set, that is to create an orienting or attending response in the instructional process (De Cecco, 1964). Second, we use them to evaluate the outcomes of instructional process.

Nuthall and Lawrence (1965) also enunciated a classificatory system for questions based on verbal actions. They found that the issue of direct and indirect modes - dominative and integrative patterns of teaching is involved in the use of question in an instructional process. They established further that while the direct mode (e.g. lecture technique) minimises the students' freedom to response, the indirect mode (e.g. teachers questions) maximizes students' response freedom.

However, central to the discussion of questions in textual materials is their relative position and types in the instructional strategy. The different types of questions asked within the classroom setting vary widely with respect to their nature, scope and purpose.

Balogun (1974), in his study of the topography of learning control pointed out that the nature of questions asked in a science lesson, determines the kinds of operations the learner will employ and the level of thinking at which he will operate. Questions often times can be related to the logic of the content and the cognitive operations sought (Mushi, 1971; Elstgust, 1971; Savage, 1972).

Usually, a question may be posed in the form of what, how and why? These questions may normally warrant certain verbal or non-verbal activities. Those activities may include the stating or demonstration of a given knowledge, skill or attitude.

Some researchers categorise questions into two groups; those that perform the psychological functions, and those that depend on the type of explanation elicited. Nuthall and Lawrence (1965) also categorised questions in terms of explanation elicited into; sequential - procedural, causal explanations, teleological explanations and normative explanations. Bingham (1979) in his study had only came up with the division of questions that perform psychological functions as including; focussing, extending and lifting questions.

Science educators generally agree that the kind of questions teachers ask play an important role in the outcomes of science teaching. However, as Balogun (1974) observed, the quality and value of questions depend on the teacher's characteristics, experience, competence, adequacy of wait-time for teachers response and the psycho-social environment of teaching. As Trowbridge (1972) asserted, for a teacher to use questions adequately, he must be a good listener, be able to percieve his students' learning difficulty fairly, maintain a good level of awareness of current issue in science teaching, and be capable of formulating challenging and appropriate questions.

Science educators have also focussed on questions within classroom reading materials. Ogunniyi (1982) in his investigation on Nigerian Biology textbooks grouped questions into; factual, rheotorical, leading and probing. Factual questions relate to soliciting direct identification or recall of facts. Rheotorical questions demand no answer. Leading questions are concerned with guiding or directing the reader to an answer; while probing questions require free expressions, personal opinions and evaluative judgement.

Carrick (1977) in her investigation of recent books published in Britain found that there was a prepounderance of factual questions. Lowery and Leonard (1978) examined the questioning styles in four commonly used Biology textbooks in the United States. They also discovered that the books contained mostly factual questions. The findings in these studies are related to the fact that most science textbooks are prepared along a definite syllabus, and for a set-out examination.

Another aspect of questioning, deals with the matter of efficiency in terms of promoting learning. Gall (1970), Rowe (1974) and Carrick (1982) studies indicate succinately that questions can be used to measure efficiency of an instructional strategy, promote learning of situations, serve as a measure of the relative merit of wait-time in the instructional process. Carrick (1982) ascertained that questions can have considerable influence on the logic, language and facts control. She further identified higher order questions (Leading and probing questions) as stimulators of inquiry behaviour. She, however, sounded a note of warning that while factual questions are capable of leading to higher order questions, their over-use can trivalise learning since they are capable of calling for bits and pieces of information.

Ogunniyi (1982) in his study of some widely used Biology textbooks, asserted that rather than the quantity of questions in a textbook, the quality and appropriateness of questions are the crucial issues in a learning process.

Pressey (1950) had earlier in his investigation on the role of questions also indicated that questions used as a review test are capable of serving didactic and diagnostic functions.

Furthermore, in their studies on the role of questions in the teaching-learning episode, Rothkopf (1966, 1970), Frase (1868, 1970) and Anderson (1970) ascertained that the inclusion of questions in written and instructional materials increased the amount of materials learnt from the textbooks.

Reinforcing this same point, Balogun (1974) had indicated that the way we use questions centre largely on the value they have for producing desirable changes in the students behaviour. More precisely, Balogun (1974) citing Frase (1970), pointed out that questions are capable of influencing learning through:

(a) Their position in a text.

(b) Their contiguity to related content.

(c) The type of questions used.

In addition to identifying different types of questions, research efforts have also been directed to the use of questions in learning. Ruthkopf (1965, 1966) and Frase (1967) pointed out that questions facilitate retention of specific and incidental information when short tests are included in prose materials.

In addition, Balogun (1974) pointed out that questions that come after prose passages are most effective for specific and general retention. According to him, pre-questioning limit the range of attentive behaviour, while post-questioning tend to lead to general orientation. He further explained that mathemagenic responses result when unrelated questions precede a passage.

Apart from the usage of various type of questions, the position of questions in the textual materials has been found to be very crucial. Ogunniyi (1982) using a modified version of the scheme developed by Lowery and Leonard (1978) categorised the position of questions in a textbook as introductory, contextual, terminal and captional. An introductory question is that placed at the beginning of a paragraph to arouse interest or curiosity about a subject-matter. A terminal question occurs at the end of a paragraph or section, and it is often used to evaluate the level of understanding of a reader. A captional question is used in reference to a topic, heading, section, table or graph; while a contextual question is used within the body of the prose material.

In their analysis of four widely used biology textbooks in America, Lowery and Leonard (1978) found that questions placed at the beginning or end of a paragraph stimulated better performance of students. Carrick (1982) and Ogunniyi (1981, 1982, 1983) on the other hand, found that captional questions when used as advance organisers tend to encourage a reader to speculate rather than take facts at their face value. They contended further that contextual questions were valuable and useful to the understanding of scientific concepts. .

Most science educators agree that the crucial factor central to the issue of questioning in science teaching has to do with the adequacy and relevance of a given question in an instructional material. When the questions used are appropriately placed and/or relate specifically to the issue at stake, they tend to stimulate curiosity and to hold the readers' interest and attention with respect to the subject matter under consideration (Balogun, 1974; Ogunniyi, 1982; Carrick, 1982).

A most significant dimension to questions in learning that need be discussed is the merit of questions as an arousal stimuli. Skinner (1947, 1953) recognised that questions questions provide a transition from the use of structured information for mediating process in learning to the use of structured information for such functions as thematic probes. He noted that questions of the specific interrogation type, function as thematic probes which induce epistemic curiosity.

Berlyne (1954) asserted that questions facilitate approach, act as receptor adjustment and are capable of manipulating the environment so as to perceive relevant stimuli observed. He further observed that questions can elicit trial and error learning in addition to insightful restructuring and curiosity. Berlyne (1954) went on to provide factors that has to be provided for questions to arouse curiosity. The factors include: the degree of the conflict, that is the number of competing tendencies and the degree of incompatibility - that is questions that give the most surprise. He concluded that while pre-questioning arouse curiosity, questions with incompatibility of concepts, are capable of arousing more curiosity.

While Kubis (1948) pointed out that questions are capable of operating as an effective arousal stimuli, Watkin and Stahler (1969) found that adjunct questions are the most adequate in improving performance of students. Putting the fact more succinately, Rothkopf (1966) asserted that test-like questions presented after reading a text material have specific and general facilitative effects on post-reading performance. He observed that questions placed before the text material produced only question-specific facilitative effects. Bruning (1978) on the other hand, indicated that infrequent testing within a learning material may be an important environmental control of positive learning behaviours.

Examining further the issue of questions as orienting stimuli, Balogun (1974) also indicated that questions like other thematic probes induce drive-producing meaning responses as well as learned (conceptual) conflicts and efforts after meaning. He further asserted that questions have a facilitative effect on learning from written materials.

It is important to examine a significant study on questions and learning carried out much earlier by Washburne (1929). This study more or less summarises basic views earlier expressed in the studies so far considered. Washburne (1929), sets out to investigate three issues:

(i) The effect of questions on recall of facts and the ability to make generalisations.

(ii) The issue of whether questions should be grouped at the end, beginning or scattered throughout the text material.

(iii) Whether the type and the placement of questions have any effect on children of different grades, ages, sex and abilities.

Washburne (1929) found that the best location of questions was at the beginning of a text material, and that questions at the end of a text material were less effective. He, however, pointed out that questions placed at the end of a paragraph aided understanding of the related parts.

Frase, Patrick and Schumer (1970) in their investigation of the effect of questions, their position and frequency on learning from a text material have added the aspect of motivation to questioning. They in fact looked at the position of questions with respect to the beginning, the end and those interspersed within a textual material. From their study, they found that the frequency and the position of questions interspersed within the text, influenced the learning of a text material. By further introducing an element of motivation, they found that motivational factors are dependent on such other factors as position and frequency of questions, the relevance of the learning items and other incidental learning items. Their investigation also showed that the frequency of questions contributed to the influence of motivational effects, and that the contiguity of questions was a primary factor in the control of text learning.

These studies have indicated that questions have facilitative effects on learning. The relative merit to learning that have been identified, relate to the type of questions, their position within the text, and their use particularly as an orienting stimuli.

With respect to type, most of the studies have concentrated on the predominant factual questions, with lesser attention paid to leading and probing questions. Other areas of interest include the issue of pre-testing, posttesting and terminal questions. But till date, little has been done in highlighting more evidently the role of introductory, captional and contextual questions in a textual material. Consequently, it could be observed that the paucity of information in this area warrant further investigation.

<u>The effect of Technical Terms, Specimens, Diagrams/Pictures and Practical Exercises on Learning</u>

Other areas of research interest relative to textual materials have been the status of pictures/diagrams, the age and grade of learners, the learner capability and previous knowledge, features of text print, technical terms, specimen, complexity of major themes and the practical exercises that have bearings on students' learning. Various studies have been carried out to determine the relative effectiveness and appropriateness of these strategies with respect to learning and comprehension of written materials.

<u>Technical Terms</u>

Biology is one of those science subjects with complex and difficult technical terms and nomenclature. Biological nomenclature are often in the latinised form with sometimes a chain of generic, subgeneric and specific names, which are capable of constituting learning difficulties.

Ogunniyi (1982) categorised technical terms in terms of those that are defined at their first occurrence; those defined immediately after they occur in the text; those defined later on in the text; and those that are not defined at all.

Evans (1976) had earlier in his study of technical vocabularies in biology textbooks, found that the best place to emphasize a technical term is at the point of first occurrence. He contended that since explanations in eliciting meaning involve the use of a language, writers should be aware of their choice of the descriptive terms in that language. He observed further, that the complexity of a given language used could create the problem of ambiguity. To Evans therefore, appropriate definitions should be used in describing technical terms. The reason for this is quite obvious. The choice of definitions in describing could clarify or becloud the understanding of what is read. The choice of appropriate definitions supports Ogunniyi's (1982) suggestion that technical terms in biology should be clearly unambigous, forming as dinstinctly as possible a precise instrument for communicating scientific information.

In his analysis of the communicational strategies in Nigerian biology textbooks, Ogunniyi (1982) suggested that technical terms should be defined as soon as they occur so as to facilitate reading and understanding of the textual materials. To him, a biology textbook with a preponderance of undefined technical terms is foreign to an uninitiated learner.

Putting the issue in yet another perspective, Carrick (1982) in her examination of recently published biology textbooks in Britain observed that defining, developing and illustrating the points in a textbook rule out dogmatism, make the material interesting to read and readily comprehensible.

Although these studies recognised that technical terms when clearly defined are desirable for science teaching, they have not provided much information about the relative importance of technical terms defined at different points within the reading material. There is an urgent need to quantify the relative merit to learning of technical terms defined immediately they occur; those defined at first occurrence; those defined later and for comparison, the value of undefined technical terms.

<u>Specimen</u>

Biology as a science subject deals with a vast array of flora and fauna ranging from microscopic to extremely large organisms. These organisms or their parts under close study are known as specimens. A given specimen may be alive or preserved in some chemical for future study. It is not always that real materials are available. At times, only a model of a specimen is all that can be obtained.

Ogunniyi (1982) has classified specimens in terms of foreign and local varieties. The former are not endemic to the region where it is being studied, while the later thrive within the local environment of the learner. From his analysis, he found that most Nigerian biology textbooks use specimens that can be obtained locally. The associated advantages of locally existing specimens in terms of enhancing familiarity and hence understanding among learners cannot be over-emphasised. Furthermore, Ogunniyi (1982) observed that although the books were written by foreigners and nationals, the former having lived long in Africa, seemed to be quite familiar with the local specimens as the nationals. In other words, the textbooks analysed were relatively well stuffed with local specimens. Less than 5 percent of the specimen could be regarded foreign.

Presently, there is a new trend of authorship in Nigeria. We now have a situation where experienced Nigerian teachers have been writing books, and others now serve as editorial board members, which are otherwise recognised in some publishing houses as co-authors or contributors for biology textbooks specifically prepared for West African English speaking schools. This has made it possible for teachers to avail themselves of existing but unrecognised community-based specimens that can be used in biology teaching. As evidenced in the new "STAN Biology" written by STAN, the textbook has not only facilitated the learning of biological concepts and principles, but has also made the subject matter more lively, interesting and relevant.

<u>Pictures and Diagrams</u>

Science educators are fully agreed about the positive role of pictures and diagrams to comprehension of a written material. Pictures and diagrams can through their form, clarity, colour and adequacy enhance communication and compliment written and verbal instructions (Ogunniyi, 1982). Good pictures and diagrams can be used to convey the meaning of concepts and principles which would otherwise have been distorted by language.

Researchers have ascertained the effect of pictures and diagrams on learning. Reid and Miller (1980) investigated the perception of pupils with respect to biological pictures, and their implication for comprehension and understanding of concepts and principles. Central to their study, was the use of colour in pictures and diagrams. They found that the use of colour in biology textbooks is capable of enhancing the students power of observation, especially in students with average ability. They, however, stated that although the use of colour in pictures and diagrams of biology textbooks could improve students observational skills, they are capable of serving as destractors to other students.

With respect to coloured pictures and diagrams of higher complexity, Reid and Miller (1980) discovered that the effect of colour in enhancing students' observational capacity was limited by the ability range of the students.

In other words, the ability to derive meaning from a coloured picture or diagram was dependent on the age and ability of the learner.

Another dimension of pictures and diagrams that has been examined, relate to their use as advance organisers. Egbugara (1983) investigated the relative effects of oral, written and pictorial organisers on students achievement in physics. He found that a combination of written and pictorial organisers were more effective in ~~h-~~ enhancing students achievement than written materials alone.

However, Ogunniyi (1982) had earlier pointed out that pictorial representations were capable of facilitating learning. He emphasised that the quality rather than the quantity of diagrams and pictures was the crucial factor in learning.

Science educators generally agree on two categories of pictures and diagrams; the labelled and those not labelled. Ogunniyi (1982) asserted that learning in biology can be exceedingly boring and uninteresting to the students when they are devoid of good and clear pictures or diagrams. A criterion of good pictures and diagrams he noted, is that they should be well labelled. A well labelled diagram he further remarked is an indispensable memory aid and comprehension guide, whereas an unlabelled diagram or picture have little use to the reader unless they are adequately described. A good diagram could conveniently replace a long portion of written material.

The merit of pictures and diagrams to learning have also been investigated by other researchers. For example, Evans (1976) in his study of technical vocabularies in Biology textbooks recognised the fact that descriptions as a way of explaining an anatomical and morphological feature is capable of distorting learning. He concluded that a long and detailed description can neither be an adequate substitute, nor a viable alternative to a clearly labelled diagram.

Putting the merit of pictures and diagrams in obvious words, Ogunniyi (1982) asserted that the foreigness of a textbook should perhaps not be construed only in terms of their country of origin, or the authors country of domicile, but rather in terms of the communicational gap that has been inadvertently created by inadequate or poorly labelled pictures and diagrams.

In spite of the notable research studies alluded to above, more information is still needed with respect to the relative merit or demerit of pictures and diagrams. The findings of such studies would further enhance our understanding about the role of pictures and diagrams in biology teaching.

Major Themes

Science educators have also recognised the value and merit of central themes in the presentation of scientific facts and knowledge.

Themes in biology teaching are varied and many. However, Ogunniyi (1982) in his analysis of communicational strategies used in Nigerian biology textbooks found that the frequently occuring themes were; evolution, history, ecology, inquiry, economic importance and knowledge. An evolutionary theme refers to origin, growth, development and adaptability of biological systems in response to ecological and environmental changes. Historical themes he remarked, relate to biological stories of how a concept, generalisation, process or skills were discovered; an ecological theme deals with the study of the inter-relationship of organisms and their environment. An inquiry theme is concerned with an attempt directed at finding out more about a phenomenon, object, event or situation, while economic importance as a theme relates to the benefit to man and the society of a given biological system, knowledge, skill or process. To him, knowledge relates to factual presentation of biological principles and facts. This categorisation of themes look comprehensive, but does not seem to include all the themes that can be found in biology textbooks. The publication of STAN Biology for instance, demand the inclusion of "world-view" as a theme of importance in Nigerian schools central to teaching and learning of biology. It has been made a major theme in this textbook as a recognition of societal values and aspirations, including cultural beliefs in the presentation of biological facts, concepts and principles.

For the past two decades, the emphasize in science education has been the presentation of school science as a form of inqury rather than a dogma. De Marris (1965) in his study on the nature of science content, indicated that historical presentation of learning materials enhances student understanding of biological teaching. In addition, Cooper and Petrosky (1974) in their investigation of students perception of science as a subject, had found that science as a subject and a way of inquiry was of great interest to students.

Ogunniyi (1982) had further observed that there is the need for more efforts at improving and impacting relevant scientific knowledge using such themes as ecology and economic importance because of recent environmental problems facing the fauna and the flora of most African countries. He further cautioned that with respect to evolution, the theme should be presented in a less dogmatic manner. This is because of the importance attached to religion as a tradition and a way of life in many traditional African societies. It should be noted that the African cultural background, rest in the belief of a Supreme God, other divinities and forces which can not be completely neglected in the presentation of biological principles. Despite the importance attached to the teaching of themes, however, there is paucity of research findings in the area.

<u>Practical Exercises</u>

Studies in science education, have been directed at identifying the nature, and types of classroom practical exercises that can promote science teaching. In an apparent realisation of this fact, Summer (1950) stated that centuries of deductive reasoning of the past, had failed to produce the utilitarian results when compared to a few decades of experimental methods.

In his work on the place of practical work in school science course, Rail (1963) enumerated that the over-all teaching of science can be broad-based if approached through experimentation. In the same way, Hurd (1969) found a positive correlation between the performance of students and the use of laboratory exercises.

The findings of these studies tend to suggest the fact that practical exercises can promote effective teaching and learning of science. In his study of the value of practical work in teaching, Holt (1969) identified that the main goal of practical exercises should be the provision of adequate opportunities for students to investigate (Schwab, 1962).

Further studies by Tamir (1978), involving the determination of inquiry and curiosity in the laboratory, revealed that laboratory exercises were capable of facilitating the development of scientific skills and attitudes.

Schunke (1979) in his investigation of curriculum and choice of task organisation, pointed out that particularly within a cooperative framework, there is an improvement in learning when psychomotor skills are used in teaching.

Ogunniyi (1983), also reiterated the fact that laboratory exercises provide students with the opportunity to study abstract concepts and generalisations through the medium of concrete materials. When practical exercises are appropriately chosen and well executed with locally available materials, they constitute an indispensable entity to the development of science teaching and learning (Blan, 1954; Schwab, 1962; Ansubel, 1968).

It is imperative at this point to consider researchers categorisation of practical exercises. Ogunniyi (1982) in his analysis of communicational strategies used in Nigerian biology textbooks, categorised practical exercises found in the textbooks to; simple, specific, general and challenging. To him, a simple experiment is concerned with a casual observation; a specific experiment requires the learner to carry out individual laboratory or field work that may involve the use of equipment such as the hand lens and microscopes to study an organism, process or anatomical feature. A general practical work he noted involves a large group of students or the whole class in an experiment or in a project - for example, an ecological study of a pond. He further noted that challenging practical exercises involve the setting up of an experiment by a student, group of students or the teacher to demonstrate a highly specialised knowledge or skill.

These findings and categorisation can further be viewed in terms of their relative merit to learning and teaching in biology. Ansubel (1968) had emphasised that practical exercises are crucial to the development of a child's cognitive ability.

Enumerating further the merit of practical exercises to learning, Ogunniyi (1982) in his analysis noted that a meaningful practical exercise should permit students an easy access and opportunity to have direct contact with the learning material. He further pointed out that while students in the lower forms could benefit from simple and specific practical exercises, the students in the higher forms should be exposed to challenging practical exercises that are capable of provoking curiosity and a search for valid evidences in scientific activities.

These studies reviewed above have shown that when practical exercises are well-planned, prepared, and adequately executed, they do contribute positively to the teaching and learning of science. It is, however, desirable to find out more about the relevance or merit of various types of practical exercises to learning. The application of varying types of practical exercises using locally improvised material might not only make biology teaching meaningful, but also relevant to the needs of the learner.

Readability of Textual Materials

The readability indices determination of textbooks has been an area of interest to educators in an attempt to ascertain the comprehensibility of reading materials. Generally, readability has been defined by educators as the relative ease at which people can respond in various ways to passages of written prose. Gilland (1972) and Yoloye (1975) recognised three important dimensions of readability.

These are: comprehension, fluency and interest. Uche (1979) identified other dimensions of readability such as the culture, reader's interest, reading speed, recall of passage, proportion of answered questions and the comprehensibility of the material.

The issue of readability is particularly concerned with providing the right textbooks for the students. Since 1939, researchers have been concerned with formulating adequate readability formulae for ascertaining the comprehensibility of classroom reading materials. Most of the formulae have been developed to determine the quality control of communication effectiveness. The focus has been in the area of vocabulary, sentence structure and human interest.

Although there are many readability formulae in use, the weaknesses of most of them as encountered in literature reviews, suggest a cautious approach in selecting which formula one uses for a given study. For instance, the readability formulae developed by Flesch in 1943 was criticised by Dale-Chall (1948) as being very cumbersome to use. On the other hand, Flesch (1943) had earlier stated that Lorges (1939; 1944, 1951) formulae could not discriminate above the

8th grade. In the same vein, Yoloye (1975), indicated that Dale-Chall (1948) formulae gave unnecessary heavy weighting to word difficulty.

In addition, the formulae developed by Morris and Halverson (1938), Gunning (1952) and McLaughin (1969) have been variously criticised for been too cumbersome to use; poor discriminative index for pupils with mixed ability and for subjects with technical terms. In the attempt at taking care of his predecessors inadequacies, Taylor (1953) developed the "close readability structure" procedure. In this procedure, comprehension difficulty is measured using multiple items. Using some of these formulae or their modified version, researchers have carried out studies to determine the comprehensibility of reading materials.

Yoloye (1975) carried out an investigation on the reading levels of pupils and teachers using the Nelson-Denny test. The test was administered to randomly chosen samples of two schools in which the African Primary Science Project (APSP) curriculum material was used. He found that five of the eight textbooks in use had readability indices of 4.83 or higher. When compared to the level of understanding of

Nigerian pupils, Yoloye (1975) ascertained that a typical Nigerian primary school pupil will have difficulty with the materials.

Yoloye (1975) ascertion could be true bearing in mind the historical, cultural and educational development of most African countries. With their Anglophone or Francophone background, most African countries and particularly those that participated in the 1965 Kano Conference which gave birth to the APSP, have comparable educational development. But this should not be taken on the surface considering the is issue of cultural variations which are also crucial to readability determination.

Using the Dale-Chall (1948) formulae, Yoloye (1975) also determined the readability indices for the Nigerian Secondary Schools Science Programme (NSSSP) and the Social Studies Programme of Aiyetoro Comprehensive High School. He found that most Form I students and fity percent of Form II students in the secondary schools would experience difficulty in comprehending the materials. He also found that while twenty-five percent would have comprehension difficulty in Chemistry among Form III students, more than twenty-five of the same group will encounter greater difficulty in Biology.

As Yoloye (1975), rightly pointed out, the readability indices vary with age and level of intellectual development. The interpretiation for the primary school level would certainly be different from the secondary school level. This is because the conceptual emphasis of the secondary school science tend to contain more technical words and consequently raising the difficulty levels of the reading material than would be encountered at the primary school level. This becomes even more obvious when the readability formulae used include the notion of "difficult words".

There has been other readability studies before and after Yoloye (1975) studies which have attempted to determine the comprehension of the reading speed of pupils. Chapman-Taylor (1965) carried out an investigation on the reading difficulties of 136 First Year undergraduates in Arts and Economics at the University of Ibadan. He found that the Nigerian students were comparable in all respects with their Australian counterparts. The only difference was in the speed of comprehension where the Nigerian students were found to be inferior to their Australian counterparts. This is an indication that reading speed and comprehension may be culture-bound and related to the technological development of the society. Consequently, in one's choice of a readability formulae, this fact should be considered.

McKillop and Yoloye (1972) also investigated the reading difficulties of 92 randomly chosen undergraduates of Arts, Science and Social Sciences at the University of Ibadan. They found the University of Ibadan undergraduates to be significantly inferior to their American counterparts especially in the area of comprehension and speed.

The variation in those findings can be ascribed to the level of educational development in the different countries. With her growing technology, the American undergraduates has a more enriched environment when compared to his Nigerian colleague living in a predominant traditional culture.

As would be discussed later, Wahome (1979), Jegede (1982), Okpalia (1982) who had examined the readability of chemistry, biology and physics textbooks respectively, have found that the textbook in these areas (which are all European-oriented), would definitely create reading difficulty for their desired readership. Perhaps the issue can not be ascribed to the traditional culture. There seems to be a clear indication of relevance and need. The findings of Guthrie (1972) and Carrick (1978) of science textbooks used in British schools indicated that the textbooks were adequate for the pupils. This is because the British textbooks were written to meet the needs of the learners in an education setting relevant to societal values.

As earlier mentioned, the major issue in readability determination has been the limitations of readability formulae in use. Consequently, researchers have attempted to provide additional explanation for the differences in students' comprehension, abilities, and reading speed in addition to other deductions derivable from estimated readability indices.

It is however crucial to examine more studies on readability determination, and isolate factors that can assist the comprehension of a science reading material.

Okpalla (1982) using Flesch's (1948) formula, examined the readability of physics textbooks used in Nigerian secondary schools. From his findings, he concluded that the difficulty level often assumed for a textbook has to be carefully estimated. Since sample pages are considered, he found that there are wide variations in the difficulty level of most of the pages in the physics textbooks. Hence he concluded that a text that may be considered readable on certain topics may not be easily understood on other topics.

Another issue of significance, is the nature of readability formulae and the nature of science teaching. Yoloye (1975), Okpalla (1982), Ogunniyi (1982) had identified that most readability formulae are inadequate predictors of some elements critical to comprehension. The identified elements include such things as illustrations, graphs, and diagrams in addition to characters of print of science textbooks.

As earlier pointed out, Wahome (1979), Uche (1979), Jegede (1982), Okpalla (1982) identified that there are varying difficulty levels associated with different grades of pupils. The Chemistry, Biology and Physics textbooks examined by these researchers respectively, were found to be unsuitable for Form Three pupils, but adequate for Forms Four and Five students.

Three reasons could be adduced for these differences:

(i) Physics, Chemistry and Biology textbooks are specifically prepared for West African School

Certificate Examination. This is an examination that is largely relevant to the needs of Forms Four and Five students rather than Form Three students.

(ii) The relatively higher cognitive capacities of Forms Four and Five students.

(iii) The language competence of Forms Four and Five students is probably greater than that of Form Three students.

It should however, be noted, that language as an entity of culture has the intellectual and socio-cultural dimensions, in addition to the status of the learner's previous knowledge. It is to be expected that a student from an enriched socio-cultural environment, and with an early start in the English language (which is the medium of expression used in science textbooks), would probably experience a lesser reading diff difficulty than one lacking such opportunities.

Furthermore, Ogunniyi (1982) ascertained that most science textbooks are only adequate for the top twenty per-cent of Nigerian science students population. This implies that the remaining eighty per cent or so, would have to cope with reading materials far above their level of cognitive development. One can say, therefore, that there is a mis-match between the expectations of the authors and those of the readership. This same phenomenon was identified for science textbooks in Britain (Shayer and Adey, 1983).

In addition to the earlier cited findings of Guthie (1972), Gould (1977); Carrick (1978) and Baker (1979) had also found that science textbooks in use in British schools have relatively low readability index. They however found out that this applied to students with a wide range of ability. Carrick's (1982) assessment of recently published biology textbooks in Britain have indicated that the texts have achieved a better readability index.

As earlier indicated, readability is a highly complex concept. This is more so when one realises that many factors other than the written material contribute to the overall readability of a given textbook. Giland (1972) as cited by Carrick (1982) observed that readability involves the intricacies of language, legibility, motivational interest, understanding and reading speed. Evans (1976) and Okpalla (1982) contend that readability formulae are difficult to apply for books with much technical vocabulary, Uche (1979) ascertained that although readability is a significant factor in comprehension, the authors' style of writing ranges from simple to complex depending on the experience and background of individual authors.

As shown in these studies, the choice of a readability formulae depends on the study and the variables in question. Although some of the readability formulae available are cumbersome, this should not imply their total abandonment. Their revised versions would continue to provide useful information till better formulae are developed. It is not likely that a perfect formula would some day emerge. In any case, a good formulae for a given context may be an effici inefficient in another. Besides, Biology like other science subjects is constantly growing. The changes occuring in the subject warrants the development of more sensitive readability formulae that could cope adequately with the changes. As Carrick (1978) points out, readability studies have to be constantly carried out especially on the publication of new editions of science textbooks. This will ensure that the comprehensibility of the textbooks are constantly monitored. The present study is an attempt in this direction.

Summary and Conclusion

In conclusion, it should be pointed out that although a considerable number of research studies have looked into the readability of textbooks, their findings about the overall merit or demerit of the readability indices used vis a vis learning are yet to be clearly determined. Besides, there are other aspects of communication other than readability which may enhance or hinder a reader's understanding of a textual material. These include technical terms, specimens, major themes, pictures/diagrams and practical exercises used in a given text. Therefore, this study will examine the readability of the various textbooks as well as these other areas.

It is hoped that this effort will yield more information about seemingly ignored or un-noticed areas that can enhance the comprehension or otherwise of biology textbooks and indeed science textual materials in general.

CHAPTER THREE

RESEARCH METHODOLOGY

This investigation was executed in two phases: a pilot study phase and a main study phase. Aspects of the methodology of research such as the design, instrumentation and the general procedure that were common to both phases of the study are reported in this chapter. Also reported are the specific procedures, results and discussions of the pilot study.

Research Design

The design used for the pilot and the main study was a pretest/post-test control group quasi-experimental design. The design was a modified version of the Solomon - 3 Experimental Design.

The format of the design is as follows:

Experimental Group I : O_1 x O_2 (E_1)

Control Group : O_3 O_4 (C)

Experimental Group II : x O_5 (E_2)

The design is presented in Table 1 below.

TABLE 1

Design of Experimental Setting

School and Subjects	Pre-test	Treatment	Post-test
School 1	SATT	Teaching a unit in biology	SATT
Experimental Group 1	SAT	-NUTRITION with selected communicational	SAT
(E_1)	SPT	strategies using designed notes of lesson	SPT
School 2	SATT	Placebo treatment is given The same unit as in E_1	SATT
Control Group	SAT	was used BUT without the selected communicational	SAT
(C)	SPT	strategies and notes of lesson.	SPT
School 3			SATT
Experimental Group 2	None	Treatment as in E_1.	SAT
(E_2)			SPT

The underlying assumption to this research design is that any significant difference between the Experimental Group 1 (E_1) and the Control Group (C) is due to the treatment and not as a result of interaction effects of the pre-test. The validity or otherwise of this assumption is verified by the result obtained from Experimental Group II (E_2). In other words, the design controls for pre-test bias common to both E_1) and C (Ogunniyi, 1986).

Another assumption of the design is the fact that the pretest score of E_1 is assumed for E_2 for comparability purposes. Since the subjects chosen were from intact classes, the design was found suitable for this study.

Variables

The study was in two major parts: the analysis of text-books, and the experimental study.

Analysis of Textbooks

This involved the determination of the readability and the communicational strategies used in the selected textbooks. In this connection, three outcome variables were determined:

1. Readability indices (R.I).

2. Textbooks analysis (T.B.A.): This was with respect to the communicational strategies contained in the textbooks involved in the study.

3. Communicational strategies survey (C.S.S.): This is with respect to recognised preference among producers and consumers of communicational strategies in Nigerian biology textbooks.

Experimental study

The second dimension of the study is the experimental setting. The variables involved are identified below:

A. Independent variables: Eight independent variables were identified. These include:

1. Leading questions
2. Probing questions
3. Contextual questions
4. Technical terms defined at first occurrence
5. Local specimens
6. Pictures and diagrams (labelled)

7. Inquiry theme
8. Challenging practical exercises

All these terms have been defined earlier (page xxvii)

B. <u>Dependent Variables:</u> Three dependent variables setting were:

1. Cognitive achievement
2. Level of development of scientific attitudes
3. Level of acquisition of practical skills

<u>Sensitivity, Internal and External Validity</u>

The issue of sensitivity, internal and external validity of the study were adequately taken care of. This was with respect to the issue of accuracy, generalizability and the ability of the research instruments to detect differences present in the population of the study.

Internal validity specifically deals with the concept of accuracy. A strong internal validity can only exist if many of the extraneous variables are controlled. Campbel and Stanley(1963) identified the factors that are capable of jeopardising internal validity as including:

(a) History: Occurrence between the first and second observation apart from experimental variables.

(b) Maturation: Processes taking place with the subjects as a function of time e.g. growing older, getting fatigued.

(c) Testing: The effect of the first test on the second which may be positive or negative.

(d) Instrumentation: Charges arising from measurement instruments or the observers themselves.

Other factors capable of jeopardising internal validity are: statistical regression, which can exist when groups are selected on the basis of extreme characteristics; biases - arising from group selection; experimental mortality; and selection, depending largely on maturation and similarity.

External validity is concerned about the usefulness of a given study, that is the generalizability of the findings. Factors that are capable of jeopardising external validity include the following;

(a) Reactive or interaction effects of testing e.g. pre-testing effect - the sensitization to experimental conditions.

(b) Reactive effects of experimental arrangements.

(c) Multiple treatment effects: that is, the interference of previous treatment effects with subsequent treatments.

(d) Failure to describe the independent variables explicitly.

(e) Unrepresentativeness of the target population.

(f) Hawthorne effect: A situation in which the subjects are highly motivated because they are aware of being tested.

Other factors relate to the poor operationised dependent variables; and the interactional effects of extraneous factors (Ogunniyi, 1986).

Factors that could jeopardize the internal validity were taken care of by a number of steps. Principally, most of these factors were annuled by the selection process and the use of a control group in the study.

The other factors that could obscure the artifacts of instrumentation or treatment were eliminated by isolating rival hypotheses through the identification of possible covariates, and their subsequent elimination through statistical procedures.

The threat of contamination and compensation as a result of subjects in different treatment conditions interacting, was taken care of by the spread of treatment conditions in comparable schools located in different parts of the town. This ensured that the subjects in the different treatment conditions did not exchange experiences.

The external validity of the study was also ensured by having the regular teachers teach the different groups in the study. Within the limitations of the study, it is expected that the findings can be extrapolated to settings similar to those of the experiment.

Precautions were also taken to ensure the sensitivity of the experiment and reduce further the factors that are capable of jeopardising the internal and external validity alluded to above.

Cox (1958) identified sensitivity as the ability of an instrument to detect differences that are present in a population. The sensitivity was ensured by a fair selection of subjects involved in the study.

The treatment effect was also increased to ensure a high within group homogeniety among the experimental teachers. The training sessions and demonstration periods of the participating teachers also ensured a high between groups homogeniety. Constant checks, pre-treatment and post-treatment briefings ensured that the teachers operated adequately their assigned modes of treatment implementation.

Instrumentation

Six research instruments were used in the study for data collection. These were:

1. Readability Index (R.I).
2. Textbooks Analysis Index (T.B.A.).
3. Communicational Strategies Survey (C.S.S.).
4. Students Achievement Test (S.A.T.).
5. Students Attitudinal Test (S.A.T.T.).
6. Students Psychomotor Test (S.P.T.).

The first three (R.I., T.B.A. and C.S.S.) were measures for the readability, communicational strategies in the textbooks and preference for communicational strategies among producers and consumers of biology textbooks.

The other three (S.A.T., S.A.T.T. and S.P.T.) are the dependent variables measures for the experimental study. The S.P.T. has an accompanied "Pratical Test Assessment Inventory", which is an observational guide. Great care was taken to ensure that the final versions of the instruments were sufficiently sensitive to defect differences between the treatment conditions. The procedures for the developments and adaptation of the instruments are discussed in subsequent paragraphs.

Readability Index (R.I.) APPENDIX 1

The readability indices of the textbooks used in the study was determined using **Flesch's** readability formulae (1948). The readability determination was to ascertain the difficulty levels of the textbooks and to find out if they were suitable for the comprehension level of the students involved in the study. Flesch's readability formula and its interpretiation data relative to Nigerian schools were used in interpreting the result obtained in the study (Wahome, 1979).

Flesch's readability formula has been used extensively by many researchers (Major and Collette, 1961; Marshall, 1962; Wahome, 1979; Jegede, 1982; Okpalla 1982). Although Dale-Chall (1948) had indicated that Flesch's formula was cumbersome to use, it was found suitable for this study for a number of reasons.

First, the formula does not employ any word list.

Rather, it utilizes measurement of sentence length and syllable count. Since it utilizes measurement of sentence complexity, and since the count of word length and the number of syllables per hundred words is an acceptable measure of abstraction (Marshall, 1962) it was found appropriate for biology textbooks.

The formula was also made available to seven science education lecturers and four secondary school biology teachers for validation. The characteristics, merits and short-comings of the formula were examined. All the specialists found the instrument appropriate for biology textbooks.

The instrument was also rated by the specialists for the inter-rater reliability. A reliability coefficient of 0.96 was obtained using the Spearman-Rank Order correlation analysis.

The formula was subsequently applied to a biology textbook that would not be used in the study to avoid any biases in the main study. The pilot analysis involved, "Modern Biology for Secondary Schools" by Ramalingan <u>et al</u> (1979). Using the Kuder-Richardson formula 21 (KR21), a reliability coefficient of 0.96 was obtained. In the light of the comments by experts and values of reliability coefficients obtained, the instrument was subsequently used in the main study.

Textbooks Analysis Index (T.B.A.) APPENDIX 3

The four textbooks used in the study were:

(i (i) Mackean, D.G. Introduction to Biology. West African Edition. Heinemann Educational Books (Nigeria) Limited, 1982.

(ii) Ewusie, J.Y. Tropical Biology for O'level and School Certificate. African Universities Press in Association with Harrap, London, 1982.

(iii) Stone, R.H. and Cozens, A.B. New Biology for West African Schools. Longman Group Limited, London, 1982.

(iv) STAN Biology. Addison Wesley, London, 1983.

The T.B.A. was a slightly modified version of the one developed by Ogunniyi (1982).

The identified communicational strategies and their specific criteria measures examined in this study were as follows:

1. <u>Questioning Styles</u>

(a) Types of Questions:

(i) Factual

(ii) Rheotorical

(iii) Leading

(iv) Probing

(b) Position of questions:

(i) Introductory

(ii) Contextual

(iii) Terminal

(iv) Captional

2. <u>Technical Terms</u>

(a) Terms defined immediately used.

(b) Terms earlier defined.

(c) Terms later defined.

(d) Terms undefined.

3. <u>Specimens</u>

(a) Local specimens

(b) Nonlocal specimens.

4. <u>Major themes</u>

(a) Evolution

(b) Ecology

(c) Economic importance

(d) Inquiry

(e) History

(f) Knowledge

(g) Traditional World-view.

5. <u>Pictures and Diagrams</u>

(a) Number of pictures

(b) Number of diagrams

(c) Number of labelled and unlabelled pictures and diagrams

(d) Number of colours used for pictures and diagrams.

6. <u>Practical Exercises</u>

(a) Simple

(b) Specific

(c) General

(d) Challenging

7. <u>Physical Characteristics</u>

(a) Number of colours on the cover.

(b) Number of colours in the text.

(c) Number of characters (type sizes) used in the text.

The instrument was made available to seven science education lecturers, and four secondary school biology teachers for validation. They were asked to examine the textbooks in terms of the criteria listed above.

The specialists determined the face and content validity of the instrument, and found it suitable for the study.

The instrument was also rated by the specialists in terms of their suitability. The reliability coefficient of 0.98, was obtained using the Spearman-Rank Order correlation analysis.

The instrument was subsequently used to analyse a biology textbook that would not be used in the study to avoid any biases in the main study.

Using the Kuder-Richardson formula 21 (KR 21) in the analysis of "Ramalingan <u>et al</u>: Modern Biology for Secondary Schools" the following reliability coefficients were obtained for each of the communicational strategies;

(i) Type of questions, 0.98.

(ii) Position of questions, 0.97.

(iii) Technical terms, 0.98.

(iv) Specimens, 0.97.

(v) Major themes, 0.97.

(vi) Pictures and diagrams, 0.98.

(vii) Practical exercises, 0.96.

(viii) Physical characteristics, 0.98.

In the light of the comments by experts, and values of reliability coefficients obtained, the instrument was subsequently used in the main study.

Communicational Strategies Survey (C.S.S.) APPENDIX 2

The survey determined the preference of communicational strategies desirable for biology textbooks as effective facilitators of learning. The respondents were the consumers and the producers of biology textbooks. The 50 respondents (ten in each group) were randomly selected from the following;

(i) Nigerian biology textbook authors.

(ii) Personel in Nigerian Publishing Companies.

(iii) Secondary school biology teachers.

(iv) Ministry of education officials involved in biology textbooks selection.

(v) Biology students in secondary schools.

The respondents indicated their choice on a graduated scale as follows:

5 = very essential

4 = essential

3 = sometimes essential

2 = hardly essential

1 = not essential.

The 43 items on the instrument were grouped into eight categories (communicational strategies). The respondents were asked to rate the items as earlier indicated. The strategies were questioning styles, technical terms, specimens, pictures and diagrams, practical exercises, maps, themes and physical characteristics.

The instrument was made available to seven science education lecturers, and four secondary school biology teachers for validation. The specialists determined the face and content validity of the instrument. In line with their comments twelve items were revised before the instrument was considered suitable for the study.

The instrument was also rated by the specialists.

A reliability of 0.99 was obtained using the Spearman-Rank Order correlation analysis.

The instrument was also administered to 20 respondents in a pilot study (Four members for each of the five groups earlier mentioned). Using the Kuder-Richardson formula 21 (KR-2D, a reliability coefficient of 0.98 was obtained.

In the light of the modification done for the validation process, and in view of the value of the reliability coefficient obtained, the instrument was found adequate for the main study.

Experimental Setting

The instruments were administered before and after treatment. The treatment involved the teaching of a unit of biology - NUTRITION - using designed notes of lesson that emphasised the eight communicational strategies involved in the study. These were:

(i) Leading questions.

(ii) Probing questions.

(iii) Contextual questions

(iv) Technical terms defined at first occurrence.

(v) Local specimens.

(vi) Labelled diagrams and pictures.

(vii) Inquiry method.

(viii) Challenging practical exercises.

Notes of Lesson APPENDIX 8

The eight communicational strategies were built into the prepared notes of lesson. The treatment lasted for six weeks. Although there were inevitable overlaps of communicational strategies during teaching, specific time interval were allocated to each strategy to ensure an average treatment period for all the communicational strategies.

The notes of lesson was made available to seven science education lecturers and four secondary school biology teachers for validation. The specialists determined the face and content validity. The notes of lesson was accordingly modified in line with the experts' comments.

The notes of lesson was also rated by the specialists in terms of suitability for the intended purpose. Using the Spearman-Rank Order correlation analysis, an inter-rater reliability coefficient of 0.99 was obtained.

In the light of the modification process for the validation and a high reliability coefficient obtained, the note was used in the main study.

Students Achievement Test (SAT) APPENDIX 6

This is a test of students' cognitive achievement in biology. The test items were referenced to the content and lesson objectives specified for the treatment. Altogether, there were 40 multiple choice questions on the instrument.

The instrument was made available to seven science education lecturers and four secondary school biology teachers for validation. They examined the face and content validity. Their comments led to the restructioning of some items, the simiplification of the language, and the deletion and/or addition of some items.

The instrument was also rated by the specialists. An inter-rater reliability coefficient of 0.98 was obtained using the Spearman-Rank Order correlation analysis.

The instrument was subsequently administered to 45 Form Four students of All Saints Grammar School, Ondo in a pilot study. From the responses of the students, the facility and discrimination indices of each item was computed.

The items in the instrument were retained or rejected on the criteria of not including too difficult items as well as items that were too easy for the respondents. Items with discrimination power of more than 0.40 and 60 facility index of between 40 and 60 percent were retained. Using the Kuder-Richardson formula 21 (KR-21) the reliability coefficient of 0.92 was obtained.

Students Psychomotor Test (SPT) APPENDIX 7

This is a modified version of a standardised test of skills associated with laboratory and manipulative work. The skills involved are methodical working, experimental techniques, manual dexterity, making and reporting measurements, describing observations, interpreting observed data, drawing conclusions, orderliness and observing safety regulations during practical sessions. The original test was developed and validated by Tamir and Glassman (1970) and later modified by Tamir, Nussinovifz and Friedler (1982).

The SPT was modified to involve those items related to the lesson topics of the study. All the SPT had an accompanying Students Psychomotor Assessment Inventory (SPAI).

The SPAI had a checklist with respect to the behaviour exhibited. Each behaviour exhibited was rated on a three point scale:

2: maximum behaviour exhibited.

1: average behaviour exhibited.

0: no behaviour exhibited.

The SPAI was used in assessing students' psychomotor ability. The items in the SPAI are shown in the table below;

TABLE 2

Students Psychomotor Assessment Inventory (SPAI)

Criteria Assessed	2	1	0
1. Sectioning skill (correct plane of section).			
2. Addition of adequate number of iodine drops.			
3. Addition of adequate number of fehling's solution drops.			
4. Method of mixture and shaking of mixture.			
5. Heating techniques.			
6. Ease of handling apparatus			
7. Accuracy of observation.			
8. Drawing skill accuracy.			
9. Carrying out exercise to time.			
10. Accuracy of recording and reporting observation.			

The items used for the SPT included;

(a) **Onion bulbs.**

(b) Iodine solution.

(c) Fehlings solution I and II (Mixed).

(d) Test tubes.

(e) Handlens.

The SPT and SPAI were validated by seven science education lecturers and four secondary school biology teachers. Using, Spearman-Rank Order correlation the inter-rater reliability coefficient obtained on the SPAI was 0.95.

The SPT and SPAI were also administered to 45 form four students as in the SAT. Using the Kuder-Richardson formula 21 (KR-21), a reliability coefficient of 0.92 was obtained for the SPAI.

Students Attitudinal Test (SATT) APPENDIX 5

The attitudinal test is a modified version of Ogunniyi's (1978) inventory on students attitude to biology. It was adopted to take care of the various communicational strategies involved in the study.

The items in the instrument were generated from; the nature of biology, learning, learner characteristics, social expectations, teacher's teaching style and the learning environment.

The respondents reacted to the items in terms of;

Agreement	=	2
Disagreement	=	1

The instrument was validated by seven science education lecturers and four secondary school biology teachers.

The instrument was also rated by the experts. A reliability coefficient of 0.92 was obtained using the Spearman-Rank Order correlation analysis.

The SATT was also administered to 45 form four students as in the SAT in the pilot study. On the basis of their score, a reliability value of 0.90 was obtained using the Kuder-Richardson formula 21 (KR-21).

General Procedure

Training of Participating Teachers

Experimental group teachers who participated in the pilot and main study phases were subjected to a rigorous training programme. This ensured that the teachers acquired the competence necessary for executing the designed notes of lesson. The training exercises ensured that all the teachers exhibited minimum within group variance. They were prepared using the following training programmes.

Phase I: The investigator familiarised the participating teachers with the general set-up of the study. No indication regarding the hypotheses to be tested was given to the teachers. This phase also included a short talk on, "Communicational strategies - their use and implication for biology teaching".

Phase 2: Five lessons based on the use of the designed notes of lesson were presented to the experimental teachers. Each lesson was followed by a discussion session involving the participants.

Phase 3: Each participating teacher was made to have a micro-teaching session involving the group in the use of the training designed notes of lesson. Each presentation was discussed.

Phase 4: The teachers in the three groups were trained in the administration of all the data gathering instruments. This phase focussed especially on the training in how practical skills could be assessed using the SPT/SPAI. An instruction package providing a general description of the experiment, protocols for each condition and mode of pre-test and post-test administrations in addition to a flow chart of the study's procedure were made available to each teacher.

Phase 5: At the end of the training exercise, the teachers in the various groups were assessed for training effect. Teachers who performed below form were disallowed from further participation in the study. The extra number of teachers involved in the study catered for such mortality.

Collection of Textbooks

The four textbooks involved in the study; Mackean, Ewusie, Stone and Cozens and STAN Biology were obtained directly from the respective publishers. This ensured that the textbooks used for the study were genuine ones rather than the pirated copies. This also ensured that the text-books editions used were the most current editions available in Nigeria.

Schematic Representation of the Research Procedure

PILOT STUDY

Validation of instruments
- Readability Index (R.I)
- Communicational strategies Survey (C.S. S.)
- Textbooks Analysis Index (T.B.A.)
- Subjects Selection Test (S.S.T.)
- Students Attitudinal Test (S.A.T.T.)
- Students Achievement Test (S.A.T.)
- Students Psychomotor Test (S.P.T.)

Notes of Lesson
↓
Inter-rater reliability
↓
Pre-test (SATT, SAT, SPT)
↓
Treatment

Post-test (SATT, SAT, SPT)
↓
Reliability Determination →

MAIN STUDY

→ Validation (Further if necessary)
↓
S.S.T.

R.I.
TBA
CSS

↓
Pre-test (SATT, SAT, SPT)

Experimental Gp 1 (E_1)

Control Group (C)
↓
Treatment
(a) E_1 and E_2 as in designed notes
(b) Placebo for C
↓
Post-test
All groups.

The Pilot Study

This phase of the investigation was carried out to fulfil three main purposes. First, it was an attempt to test the viability and workability of the research design. This was an attempt to isolate the design weaknesses and short-comings and apply necessary corrective measures before the main study was carried out. Second, it was aimed at collecting further data concerning the reliability of the instruments with a view to improving their quality and sensitivity. The third purpose of the pilot study was to identify the administrative and logistic problems that were likely to be encountered in the main study.

Sample Selection

A. Teachers: Six regular biology graduate teachers of All Saints Grammar School, Ondo, Independence Grammar School, Ondo and Ondo Grammar School, Ondo were selected as the experimental and control group teachers respectively.

B. Schools: An inspection of the schemes of work for form four biology students in and around Ondo revealed that eight schools have not taught their students the content specified for the treatment in the study. Three schools - All Saints Grammar School, Independence Grammar School and Ondo Grammar School - all in Ondo town - were selected; the first two as the experimental groups and the third as the control group.

C. Students: All cl ss four students in the selected schools were included in the study for the purpose of treatment. However, data in respect of students in only one arm in each selected school were collected and analysed. The arm was selected on a random basis.

D. Textbooks: The textbooks involved in the study; Mackean, Ewusie, Stone and Cozen were chosen on the basis of their wide usage (Balogun, 1978), and STAN Biology was selected on its likely popularity in Nigerian secondary schools as the sister publication to STAN Integrated Science.

E. Authors: Four biology textbook authors based in Ondo State were selected. They are biology graduates who have at least a published book in addition to at least 5 years teaching or post-qualification experience.

F. Ministry Officials: Four officials of the Ondo State Ministry of Education responsible for biology textbooks selection were selected. They are biology graduates who have performed such functions for at least 5 years.

G. <u>Publishers</u>: Four publishing house personel were selected. They are biology graduates who have been involved in biology textbooks preparation for at least 5 years.

<u>Instrumentation</u>

The readability indices were estimated by the Readability Index (R.I.). The communicational strategies in the textbooks were analysed using the Textbooks Analysis Index (T.B.A.), while the preferences of communicational strategies among producers and consumers was estimated by the Communicational Strategies Survey (C.S.S.).

Achievement data were collected using the Students Achievement Test (SAT). The scientific attitudes of the students were measured using the Students Attitudinal Test (SATT). The sixth outcome measure - practical skills was assessed by way of the Student Psychomotor Test (SPT) in conjuction with the Students Practical Assessment Inventory (SPAI).

The responses of the pilot study samples to these instruments when administered as pre-tests were further analysed to provide further information concerning their reliabilities and item characteristics.

The Kuder-Richardson (21) reliability estimates of the instruments were as follows; RI = 0.96; T.B.A. = 0.98; C.S.S. = 0.99; S.A.T. = 0.98; SATT = 0.90; SPT/SPAI = 0.95.

Procedure

Training of Participating Teachers

The six experimental group teachers were assigned two each to Experimental Groups I and II. The other two teachers who were given placebo treatment were assigned to the control group. These teachers were subjected to a total of two weeks training. It was made up of 80 minutes session per day. The schedule of training based on the identified phases was implemented. The pilot study thus helped to ascertain the feasibility of the training programme.

At the end of the training period, the investigator was satisfied with the high degree of homogeniety obtained for the teachers. Although only one teacher was finally selected from each group for the purpose of the pilot study, this training effect convinced the investigator that the teachers that would be trained for the purpose of the main study would also exhibit desirable homogenous characteristics needed for each treatment condition.

Pre-treatment Activities

Pre-treatment activities were in the following areas:

Textbooks: This involved the collections and identification of textbooks to be used in the readability determination and textbooks analysis. The 1982 editions (the most current) of the textbooks were used, and STAN 1983 edition. The pages were examined to make sure there were no missing pages.

Communications Strategies Survey Respondents: To reduce communication and enhance a fast administration of the C.S.S. in the pilot study, the investigator carried out a pl preliminary survey of respondents' locations.

Teaching Unit: This involved the visit to some schools in and around Ondo town to identify a unit to be taught during the treatment phase. NUTRITION was the unit chosen, because it has not been taught in all the schools visited and the schemes of work showed that it would not be taught before the completion of the main study.

For the treatment period, the unit - NUTRITION was broken down into the following lesson topics;

1. Food for metabolism.
2. Holophytic, holozoic and saprophytic nutrition.
3. Mineral salts for mammals and angiosperms.
4. Carbohydrates, fats and proteins: their composition, use and guide to food test.
5. Vitamins: Sources, functions and deficiency diseases.
6. Feeding methods of animals: herbivores, carnivores, omnivores, filter-feeders, parasites and saprophytes.
7. Digestion and its consequences: Ingestion, physical and chemical digestion.
8. Mammalian teeth and jaws: Tooth structure and types of teeth.
9. Herbivores and carnivores teeth and jaws.
10. Mammalian alimentary canal.
11. Absorbtion of food at the villi.
12. Practical exercises on food tests, and experiment with digestive enzymes.
13. Gut of herbivores and carnivores.
14. Storage of food.

15. The liver: Functions and secretions.

16. Diet--balanced diet and the occurrence of Kwanshiokor.

Notes of Lesson: These have been designed for the treatment period. It was based on the identified teaching unit. The notes of lesson emphasised the eight communicational strategies under consideration. The notes indicated specific time allowed for the treatment of a material and the specific communicational strategy involved. For the six weeks duration assigned for the study, treatment was for 80 minutes per week.

On the appointed day when the study was expected to start, each teacher administered the SAT, SATT and SPT/SPAI as pre-test to the experimental group E_1 and control group C.

A list of materials and all the materials needed during the treatment phase were collected and checked. These included; Onion bulbs, iodine solution, fehling's solutions I and II (mixed), razor blades, test-tubes and hand lenses.

Only the experimental groups E_1 and E_2 used the designed notes of lesson, while the control group C were taught based on the teachers style and method.

Treatment Implementation

The treatment phase were in different categories. Each stage is described blow:

Readability Determination

Flesch's (1948) readability formulae and its interpretation data relative to Nigerian schools was used (Wahome, 1979). The readability indices were for all the textbooks involved in the study.

Twenty pages were sampled from each of the textbooks used in the pilot study. The procedure adopted was, to sample every tenth page starting from page one.

From each of the sampled pages, a paragraph with about 100 words were chosen. The following data were subsequently quantified;

(i) Number of words in the sample.

(ii) Number of syllables in the sample.

(iii) Number of sentences in the sample.

(iv) Average sentence length (ASL).

$$ASL = \frac{\text{Number of words in the sample}}{\text{Number of sentences in the sample}}$$

(v) Word length = Number of syllables in 100 words.

From the data, the Flesch's readability score (RS) for each of the pages is given by;

R.S. = 206.835 - 0.846 WL - 1.015 ASL.

Where R.S. = Readability score; WL = Word length;

ASL = Average sentence length.

For all the textbooks, the readability score was estimated for all the sampled pages. The average readability score for each textbook was subsequently estimated.

The readability scores were then interpreted using adapted Wahome's (1979) interpretiation of readability data relative to Nigerian schools.

TABLE 3

Wahome (1979) Interpretiation Data (Adapted)

Readability Scores	70-79	60-69	50-59	40-45
Average sentence length (ASL)	14	17	21	25
Syllables per 100 words	139	147	155	167
Description of style (4th Year Students)	Easy	Fairly easy	Standard	Fairly difficult

Communicational Strategies Analysis

The communicational strategies specified for the study that were used in all the textbooks were analysed. These were in respect of all categories of: questioning styles, technical terms, specimens, major themes, pictures and diagrams, practical exercises and physical characteristics.

The same sampling method was used as in the readability determination.

Communicational Strategies Survey

The survey was to determine among producers and consumers of biology textbooks their preferences of the type and nature of communicational strategies they preferred. Four members of the groups involved were randomly selected for the survey. Altogether, there were twenty respondents in the pilot study.

Each of the respondents was given the instrument to complete. The respondents in the presence of the investigator read through the material for necessary clarifications. On the average, each respondent spent 40 minutes to complete the instrument.

Experimental Setting

At the end of the secor: week, the experimental and control groups teachers engaged the students in biology lessons based on individual notes of lesson.

In each condition, the teacher started by briefly reviewing the previous lesson and then introduced the day's lesson to the whole class. This took an average of 5 minutes. The new materials were then introduced. This usually lasted for about 70 minutes. Towards the end of the lesson, the teachers reviewed the lesson. This lasted about 5 minutes.

Post-Treatment Stage

This stage only involved the experimental setting. This stage was executed at the end of the treatment stage. The post-test involved the administration of the SAT, SATT and SPT/SPAI. These were exactly the same instrument as the one used in the pre-test stage. This fact was never disclosed to the teachers, nor the students, it was exclusively known to the investigator.

Each of the instruments were administered for 60 minutes each. The sequence adopted was; Day 1: SATT; Day 2: SAT;

and Day 3: SPT/SPAI. This was done in the week immediately after the treatment phase.

Conclusion

It is pertinent to observe that the pilot study has provided certain useful information such as;

(a) A reasonable degree of confidence in the design used in the study.

(b) An improvement in the quality and the sensitivity of instruments.

(c) Availability of instructional materials for the main study.

(d) The development of useful experiences and insight relative to the rigour involved in carrying out an experiment in a field setting.

It was the investigator's hope that the pilot study would provide a suitable platform upon which the main study would be based.

CHAPTER FOUR

MAIN STUDY METHODOLOGY

Sample Selection

The following samples were involved in the main study.

1. **Biology Textbooks:** The four biology textbooks involved in the study were:
   (a) Mackean, D.G. Introduction to Biology. West African Edition. Heinemann Educational Books (Nigeria) Limited, 1982.
   (b) Ewusie, J.Y. Tropical Biology for O'Level and School Certificate. African Universities Press in Association with Harrap, London, 1982.
   (c) Stone, R.H. and Cozens, A.B. New Biology for West African Schools. Longman Group Limited, London, 1982.
   (d) STAN Biology. Addison Wesley, London 1983.

The first three were chosen on the basis of their popularity and wide usage (Balogun, 1978). The fourth is the latest biology textbook in the market, it was selected as earlier stated on the probability of its success judging from an earlier effort with respect to STAN Integrated Science.

2. Publishing Company Personel: Ten randomly selected personel in the publishing industry were involved in the survey aspect of the study. They are biology graduates with at least five years experience in the publication and/or marketing of biology textbooks. They were all based in Oyo State.

3. Ministry of Education Officials: Ten randomly selected Ministry of Education officials were involved in the C.S.S. They are biology graduates who had been involved for at least five years in biology textbooks selection for schools in Oyo State.

4. Authors of Biology Textbooks: Also included in the C.S.S. were ten randomly selected authors who had published at least a biology textbook for the Nigerian secondary schools. Co-authors and contributors to biology textbooks were included. They were all biology graduates with 5 years post-qualification experience in the educational enterprise.

5. Biology Teachers: A random selection was made of 19 biology teachers from Oyo State secondary schools. Ten of them participated in the C.S.S. and nine in the

experimental setting. They were all biology graduates with at least 5 years post-qualification experience. The selection of the experimental setting teachers was based on two conditions.

First, the teachers should be amenable to the vigorous training programme required of the experiment. The regular teachers fulfilled this condition.

Second, participating teachers must be able to operate within the school system for a minimum of fourteen weeks. This also made the choice of the regular teachers imperative. Although only three teachers participated in the experiment, the decision to allow additional six was to make ample provision for mortality during training as well as during the treatment period.

6. <u>Students</u>: One hundred and fifty-four students were involved in the study. They were selected from three secondary schools in Ibadan. Form four students were found desirable because unlike the form three students, they had been sufficiently exposed to biology. Also they are not under any pressure to prepare for the WASC examination as is the case of form five students.

7. <u>Secondary Schools:</u> Three secondary schools in Ibadan were selected for the main study. The three selected schools were;

(i) Cheshire High School, Ibadan: Experimental Group 1 (E_1).

(ii) Jericho High School, Ibadan: Experimental Group 2 (E_2).

(iii) Bishop Onabanjo High School, Ibadan: Control Group (C).

The selection of the schools was based on the following criteria;

(i) The schools were approved by the Oyo State Ministry of Education to offer science subjects at the WASC examination.

(ii) The schools had approved science laboratories as determined by WAEC.

(iii) The schools had qualified biology teachers, with at least a graduate in biology who had a minimum of five years post-qualification experience.

(iv) To further ensure comparability of schools, a

"Subject Selection Test" (SST) was administered. Originally, twelve schools with a population of 486 students were involved. On the basis of their performance, three schools with comparable results were selected. This is given below;

TABLE 4

Pre-Treatment Sample Mean Score in Nine Schools

School	N	$\bar{X}$	S.D.
1	48	46.13	2.44
2	48	45.96	2.44
3.	48	45.94	2.40
4	48	50.14	3.0
5	48	40.12	2.21
6	48	40.24	2.23
7	48	35.24	2.01
8	48	34.91	1.91
9	48	53.12	3.21

The comparability of the schools was further confirmed by the low t-test values. A critical t-test value of 2.01

was required to establish any significant differences in the three schools. In no case did the t-test value reach unity in all the pairwise comparisons. This is given below;

TABLE 5

Pre-Treatment Sample Scores Analysis in the Three Schools Selected (N = 48

School	$\bar{X}$	S.D.	$\bar{X}$ Difference	T-test Value
1	46.13	2.44		
vs			0.17	0.40 (ns)
2	45.96	2.44		
1	46.13	2.44		
vs			0.19	0.40 (ns)
3	45.94	2.40		
2	45.96	2.44		
vs			0.02	0.06 (ns)
3	45.94	2.40		

Note: ns = not significant at 0.05, α - level.

It should be pointed out that the content of the S.S.T.

was not in any way related to the content of the instruments used in the study.

The S.S.T. (APPENDIX 4) was administered eight weeks before the begining of the main study.

The S.S.T. was made up of 50 items. The content was based on the extent of coverage of designed syllabus for form three students in biology for Oyo State secondary schools. Originally, it consisted of 60 items. However, after the validation process by nine secondary school biology teachers, ten items considered unsuitable were eliminated leaving 50 items on the test. A preliminary administration of the instrument on 48 other students yielded a reliability coefficient of 0.97 using the Kuder-Richardson 21.

As can be seen in Table 5; the three school chosen were not significantly different from each other. The schools and their students were consequently found suitable for the study.

Instrumentation

All the instruments employed for data gathering during the pilot study phase were used after appropriate modifications were made. The coefficient of reliability (KR 21) obtained for the instruments for the main study sample are; RI = 0.97; T.B.A. = 0.97; C.S.S. = 0.98; S.A.T. = 0.97; S.A.T.T. = 0.90; and SPT/SPAI = 0.95.

Procedure

Four weeks before the study began, the nine teachers involved in the study were subjected to a training programme identical to that of the pilot study. It was relatively easier implementing the training programme during this phase of the study. During the training session the investigator assessed the experimental group teachers for training effect. This was complemented with discussions on noticed deficiences.

At the end of the training, the experimental and control group teachers adjusted their time-table. This was to ensure that a lesson lasted 80 minutes and convinient for the investigator to be present for at least 50 minutes during the lessons.

For the readability determination and textbooks analysis, the investigator collected all the textbooks to be used for examination. The examination was to ensure that the texts were the most current editions (all were

1982 except STAN Biology which was 1983) available in Nigeria. The examination also involved ensuring that the texts were genuine ones since textbooks pirated are numerous in Nigeria. All the pages of the textbooks were also ascertained to ensure there were no missing pages.

After these examinations, the investigator commenced with the readability determination of all the textbooks. This lasted for seven days consecutively.

The textbooks analysis was carried out a week after the readability determination of the textbooks. The analysis lasted for ten days.

Respondents' preferences for communicational strategies in biology textbooks were sought two weeks after the textbooks analysis. The survey was done in two weeks.

Pre-Treatment Activities

The pre-treatment activities as were carried out in the pilot study were also ensured in the main study. This was with respect to the textbooks to be used, the survey of respondents, the teaching of the units and the notes of lesson.

The first 3 days of the experiment was devoted to the administration of the SATT, then the SAT and the SPT/SPAI on the third day. This pre-test phase was only for Exp! Experimental Group I (E_1) and Control Group (C).

The investigator also ensured that the Experimental Group 1 and 2 (E_1 and E_2) teachers had their designed notes of lesson. The materials for the practical sessions were also checked. The teacher for the Control Group (C) was also checked to ensure that he has the scheme of work and the topics to be taught.

Treatment Implementation

The treatment was implemented as described for the pilot study. A rigorous check and monitoring system was employed to ensure the reliability of treatment implementation. Three teachers previously trained took part in the experiment. The treatment lasted for six weeks. The Experimental Group teachers 1 and 2, (E_1 and E_2) use the same treatment while the Control Group (C) teacher used his own method. All the teachers taught identical content.

Post-Treatment events

At the beginning of the week following the treatment, the SATT, SAT and SPT/SPAI were administered to all the groups as post-test. The teachers involved in the study were written letters of appreciation and later visited by the investigator. Scheduled visits were also paid to the publishing houses, ministry of education and Principals to express gratitude for their understanding and co-operation.

Observations in the Field

There were numerous problems which investigators might encounter. Hearney's (1969) schema, modified by Balogun (1975) identified the following;

(i) Personal: Time, administration and public relations.

(ii) Design: Design features, sample and tests.

(iii) School: Head, teacher and pupils.

(iv) Materials: Relevance.

In addition to the time and care required for the readability determination, textbooks analysis and survey of preferences, it is worth mentioning the difficulty involved in getting an accurate syllable count. In the end, the investigator and four english graduates had to use tape-recorded paragraphs of the sampled books to get the accurate syllable counts.

Obtaining the necessary co-operation from school heads was al was also a difficult task. With low student-teacher ratio; others on maternity leave or leave of absence, many principals saw the investigator as an intolerable intruder who came to distrupt the school scheme of work. These problems had made it difficult to involve as many schools as one would have wished in the study.

Analysis of the data

All the data collected for testing the hypotheses were analysed with the computer using the appropriate SPSS sub-programmes.

The F-test and t-test, were found adequate in determining the differences that might exist in the samples compared.

CHAPTER FIVE

RESULTS

In this chapter, the results have been presented as they relate to the hypotheses of interest. In presenting the result, the descriptive and inferential statistics associated with the dependent variables have been described.

Hypothesis 1 (Ho 1)

There is no significant differercein the frequency of questioning styles, technical terms, major themes, diagrams and pictures, specimens and practical exercises used by the four biology textbooks involved in the study.

This hypothesis was tested using the analysis of variance and Tukey's post-hoc test.

Questioning Styles

The levels of questioning styles analysed included: factual, rheotorical, leading, probing, introductory, contextual, terminal and captional.

TABLE 6

Frequency and Percentage of Types of Questions Used in Four Biology Textbooks

Type of Questions	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Factual	153	78.46	270	79.65	200	85.47	142	89.30
Rheotorical	0	0.00	0	0.00	0	0.00	0	0.00
Leading	14	7.18	36	10.62	14	5.98	7	4.41
Probing	28	14.36	33	9.73	20	8.55	10	6.29
Total No. of Questions	195	100.00	339	100.00	234	100.00	159	100.00
No of Statements	12,530		9,605		8,895		4,820	
Percentage of Questions per Statement	1.60		3.53		2.63		3.30	

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

Table 6 represents the frequency and percentage of the different types of questions in the four biology textbooks.

The table reveals that all the textbooks have mostly factual questions. The magnitude was in the order of ST = 153 (78.46%), MK 270 (79.65%), EW 200 (85.47%) and SC 142 (89.30%). Rheotorical questions were not represented in any of the textbooks. Leading and probing questions ranged from 4% to 15% which is very low.

TABLE 7

Frequency and Percentage of Questions by Position in Four Biology Textbooks

Position of Questions	ST		MK		EW		SC	
	Freq	%	Freq	%	Freq	%	Freq	%
Introductory	0	0.00	2	0.59	0	0.00	9	5.66
Contextual	0	0.00	9	2.66	0	0.00	0	0.00
Terminal	195	100.00	328	96.75	234	100.00	150	94.34
Captional	0	0.00	0	0.00	0	0.00	0	0.00
TOTAL	195	100.00	339	100.00	234	100.00	159	100.00

Key: ST = STAN BIOLOGY: MK = MACKEAN: EW = EWUSIE

SC = STONE AND COZENS.

Table 7 also represents the frequency and percentage of questions in the textbooks with respect to their position of occurrence. The table indicate a preponderance of terminal questions represented as ST 195 (1.00%); MK 328 (96.75%); EW 234 (100.00%); SC 150 (94.34%). Amongst the textbooks, contextual questions was present only in Mackean 9 (2.66%). In all the textbooks, introductory questions were poorly represented, while captional questions were not represented at all.

On the whole, Mackean has the highest number of questions. It contained 339 questions in 9,600 statements which is about 3.53% of questions per statement.

Ewusie has 234 questions in 8,895 statements representing 2.63% of questions per statement.

Stone and Cozens has the lowest number of 159 questions in 4,820 statements, representing 3.30% questions per statements.

With 195 questions in 12,530 statements, STAN Biology has the least percentage of 1.60% per statement.

The summary of the analysis of variance performed on the questioning styles scores is presented in Table 8.

TABLE 8

Summary of the Analysis of Variance of Introductory, Contextual, Terminal, Factual, Leading and Probing Questions (Questioning Styles) in Four Biology Textbooks

Measure (Strategy)	Source	SS	df	MS	F
	Between	10166.80	3	3388.93	
Factual	Within	28000.00	36	780.00	4.34*
	Total	38166.80	39		
	Between	4767.50	3	1589.17	7.15*
Leading	Within	8050.00	36	222.00	
	Total	12817.50	39		
	Between	3027.50	3	1009.17	4.83*
Probing	Within	7520.00	36	208.89	
	Total	10547.50	39		
	Between	447.50	3	149.17	0.00
Introductory	Within	0.00	36	0.00	
	Total	447.50	39		
	Between	480.00	3	160.00	0.00
Contextual	Within	0.00	36	0.00	
	Total	480.00	39		
	Between	17202.80	3	5733.00	4.50*
Terminal	Within	45000.00	36	1250.00	
	Total	62202	39		

Textbooks = ST (STAN BIOLOGY); MK (MACKEAN); EW = EWUSIE; SC = STONE AND COZENS;

F_{table} (Critical value) = 4.31; α-Level = 0.001; * = Significant scores.

On the basis of the F-values in Table 8, the following decision has been reached concerning Ho_1:

The notion that there is no significant difference in the number of factual ($F_{3,36} = 4.34$, $p < 0.001$); leading ($F_{3,36} = 7.15$, $p < 0.001$); probing ($F_{3,36} = 4.83$, $p < 0.001$) and terminal ($F_{3,36} = 4.50$, $p < 0.001$) questions can not be upheld and the hypothesis is therefore rejected.

However, the assertion that there is no significant difference in the number of introductory ($F_{3,36} = 0$, $p < 0.001$) and contextual ($F_{3,36} = 0$, $p < 0.001$) questions have been upheld, and hence the hypothesis is accepted.

In all these cases a critical F-value of 4.31 is needed to reject the Null hypothesis.

The strategies that displayed significant differences were further subjected to <u>a posteriori</u> contrasts. Application of the Tukey's test indicates that these 'Honestly significant Differences' lie as in Table 9.

TABLE 9

Summary of Tukey's a posteriori procedure on Introdutory, Contextual, Terminal, Factual, Leading and Probing Questioning Styles in Four Biology Textbooks

Measure (Strategy)	Range of Significant Scores
Factual	Mk (270.00)>EW (200.00)>ST (153.00)>SC (142.00)
Leading	MK (36.00)> ST (14.00) = EW (14.00)> SC (7.00)
Probing	MK (33.00)>ST (28.00)>EW (20.00)> SC (10.00)
Introductory	No significant differences
Contextual	No significant differences
Terminal	MK (328.00)>EW (234.00)>ST (195.00)>SC (150.00)

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

<u>Factual questions:</u> Mackean was found to have significantly higher number than Ewusie. Ewusie in turn was higher than STAN Biology, while STAN Biology had significantly more factual questions than Stone and Cozens. As in Table 9, the performance is in the order of; MK > EW > ST > SC.

<u>Leading questions:</u> The significant differences were in the order of Mackean, followed co-jointly by STAN Biology and Ewusie and lastly Stone and Cozens. As in Table 9, the performances are in the order of; MK > ST = EW > SC.

<u>Probing questions:</u> The significant difference in the number of probing questions ranged from Mackean, then STAN Biology, Ewusie and lastly Stone and Cozens. As indicated in Table 9, the performances are in the order of; MK > ST > EW > SC.

<u>Terminal Questions:</u> The significant differences ranged from Mackean, then Ewusie, STAN Biology and lastly Stone and Cozens, that's MK > EW > ST > SC (Table 9).

<u>Technical Terms</u>

The different levels of technical terms analysed were: terms defined at first occurrence; terms defined immediately after their occurrence; terms defined later in the text and undefined terms.

TABLE 10

Frequency and Percentage of Technical Terms Used in Four Biology Textbooks

Technical Terms	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Defined at first Occurrence	346	91.53	481	89.07	240	86.02	370	84.67
Defined immediately after occurrence	22	5.82	40	7.41	24	8.15	30	6.87
Defined later in text	10	2.65	19	3.52	15	5.83	17	3.89
Undefined	0	0.00	0	0.00	0	0.00	20	4.57
Total	378	100.00	540	100.00	279	100.00	437	100.00

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

Table 10 represents the description of the frequency and percentage of technical terms in the textbooks.

As shown in Table 10, all the textbooks defined most of the technical terms at their first occurrence. It was found out that there were few technical terms defined immediately after occurrence. Technical terms defined later in the text were fewer still. Except Stone and Cozens with a few undefined technical terms, virtually all the textbooks defined their terms.

When the defined technical terms in the four textbooks are considered, Mackean was found to contain the highest (540), Stone and Cozens was next with 417, less 20 undefined technical terms) STAN Biology had 378 and Ewusie had the least number of 279.

In addition, in Stone and Cozens, it was found that there were more undefined technical terms 20 (4.57%) than technical terms defined later in the text 17 (3.89%).

The summary of the analysis of variance performed on the technical terms is provided in Table 11.

TABLE 11

Summary of the Analysis of Variance of Status of Technical Terms Used in the Four Biology Textbooks

Measure (Category)	Source	SS	df	MS	F
Defined at first occurrence	Between	5403.48	3	1801.16	8.12*
	Within	8000.00	36	222.20	
	Total	13403.48	39		
Defined immediately after occurrence	Between	1960.00	3	653.33	4.58*
	Within	5140.00	36	142.78	
	Total	7100.00	39		
Defined later	Between	447.50	3	149.17	4.41*
	Within	1216.50	36	33.79	
	Total	1664.00	39		
Undefined	Between	2707.50	3	902.50	5.08*
	Within	6400.00	36	177.78	
	Total	2711.50	39		

Textbooks = ST (STAN BIOLOGY); MK (MACKEAN); EW (EWUSIE); SC (STONE AND COZENS).

Ftable (critical value) = 4.31; α-level = 0.001;

* = Significant scores.

On the basis of the F-values in Table 11, the following decision has been reached concerning Ho_1:

The hypothesis that there is no significant difference in the number of technical terms defined at first occurrence ($F_{3, 36} = 8.12$, $p < 0.001$); technical terms defined immediately after occurrence ($F_{3, 36} = 4.58$, $p < 0.001$); technical terms defined later ($F_{3, 36} = 4.41$, $p < 0.001$) and undefined technical terms ($F_{3, 36} = 5.08$, $p < 0.001$) has not been upheld by the data available. The critical F-value needed to reach this decision is 4.31. All the calculated F-values are higher than the critical value.

These significant differences were further subjected to Tukey's *a posteriori* contrast test. The test indicates that these 'Honestly Significant Differences' lie as in Table 12.

TABLE 12

Summary of Tukey's *a posteriori* procedure on Status of Technical Terms Used in the Four Biology Textbooks: Defined at First Occurrence; Defined immediately after Occurrence: Defined later; Undefined

Measure (Strategy)	Range of significant scores
Defined at first occurrence	ST (546.00) > MK (481.00) > SC (370.00) > EW (240.00)
Defined immediately after occurrence	MK (40.00) > SC (30.00) > EW (24.00) > ST (22.00)
Defined later	MK (19.00) > SC (17.00) > EW (15.00) > ST (10.00)
Undefined	SC (20.00) > ST (1.00) = MK (1.00) = EW (1.00)

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

<u>Technical terms defined at first occurence</u>; The performances were in the order of STAN Biology, then Mackean, Stone and Cozen and lastly Ewusie, that's ST > MK > SC > EW (Table 12).

<u>Technical terms defined immediately after occurrence</u>; As in Table 12, the performances were in the order of Mackean, then Stone and Cozen, Ewusie and lastly STAN Biology, that's MK > SC > EW > ST.

<u>Technical terms defined later</u>; Mackean has the highest, followed by Stone and Cozens, then Ewusie and lastly STAN Biology, that's MK > SC > EW > ST (Table 12).

<u>Technical terms undefined</u>; Stone and Cozens had the highest, while STAN Biology, Ewusie, Stone and Cozens had equal number, though appreciably very low. As in Table 12, the performance is of the order; SC > ST = MK = EW.

<u>Specimen</u>

The different categories of specimens examined were; local and nonlocal.

TABLE 13

Frequency and Percentage of Specimen in the Four Biology Textbooks

Specimen	ST		MK		EW		SC	
	Freq	%	Freq	%	Freq	%	Freq	%
Local	374	100.00	267	98.52	230	97.87	274	97.51
Nonlocal	0	0.00	4	1.48	5	2.13	7	2.49
Total	374	100.00	271	100.00	235	100.00	281	100.00

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE
SC = STONE AND COZENS.

Table 13 represents the description of the frequency and percentage of specimens mentioned in the textbooks.

Table 13 shows that all the textbooks use mostly local specimens in their illustrations. STAN Biology which has the highest number of local specimens (374), has no non-local specimen. Although Stone and Cozens has the next highest number of local specimens(274), it also has the highest number of non-local specimens (7). Both Mackean and Ewusie has 267 and 230 local specimens respectively. Also, Mackean and Ewusie had 4 and 5 non-local specimens respectively.

The summary of the analysis of variance of the number of specimens in the textbooks is shown in Table 14.

TABLE 14

Summary of the Analysis of Variance of Local and Non-Local Specimens in the Four Biology Textbooks

Measure (Strategy)	Source	SS	df	MS	F
	Between	1138.48	3	379.49	
Local	Within	2841.00	36	78.92	4.81*
	Total	3979.48	39		
	Between	194.08	3	64.69	
Non-Local	Within	538.25	36	14.95	4.33*
	Total	732.33	39		

Textbooks = ST (STAN BIOLOGY): MK (MACKEAN); EW (EWUSIE) SC (STONE AND COZENS).

F table (Critical Value) = 4.31; α -Level = 0.001;
* = Significant Scores.

On the basis of the F-values shown in Table 14, the following decision has been reached concerning Ho_1;

The ascertion that there is no significant difference in the number of local specimens ($F_{3,36} = 4.81$, $P < 0.001$) and non-local specimens ($F_{3,36} = 4.33$, $p < 0.001$) has not been supported by the findings in this study.

These significant differences were further subjected to Tukey's a posteriori contrasts test. The test indicates that these 'Honestly Significant Differences' lie as whown in Table 15.

TABLE 15

Summary of Tukey's a Posteriori procedure on Local and Non-Local Specimens in the Four Biology Textbooks

Measure (Strategy)	Range of Significant Scores
Local	ST (374.00) > SC (274.00) > MK (267.00) > EW (230.00)
Non-Local	SC (7.00) > EW (5.00) > MK (4.00) > ST (0.90)

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE;

SC = STONE AND COZENS.

<u>Local Specimens</u>: STAN Biology was found to contain significantly the highest number of local specimens followed by Stone and Cozens, then Mackean and lastly Ewusie, that is ST > SC > MK > EW (Table 15).

<u>Non-Local Specimens</u>: Stone and Cozens had significantly more non-local specimens followed by Ewusie, then Mackean and lastly STAN Biology, that's SC > EW > MK > ST (Table 15).

<u>Major Themes</u>

The various levels of major themes examined were; evolution, ecology, economic importance, inquiry method, history, knowledge, world-view.

These themes were selected by the investigator based on their frequency of occurrence in all the biology textbooks examined. Their selection was also based on the expressed opinion of classroom teachers and science educators during the validation process. They represent the most prominent themes in Nigerian secondary schools biology textbooks.

TABLE 16

Frequency and Percentage of Major Themes in the Four Biology Textbooks

Major Themes	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Evolution	36	14.00	20	12.90	25	12.14	23	11.98
Ecology	36	14.00	23	14.84	24	11.65	22	11.46
Economic Importance	20	7.78	23	14.84	31	15.05	28	14.58
Inquiry	86	33.46	20	12.90	54	26.21	47	24.48
History	24	9.34	30	19.36	23	11.17	24	12.50
Knowldege	35	13.64	39	25.16	49	23.78	48	25.00
World-view	20	7.78	0	0.00	0	0.00	0	0.00
TOTAL	257	100.00	155	100.00	206	100.00	192	100.00

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE; SC = STONE AND COZENS.

Table 16 represents the description of the frequency and percentage of major themes in the textbooks. As shown in the table, all the textbooks have the major themes well represented in them. With respect to the evolutionary theme, STAN Biology had the highest value of 36, while Ewusie had 25 and Stone and Cozens had 23. Mackean had the least value of 20.

For the ecological theme, STAN Biology had the highest value of 36. The other textbooks have comparable values of Ewusie 24, Mackean 23 and Stone and Cozens 22.

On economic importance, Ewusie had the highest value of 31, then Stone and Cozens 28, Mackean 23 and STAN Biology had the least value of 20.

With regard to inquiry method, STAN Biology had the highest value of 86, Ewusie, Stone and Cozens and Mackean have 54, 47 and 20 respectively.

For historical theme, Mackean had the highest value of 30, STAN Biology and Stone and Cozens had 24 each, while Ewusie had 23.

For the knowledge theme, Ewusie had the highest value of 49, followed by Stone and Cozens 48, Mackean had 39 and STAN Biology 35.

Considered on the basis of the most occurring themes in each textbook, a clear picture is painted.

In STAN Biology, the range of occurrence is, inquiry 33.46%, evolution 14%, ecology 14%, knowledge 13.64%, history 9.34%, world-view 7.78% and economic importance 7.78%.

The range in Mackean is, knowledge 25.16%, history 19.36%, ecology 14.84, economic importance 14.84, evolution 12.90%, inquiry 12.90% and world-view 0.00%.

Ewusie has the representation as, inquiry 26.21%, knowledge 23.78%, economic importance 15/05%, evolution 12.14%, ecology 11.65%, history 11.17% and world-view 0.00%.

For Stone and Cozens, the range is, knowledge 25.00%, inquiry 24.48%, economic importance 14.58%, history 12.50%, evolution 11.98%, ecology 11.46%, and world-view 0.00%.

It is significant to emphasize that traditional world-view was represented as a theme only in STAN Biology.

The summary of the analysis of variance performed on the major themes represented in the textbooks is described in Table 17.

TABLE 17

Summary of the Analysis of Variance of Major Themes (Evolution; Ecology; Economic Importance; Inquiry; History; Knowledge and World-view in the Four Textbooks

Measure (Strategy)	Source	SS	df	MS	F
	Between	1460.00	3	486.69	
Evolution	Within	3180.00	36	88.33	5.51*
	Total	4640.00	39		
	Between	1274.81	3	424.94	
Ecology	Within	3116.60	36	86.57	4.91*
	Total	4390.41	39		
Economic	Between	730.00	3	243.33	
Importance	Within	2015.00	36	55.97	4.34*
	Total	2745.00	39		
	Between	2211.67	3	737.23	
Inquiry	Within	5220.00	36	145.00	5.08*
	Total	7431.67	39		
	Between	307.50	3	102.50	
History	Within	845.22	36	23.48	4.36*
	Total	1152.72	39		
	Between	1407.50	3	469.17	
Knowledge	Within	3282.50	36	91.18	5.15*
	Total	4690.00	39		
	Between	2707.50	3	902.50	
Worldview	Within	0.00	36	0.00	0.00
	Total	2707.50	39		

TEXTBOOKS = ST (STAN BIOLOGY): MK(MACKEAN); EW(EWUSIE); SC (STONE AND COZENS); Ftable (CRITICAL VALUE) = 4.31; α -level = 0.001; * = Significant Scores.

On the basis of the F-values in Table 17, the following decision has been reached concerning Ho_1;

The notion that there is no significant differences in the number of evolutionary themes ($F3,36 = 5.51$, $p < 0.001$); ecological themes ($F3,36 = 4.91$, $p < 0.001$); economic importance themes ($F3,36 = 4.34$, $p < 0.001$); inquiry themes ($F3,36 = 5.08$, $p < 0.001$); historical themes ($F3,36 = 4.36$, $p < 0.001$) and knowledge themes ($F3,36 = 5.15$, $p < 0.001$), as contained in the textbooks has not been upheld with the data presented in Table 17.

The notion that there is no significant difference in the number of traditional world-view themes is, however, upheld ($F3,36 = 0.00$, $p < 0.001$), since the computed value is less than the critical F-value of 4.31.

The significant differences were subjected to Tukey's <u>a posteriori</u> contrasts test. The application of this test indicates that these 'Honestly Significant Differences' are in the order shown in Table 18.

TABLE 18

Summary of Tukey's aoposteriori Procedure on Major Themes: Evolution, Ecology, Economic, Inquiry, History, Knowledge, World-view in the Four Biology Textbooks

Measure (Strategy)	Range of Significant Scores
Evolution	ST(36.00) > EW(25.00) > SC(23.00) > MK(20.00)
Ecology	ST(36.00) > EW(24.00) > MK(23.20) > SC(22.00)
Economic Importance	SW(31.00) > SC(28.00) > MK(23.00) > ST(20.00)
Inquiry	ST(86.00) > EW(54.00) > SC(46.70) > MK(20.00)
History	MK(30.00) > ST(24.00) = SC(24.00) > EW(23.00)
Knowledge	SW(49.00) > SC(48.00) > MK(39.00) > ST(35.00)
Worldview	No Significant Difference in Scores.

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE; SC = STONE AND COZENS.

<u>Evolutionary Themes</u>; STAN Biology was found to significantly contain more evolutionary themes than Ewusie. The latter in turn contains more themes than Stone and Cozens. Mackean seems to contain the least occurrence of evolutionary themes. As in Table 18, the performances are in the order of; ST > EW > SC > MK.

<u>Ecological Themes</u>; The performances ranges from STAN Biology (highest), then Ewusie, Mackean and lastly Stone and Cozens that's ST > EW > MK > SC.

<u>Economic Importance</u>; The significant differences vary from Ewusie having the highest, then Stone and Cozens, Mackean and lastly STAN Biology, that's EW > SC > MK > ST.

<u>Inquiry Themes</u>; The significant differences vary from STAN Biology having the highest frequency, then Ewusie, Stone and Cozens and lastly Mackean, that's ST > EW > SC > MK.

<u>Historical Themes</u>; Mackean was found to significantly contain the highest number, followed by STAN Biology and Stone and Cozens with equal number, while Ewusie had the least number, that's MK > ST = SC > EW.

Knowledge: The significant differences vary from Ewusie having the highest frequency, then Stone and Cozens, Mackean and lastly STAN Biology, that's EW > SC > MK > ST.

Pictures and Diagrams

Another aspect of textbooks quality examined in this study include; labelled and unlabelled pictures, labelled and unlabelled diagrams.

TABLE 19

Frequency and Percentage of Pictures in the Four Biology Textbooks

Pictures	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Labelled	0	0.00	34	3908	1	2.13	19	11.31
Unlabelled	159	100.00	53	60.92	46	97.87	149	88.69
Total	159	100.00	87	100.00	47	100.00	168	100.00
Percentage Per Sampled Pages	79.50		43.50		23.50		84.00	

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE
SC = STONE AND COZENS.

TABLE 20

Frequency and Percentage of Diagrams in the Four Biology Textbooks

Diagrams	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Labelled	451	75.17	488	72.5511	275	64.55	434	62.63
Unlabelled	149	24.833	185	27.49	151	35.45	259	37.37
Total	600	100.00	673	100.00	426	100.00	693	100.00
Percentage Per Sampled Pages	300.00		336.50		213.00		346.50	

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE; SC = STONE AND COZENS.

Tables 19 and 20 represent the description of the frequency and percentage of pictures and diagrams in the textbooks.

An examination of Table 19 on pictures shows that all the textbooks are guilty of a preponderance of unlabelled pictures. On the whole, Stone and Cozens had the highest number of pictures (168), followed by STAN Biology (159), Mackean (87) and lastly Ewusie (47).

It was also observed that all the textbooks contained more diagrams than pictures (Table 20). Stone and Cozones had 693 diagrams; Mackean, 673; STAN Biology, 600 and Ewusie, 426.

STAN Biology had the highest number of unlabelled pictures (159), next was Stone and Cozens (149), Mackean (53) and Ewusie (46).

On unlabelled diagrams, Stone and Cozens had the highest (259), Mackean (185), Ewusie (151) and STAN Biology (149).

The summary of the analysis of variance performed on the diagrams and pictures contained in the textbooks are as shown in Table 21.

TABLE 21

Summary of the Analysis of Variance of Diagrams and Pictures in the Four Biology Textbooks

Measure (Category)	Source	SS	df	MS	F
Labelled diagrams	Between	2652.27	3	884.09	
	Within	5282.25	36	146.73	6.03*
	Total	7934.52	39		
Unlabelled diagrams	Between	7858.10	3	2619.36	
	Within	20125.25	36	559.03	4.69*
	Total	27983.25	39		
Labelled Pictures	Between	762.75	3	254.25	
	Within	2019.28	36	56.09	4.53*
	Total	2782.03	39		
Unlabelled Pictures	Between	1099.48	3	366.49	
	Within	3006.00	36	83.50	4.38*
	Total	4105.48	39		

TEXTBOOKS ST = (STAN BIOLOGY ; MK(MACKEAN); EW (EWUSIE); SC (STONE AND COZENS).

Ftable (Critical value) = 4.31; α -level = 0.001)

* = Significant Scores.

On the basis of the F-values shown in Table 21, the following decision has been reached concerning Ho_1;

The notion that there is no significant difference in the number of labelled diagrams ($F_{3,36} = 6.03$, $p < 0.001$); Unlabelled diagrams ($F_{3,36} = 4.69$, $p < 0.001$); Labelled pictures ($F_{3,36} = 4.53$, $p < 0.001$); Unlabelled pictures ($F_{3,36} = 4.38$, $p < 0.001$) contained in the textbooks can not be upheld.

These significant differences were further subjected to Tukey's a posteriori contrast test (Table 22). The test indicates that these 'Honestly Significant Differences' lie as shown in Table 22.

As shown in the table, when labelled diagrams and pictures are considered, Mackean performed significantly better than the other textbooks. Conversely, while Ewusie performed lower than the others in labelled diagrams, Ewusie and STAN Biology had the poorest representations on labelled pictures.

The various performances are as follows:

TABLE 22

Summary of Tukey's a posteriori procedure on Diagrams and Pictures in the Four Biology Textbooks

Measure (Strategy)	Range of Significant Scores
Labelled diagrams	MK(488.00) > ST(451.00) > SC(434.00) > EW(275.10)
Unlabelled diagrams	SC(259.00) > MK(185.00) > EW(151.00) > ST(149.9[illegible])
Labelled Pictures	MK(34.00) > SC(19.00) > EW(1.00) = ST(1.00)
Unlabelled pictures	ST(159.00) > SC(149.00) > MK(53.00) > EW(46.00)

Key: ST = STAN BIOLOGY; MK = MACKEAN, EW = EWUSIE

SC = STONE AND COZENS.

<u>Labelled diagrams;</u> The significant performances range from Mackean having the highest, then STAN Biology, Stone and Cozens and Ewusie having the least, that is in the order of, MK > ST > SC > EW.

<u>Unlabelled diagrams;</u> The significant performances range from Stone and Cozens having the highest, then Mackean, Ewusie and STAN Biology having the least. The performances are in the order, SC > MK > EW > ST.

<u>Labelled pictures;</u> Mackean was found to contain significantly the highest number. The next in rank is Stone and cozens, followed by Ewusie and STAN Biology with equal number. The performances are in the order, MK > SC > EW = ST.

<u>Unlabelled pictures;</u> STAN Biology has the highest number, followed by Stone and Cozens, Mackean and lastly Ewusie, that's ST > SC > MK > EW.

<u>Practical Exercises</u>

The different levels of practical exercises examined were; simple, specific, general and challenging.

TABLE 23

Frequency and Percentage of Practical Exercises in the Four Biology Textbooks

Practical Exercises	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Simple	30	22.06	15	18.29	65	46.10	70	31.39
Specific	28	20.59	7	8.54	26	18.44	50	22.42
General	8	5.88	5	6.10	9	6.38	13	5.83
Challenging	70	51.47	55	67.07	41	29.08	90	40.36
Total	136	100.00	82	100.00	141	100.00	223	100.00

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

Table 23 represents the description in terms of the frequency and percentage of practical exercises in the textbooks. As indicated in the table, the textbooks have more of challenging exercises and very little of general exercises. Simple and specific exercises were averagely represented.

On challenging exercises, Stone and Cozens had 90, which was the highest, followed by STAN Biology (70), then Mackean (55) and lastly Ewusie (41).

On simple exercises, Stone and Cozens had 70, then comes Ewusie (65), STAN Biology with 30 and lastly Mackean with only 15.

On specific exercises, Stone and Cozens had 50, STAN Biology 28, Ewusie 26 and lastly Mackean with 7.

On general exercises, all the textbooks had poor representation. Stone and Cozens had 13, Ewusie 9, STAN Biology 8 and Mackean 5.

The summary of the analysis of variance performed on the practical exercises in the textbooks is provided in Table 24.

TABLE 24

Summary of the Analysis of Variance of Practical Exercises in the Four Biology Textbooks

Measure (Strategy)	Source	SS	df	MS	F
	Between	2150.00	3	716.66	
Simple	Within	5112.20	36	142.01	5.05*
	Total	7262.20	39		
	Between	9287.50	3	3095.83	
Specific	Within	25282.20	36	702.28	4.41*
	Total	34569.70	39		
	Between	327.50	3	109.17	
General	Within	852.30	36	23.68	4.61*
	Total	1179.80	39		
	Between	1322.00	3	440.66	
Challenging	Within	3285.20	36	91.26	4.83*
	Total	4607.20	39		

Textbooks = ST (STAN BIOLOGY); MK (MACKEAN); EW (EWUSIE); SC (STONE AND COZENS).

Ftable (Critical Value) = 4.31; α -Level = 0.001;

* = Significant Scores.

On the basis of the F-values the following decision has been reached concerning Ho_1;

The notion that there is no significant differences in the number of simple exercises ($F3,36 = 5.05$, $p < 0.001$); specific exercises ($F3,36 = 4.14$, $p < 0.001$); general exercises ($F3,36 = 4.61$, $p < 0.001$) and challenging exercises ($F3,36 = 4.83$, $p < 0.001$) contained in the text-books can not be upheld.

Consequently, with respect to the varying categories of practical exercises in the four textbooks, the assertion that there are no significant differences in their number is rejected.

The hypothesis was rejected because a critical value of 4.31 is all that is needed to reject the hypothesis.

TABLE 25

Summary of Tukey's a posteriori Procedure on Practical Exercises in the Four Biology Textbooks

Measure (Strategy)	Range of Significant Scores
Simple	SC (70.00) > EW (65.00) > ST (30.00) > MK (15.00)
Specific	SC (50.00) > ST (28.00) > EW (26.00) > MK (7.00)
General	SC (13.00) > EW (9.00) > ST (8.00) > MK (5.00)
Challenging	SC (90.00) > ST (70.00) > MK (55.00) > EW (41.00)

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

These significant differences were further subjected to Tukey's _a posteriori_ contrasts test (Table 25). The test indicates that these 'Honestly Significant Differences' lie as in Table 25.

Simple exercises: The significant performances ranging from the highest to the lowest are; Stone and Cozens, then Ewusie, STAN Biology and Mackean, that's SC > EW > ST > MK.

Specific exercises: The significant performances starting from the highest to the lowest are; Stone and Cozens, Stan Biology, Ewusie and Mackean, that's SC > ST > EW > MK.

General exercises: The significant performances starting from the highest to the lowest are; Stone and Cozens, Ewusie, STAN Biology and lastly Mackean, that's SC > EW > ST > MK.

Challenging exercises: The significant performances commencing from the highest to the lowest are; Stone and Cozens, then STAN Biology, Mackean and lastly Ewusie, that's SC > ST > MK > EW.

Physical Characteristics

The different types of physical characteristics of the textbooks examined in this study were; cover colours, text colours and a number of characters in a text.

TABLE 26

Frequency and Percentage of Physical Characteristics in the Four Biology Textbooks

Physical Character-istics	ST Freq	ST %	MK Freq	MK %	EW Freq	EW %	SC Freq	SC %
Cover Colours	7	21.88	5	29.41	4	30.77	4	23.53
Text Colours	15	46.88	2	11.76	2	15.39	2	11.77
Number of Characters	10	31.24	10	58.83	7	53.84	11	64.70
Total	32	100.00	17	100.00	13	100.00	17	100.00

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE;,

SC = STONE AND COZENS.

Table 26 represents the description of the frequency and percentage of the textbooks physical characteristics. It was found out that the number of colours on the cover of the textbooks were comparable. STAN Biology had 7, Mackean 5, while Ewusie and Stone and Cozens had 4 each.

Within the text, there were 15 colours in STAN Biology, while the other three had 2 each. The type of characters used in all the textbooks were also comparable. Stone and Cozens had 11, Mackean 10, STAN Biology 10 and Ewusie 7.

When the type of characters in the textbooks are considered, Stone and Cozens had the highest (11). Next were STAN Biology and Mackean with 10 each, while Ewusie had only 7 characters.

When the physical characteristics are viewed as a unit, STAN Biology had the highest (32), Mackean, Stone and Cozens had 17 each, while Ewusie had the least number of 13.

The summary of the analysis of variance performed on the physical characteristics of the textbooks is presented in table 27.

TABLE 27

Summary of the Analysis of Variance of Physical Characteristics in the Four Biology Textbooks

Measure (Strategy)	Source	SS	df	MS	F
Cover Colours	Between	60.00	3	20.00	
	Within	150.25	36	4.17	4.80*
	Total	210.25	39		
Text Colours	Between	1267.50	3	422.50	
	Within	3285.20	36	91.26	4.63*
	Total	4552.70	39		
Number of Characters	Between	90.00	3	30.00	
	Within	240.52	36	6.68	4.49*
	Total	330.52	39		

TEXTBOOKS = ST (STAN BIOLOGY); MK (MACKEAN); EW (EWUSIE); SC (STONE AND COZENS)

Ftable (critical value) = 4.31; α-Level = 0.001; * =

* = Significant Scores.

On the basis of the F-values shown in Table 27, the following decision has been reached concerning Ho_1:

The notion that there are no significant differences in the number of cover colours ($F3,36 = 4.80$, $p < 0.001$), text colours ($F3,36 = 4.63$, $p < 0.001$); number of characters in the text ($F3,36 = 4.49$, $p < 0.001$) contained in the textbooks can not be upheld.

These significant differences were further subjected to Tukey's a posteriori contrasts test (Table 28. The test indicates that these 'Honestly Significant Differences' lie as in Table 28.

The table shows that in terms of colours used in the textbooks, STAN Biology had significantly higher number of colours, while Ewusie, Stone and Cozens had the least number of colours.

However, on the number of characters used in the textbooks, Stone and Cozens had the highest, while Ewusie had the lowest.

The picture for each of this strategy is described as in Table 28.

TABLE 28

Summary of Tukey's *a posteriori* procedure on Physical Characteristics in the Four Biology Textbooks

Measure (Strategy)	Range of Significant Scores
Cover Colours	ST(7.00) > MK(5.00) > EW(4.00) = SC(4.00)
Text Colours	ST(15.00) > MK(2.00) = EW(2.00) = SC(2.00)
Number of Characters	SC(11.00) > MK(10.00) = ST(10.00) > EW(7.00)

Key: ST = STAN BIOLOGY; MK = MACKEAN; EW = EWUSIE

SC = STONE AND COZENS.

<u>Cover Colours:</u> STAN Biology was found to contain significantly higher number than Mackean. Then, followed was Ewusie, Stone and Cozens with equal number, that's

ST > MK > Ew = SC.

<u>Text Colours:</u> The colours in STAN Biology was significantly higher than Mackean. Next was Ewusie and Stone and Cozens with equal number of colours that's ST > MK = EW = SC.

<u>Number of Characters:</u> The performances of the textbooks were in the order of Mackean and STAN Biology with equal number of characters. They however have lower number than Stone and Cozens, while Ewusie had the least, that's

SC > MK > = ST > EW.

<u>Communicational Strategies Survey</u>

In order to demonstrate the relationship between data obtained in this study and actual field experiences of consumers and producers of biology textbooks, a survey of preferred communicational strategies was conducted. Respondents in the survey included teachers, students, authors, publishers and ministry officials.

TABLE 29

Mean, Standard Deviation of Respondents in the Communicational Strategies Survey

Strategy	Group	Mean	Standard Deviation
Questioning Styles	AT	39.00	0.00
	PB	37.30	0.68
	MO	37.30	0.68
	T	38.80	0.42
	S	37.30	0.68
Technical terms	AT	15.70	0.48
	PB	15.80	1.69
	MO	15.90	1.66
	T	16.00	0.67
	S	16.20	1.93
Specimen	AT	11.70	0.48
	PB	14.10	0.32
	MO	14.10	0.32
	T	11.50	0.71
	S	14.10	0.32
Pictures and Diagrams	AT	48.00	0.00
	PB	49.90	0.32
	MO	49.90	0.32
	T	48.20	0.63
	S	49.90	0.32
Practical Exercises	AT	16.30	0.48
	PB	17.70	0.68
	MO	17.30	0.95
	T	16.30	0.48
	S	17.70	0.68
Major Themes	AT	35.00	0.00
	PB	29.00	0.00
	MO	29.20	0.42
	T	35.00	0.00
	S	29.00	0.00
Physical Characteristics	AT	29.70	0.48
	PB	31.80	1.69
	MO	31.60	1.84
	T	29.80	0.42
	S	31.80	1.69

Key: AT = Authors; PB = Publishers; MO = Ministry officials; T = Teachers, S = Students.

Table 29 represents the mean scores and standard deviations of the various group responses to the survey. An examination of the table reveals the following with respect to preferences for communicational strategies used in biology textbooks:

With respect to questioning styles, the highest mean score of 39 was obtained for authors. This was followed by the teachers (38.80), then publishers, ministry officials and students with equal mean scores (37.30).

On technical terms, the highest mean score 16.20 was obtained for students followed by teachers (16.00), ministry officials (15.90), publishers (15.80) and lastly authors (15.70).

With regard to specimens, the publishers, ministry officials and students had equal mean scores (14.10), then the authors (11.70) and lastly the teachers (11.50).

On pictures and diagrams, the publishers, ministry officials and the students again have equal mean scores (49.90). They were closely followed by teachers (48.20) and then authors (48.00).

With regard to practical exercises, the highest mean scores were obtained among the ministry officials and the students (17.70; each). They were closely followed by the authors (16.30) and the teachers also with 16.30.

On major themes, the highest mean score were obtained among the authors and the teachers each scoring a mean of 35.00. The ministry officials had mean of 29.20, while the publishers and students scored a mean of 29.00 each. On physical characteristics, the highest mean score was obtained by the publishers and students with 31.80 each. This is followed by the ministry officals (31.60), then the teachers (29.80) and lastly the authors (29.70).

The summary of the analysis of variance performed on the responses obtained in the survey is shown on Table 30.

TABLE 30

Summary of the Analysis of Variance on Preferences of Authors, Publishers, Ministry Officials, Teachers and Students Relative to Communicational Strategies in Biology Textbooks

Measure (Strategy)	Source	SS	df	MS	F
Questioning styles	Between	30.94	4	7.73	
	Within	80.25	45	1.78	4.34*
	Total	111.19	49		
Technical terms	Between	41.48	4	10.37	
	Within	143.00	45	3.18	3.26
	Total	184.48	49		
Specimens	Between	75.20	4	18.80	
	Within	195.52	45	4.34	4.33*
	Total	270.72	49		
Pictures and Diagrams	Between	39.06	4	9.77	
	Within	112.22	45	2.49	3.92*
	Total	151.28	49		
Practical Exercises	Between	20.31	4	5.08	
	Within	52.21	45	1.16	4.38*
	Total	72.52	49		
Major Themes	Between	42.27	4	10.57	
	Within	102.46	45	2.28	4.64*
	Total	144.73	49		
Physical Character-istics	Between	47.52	4	11.88	
	Within	108.25	45	2.41	4.93*
	Total	155.77	49		

Ftable (Critical value) = 3.83; α-Level = 0.001;

* = Significant Scores.

On the basis of the F-values the following decision has been reached:

The notion that there are no significant differences among the groups with respect to their preferences for questioning styles ($F_{4,45} = 4.34$, $p < 0.001$); specimens ($F_{4,45} = 4.33$, $p < 0.001$); pictures and diagrams ($F_{4,45} = 3.92$, $p < 0.001$); practical exercises ($F_{4,45} = 4.38$, $p < 0.001$); major themes ($4,45 = 4.64$, $p < 0.001$); physical characteristics ($F_{4,45} = 4.93$, $p < 0.001$) has not been upheld by the data as presented in Table 30.

However on technical terms, the group exhibited no significant differences ($F_{4,45} = 3.26$ $p < 0.001$).

The significant differences obtained were further subjected to Tukey's a posteriori contrasts test (Table 31). The test indicates that these 'Honestly Significant Difference' lie as in Table 31.

TABLE 31

Summary of Tukey's a postoriori Procedure on Respondents Scores in the Communicational Strategies Survey

Measure (Strategy)	Range of Significant Responses
Questioning styles	AT(39.00) > T(38.80) > S(37.30) = Mo(37.30) = PB(37.30)
Technical terms	No Significant Differences
Specimens	S(14.10) = MO(14.10) = PB(14.10) > AT(11.70) > T(11.50)
Pictures and Diagrams	S(49.90) = MO(49.90) = PB(49.90) > T(48.20) > AT(48.00)
Practical Exercises	S(17.70) = PB(17.70) > MO(17.30) > T(16.30) = AT(16.30)
Major Themes	T(35.00) = AT(35.00) > MO(29.20) > S(29.00) = PB(29.00)
Physical Characteristics	S(31.80) = PB(31.80) > MO(31.60) > T(29.80) > AT(29.70)

Key: AT = Authors; PB = Publishers; MO = Ministry officials;
T = Teachers; S = Students.

Questioning Styles; The significant responses beginning from the highest to the lowest are: authors, teachers, followed by students, ministry officials and publishers with equal values, that's AT > T > S = MO = PB.

Specimen; Again students, officials and publishers had the same value. Their value were significantly higher than that of authors. The authors responses were in turn significantly higher than the teachers, that's S = MO = PB > AT > T.

Pictures and Diagrams; Once again, the students, officials and publishers had the same value. Their values were however, significantly higher than the teachers' and authors, that's S = MO = PB > T > AT.

Practical Exercises: The students and the publishers had the same value. After these came the ministry officials and lastly the teachers and the authors with equal values, that's S = PB > MO > T = AT.

Major Themes: Authors and teachers had the same value. After these came the students and the publishers also with equal values. However, the values of the authors and the teachers were significantly higher than those of the ministry officials. Ministry officials have in turn higher values than students and publishers, that's $T = AT > MO > S = PB$.

Physical Characteristics: Students and publishers had the same value. In a descending order they were followed by the officials then the teachers and lastly the authors, that's $S = PB > MO > T > AT$.

Hypothesis 2 (Ho_2)

There is no significant difference in the cognitive, affective and psychomotor performances of high school students exposed to selected communicational strategies such as styles of questioning, defined technical terms, local specimens, labelled diagrams and pictures, inquiry method and challenging practical exercises and those not so exposed.

This hypothesis was tested using the student t-test.

TABLE 32

Means, Standard Deviations and t-test of the Relative Effects of leading Questions on Cognitive Performance of Experimental and Control Group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pre-test	E_1 vs C	0.52 0.63	0.58 0.64	0.10	0.78
	E_1 vs C	3.29 0.44	0.85 0.68	2.85	18.50*
Post-test	E_1 vs E_2	3.29 3.49	0.85 0.99	0.20	1.34
	C vs E_2	0.44 3.49	0.68 0.99	3.05	19.23*
Pre-test vs Post-test	E_1 (Pre-test) vs E_1 (Post-test)	0.52 3.29	0.58 0.85	2.77	21.79*
Differences	C (Pre-test) vs C (post-test)	0.63 0.44	0.64 0.68	0.19	1.32

No of Cases = 48; df = 47; * = Significant Scores
Ttable (Critical value) = 2.01; Confidence Level = 0.05
Key: E_1 = Experimental group 1; E_2 = Experiment group 2 (No pre-test), C = Control group.

Cognitive Performance

Leading Questions: Table 32 represents the means, standard deviations and t-test values of the different groups with respect to leading questions.

At the pre-test stage, there was no significant difference between the mean scores of Experimental group 1 (E_1) and the Control group (C) tc = 0.79 $< t_t$ 2.01. At the post-test stage however, the t-test value shows a significant difference between the Experimental group 1 (E_1) and Control group (C) (tc 18.50 $> t_t$ 2.01). The same is true of the pair wise comparison between Experimental group 2 (E_2) and the Control group (C). There is also a significant difference between the Experimental group 2 (E_2) and the Control group C post-test scores (t_c 19.23 $> t_t$ 2.01).

Since the design used in the study is a modified Solomon -3, Experimental group(E_2) had no pretest.

When the individual groups were considered for the pre-test - post-test differences, there was a significant difference for Experimental group 1 (E_1) (t_c 21.79 $> t_t$ 2.01). In the Control group (C) there was however no significant difference (t_c 1.32 $<$ t_t 2.01).

With respect to the Experimental group 1 (E_1 and Experimental group 2 (E_2), there was no significant difference between their post-test scores (t_c 1.34 $<$ t_t 2.01).

Since there was no significant difference in the pre-test scores of Experimental and Control groups, and since there was a difference in the post-test scores of the groups, the hypothesis (Ho_2) can not be upheld.

<u>Probing Questions</u>: Table 33 represents the means, standard deviations and t-test values of the groups with respect to their cognitive performance in probing questions.

As for leading questions, there is a significant difference between the post-test scores of groups E_1 and C (t_c 16.75 $>$ t_t 2.01). A significant difference also exist between E_2 and C (t_c 17.95 $>$ t_t 2.01) Based on the available data, the hypothesis (Ho_2) can not be upheld.

TABLE 33

Means, Standard deviations and t-test of the Relative Effects of Probing Questions on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard deviation	Mean difference	t
Pre-test	E_1 vs C	0.60 0.65	0.61 0.64	0.04	0.37
	E_1 vs C	2.94 0.40	0.78 0.61	2.54	16.75*
Post-test	E_1 vs E_2	2.94 3.15	0.78 0.99	0.21	1.36
	C vs E_2	0.40 3.15	0.61 0.99	2.75	17.95*
Pretest vs Post-test	E_1 (Pretest) vs E_1 (Posttest)	0.60 2.94	0.61 0.78	2.33	14.72*
Differences	C (Pretest) vs C (Posttest)	0.65 0.40	0.64 0.61	0.25	2.13*

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05
Key: E_1 = Experimental group 1; E_2 = Experimental group E_2 (No pretest); C = Control group.

TABLE 34

Means, Standard deviations and t-test of the Relative Effects of Contextual Questions on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1 vs C	0.52 0.54	0.58 0.77	0.02	0.15
	E_1 vs C	2.33 0.21	1.06 0.41	2.13	12.69*
Posttest	E_1 vs E_2	2.33 2.55	1.06 1.17	0.22	0.17
	C vs E_2	0.21 2.55	0.41 1.17	2.34	13.02*
Pretest vs Posttest	E_1 (Pretest) vs E_1 (Posttest	0.52 2.33	0.58 1.06	1.81	10.19*
Differences	C (Pretest) vs C (Posttest)	0.54 0.21	0.77 0.41	0.33	2.48*

No. of cases = 48; df = 47; * = Significant scores.
t table (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

<u>Contextual Questions:</u> Table 34 represents the means, standard deviations and t-test values with respect to the relative effects of contextual questions on cognitive performance.

There is a significant difference between the post-test scores of E_1 and C (t_c 12.69 $>$ t_t 2.01), and also of E_2 and C (t_c 13.02 $>$ t_t 2.01), consequently the hypothesis (Ho_2) is rejected.

<u>Defined Technical Terms:</u> Table 35 represents the means, standard deviations and t-test values with regard to cognitive consequences of defined technical terms.

There is a significant difference between the post-test scores of E_1 and C (t_c 7.39 $>$ t_t 2.01), and also between E_2 and C (t_c 8.02 $>$ t_t 2.01) hence hypothesis (Ho_2) can be upheld.

TABLE 35

Means, Standard deviations and t-test of the Relative Effects of Defined Technical terms on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard deviation	Mean Difference	t
Pretest	E_1 vs C	0.67 0.56	0.60 0.65	0.10	0.93
Posttest	E_1 vs C	1.79 0.21	1.46 0.46	1.58	7.39*
	E_1 vs E_2	1.79 2.00	1.46 1.52	0.20	1.78
	C vs E_2	0.21 2.00	0.46 1.52	1.79	8.02*
Pretest vs posttest Differ-ences	E_1 (Pretest) vs E_1 (Posttest)	0.67 1.79	0.60 1.46	1.13	4.89*
	C (Pretest) v C (Posttest)	0.56 0.21	0.65 0.46	0.35	3.02*

No. of cases = 48; df = 47; * = Significant Scores.
t table (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

TABLE 36

Means, Standard deviations and t-test of the Relative Effects of Local specimens on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.29	0.50	0.02	0.24
	vs				
	C	0.31	0.55		
	E_1	4.46	0.77	3.63	23.16*
	vs				
	C	0.83	0.81		
Posttest	E_1	4.46	0.77	0.20	1.79
	vs				
	E_2	4.66	0.91		
	C	0.83	0.81	3.83	24.85*
	vs				
	E_2	4.66	0.91		
Pretest vs Posttest	E_1 (Pretest)	0.29	0.50	4.17	33.61*
	vs				
	E_1 (Posttest)	4.46	0.77		
Differences	C (Pretest)	0.31	0.55	0.52	4.01*
	vs				
	C (Posttest)	0.83	0.81		

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

<u>Local Specimens:</u> Table 36 represents the means, standard deviations and t-test values with respect to the cognitive performances of the subjects as a result of using local specimens.

There is a significant difference between the post-test scores of E_1 and C (t_c 23.16 > t_t 2.01), and also between E_2 and C (t_c 24.85 > t_t 2.01).

<u>Labelled diagrams and pictures:</u> Table 37 represents the means, standard deviations and t-test values relative to the subjects cognitive performance on labelled diagrams and pictures.

There is a significant difference between the post-test scores of E_1 and C (t_c 26.06 > t_t 2.01), and between E_2 and C (t_c 26.94 > t_t 2.01).

TABLE 37

Means, Standard deviations and t-test of the Relative Effects of Labelled Diagrams and Pictures on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.46	0.62		
	vs			0.06	0.44
	C	0.52	0.74		
	E_1	4.71	0.54		
	vs			3.67	26.06*
	C	1.04	0.92		
	E_1	4.71	0.54		
Posttests	vs			0.09	0.63
	E_2	4.80	0.57		
	C	1.04	0.92		
	vs			3.76	26.94*
	E_2	4.80	0.57		
Pretest vs Posttest	E_1 (Pretest)	0.46	0.62		
	vs			4.25	34.12*
	E_1 (Posttest)	4.71	0.54		
Differences	C (Pretest)	0.52	0.74		
	vs			0.52	3.00*
	C (Posttest)	1.04	0.92		

No. of cases = 48; df = 47; * = Significant scores.
ttable (critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

TABLE 38

Means, Standard Deviations and t-test of the Relative Effects of Inquiry Method on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
	E_1	0.58	0.61		
Pretest	vs			0.06	0.50
	C	0.52	0.62		
	E_1	1.23	1.13		
	vs			0.96	5.69*
	C	0.27	0.45		
	E_1	1.23	1.13		
Posttest	vs			0.06	1.00
	E_2	1.17	1.12		
	C	0.27	0.45		
	vs			0.90	5.22*
	E_2	1.67	1.12		
	E_1 (Pretest)	0.58	0.61		
Pretest vs Posttest	vs			0.65	3.29*
	E_1 (Posttest)	1.23	1.13		
	C (Pretest)	0.52	0.62		
differences	vs			0.25	2.29*
	C (Posttest)	0.27	0.45		

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest), C = Control group.

<u>Inquiry Method:</u> Table 38 represents the means, standard deviations and t-test values with respect to the subjects cognitive performance on the inquiry method.

There is a significant difference between the post-test scores of E_1 and C (t_c 5.69 $>$ t_t 2.01), and between E_2 and C (t_c 5.22 $>$ t_t 2.01).

<u>Challenging Practical Exercises:</u> The data in Table 39 represents the means, standard deviation and t-test values in terms of the subjects cognitive performance with respect to challenging practical exercises.

There is a significant difference between the post-test scores of E_1 and C (t_c 24.73 $>$ t_t 2.01), and between E_2 and C (t_c 24.72 $>$ t_t 2.01) hence the hypothesis (Ho_2) can not be upheld.

TABLE 39

Means, Standard deviations and t-test of the Relative Effects of Challenging Practical Exercises on Cognitive Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.60	0.57	0.08	0.64
	vs				
	C	0.52	0.68		
	E_1	3.94	0.73	3.23	24.73*
	vs				
	C	0.71	0.71		
Posttest	E_1	3.94	0.73	0.02	1.00
	vs				
	E_2	3.96	0.74		
	C	0.71	0.71	3.25	24.72*
	vs				
	E_2	3.96	0.74		
Pretest vs Posttest	E_1 (Pretest)	0.60	0.57	3.33	28.59*
	vs				
	E_1 (Posttest)	3.94	0.73		
differences	C (Pretest)	0.52	0.68	0.19	1.42
	vs				
	C (Posttest)	0.71	0.71		

No of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

TABLE 40

Means, Standard deviations and t-test of the Relative Effects of Questioning styles on Affective Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.75	0.70	0.13	1.35
	vs				
	C	0.62	0.64		
	E_1	5.00	0.90	4.12	22.90*
	vs				
	C	0.83	0.72		
Posttest	E_1	5.00	0.90	0.00	0.00
	vs				
	E_2	5.00	0.92		
	C	0.83	0.72	4.12	24.24*
	vs				
	E_2	5.00	0.92		
Pretest vs Posttest	E_1 (Pretest)	0.75	0.70	4.30	27.73*
	vs				
	E_1 (Posttest)	5.00	0.90		
Differences	C (Pretest)	0.63	0.64	0.21	1.65
	vs				
	C (Posttest)	0.83	0.72		

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No Pretest); C = Control group.

Affective Performance

Questioning Styles: Table 40 represents the means, standard deviations and t-test values of the subjects with respect to their affective performance on questioning styles.

There is a significant difference in the post-test scores of E_1 and C (t_c 22.90 > t_t 2.01) and between E_2 and C (t_c 24.24 > t_t 2.01) hence hypothesis (Ho_2) can not be upheld.

Defined Technical Terms: Table 41 represents the means, standard deviation and t-test values of the subjects with respect to their affective performance on defined technical terms.

There is a significant difference between the post-test scores of E_1 and C (t_c 20.47 > t_t 2.01), and between E_2 and C (t_c 21.11 > t_t 2.01), hence hypothesis (Ho_2) is rejected.

TABLE 41

Means, Standard deviations and t-test of the Relative Effects of Defined Technical Terms on Affective Performance of Experimental and Control Group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1 vs C	0.67 0.65	0.60 0.48	0.02	0.22
	E_1 vs C	4.58 0.73	1.05 0.61	3.85	20.47*
Posttest	E_1 vs E_2	4.58 4.65	1.05 1.06	0.06	0.37
	C vs E_2	0.73 4.65	0.61 1.06	3.92	21.11*
Pretest vs Posttest	E_1 (Pretest) vs E_1 (Posttest)	0.67 4.58	0.60 1.05	3.92	23.31*
Differences	C (Pretest) vs C (Posttest)	0.65 0.73	0.48 0.61	0.08	0.71

TABLE 42

Means, Standard Deviations and t-test of the Relative Effects of Local Specimens on Affective Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1 vs C	0.65 0.54	0.60 0.54	0.10	1.15
Posttest	E_1 vs C	5.21 0.73	0.65 0.57	4.48	38.86*
	E_1 vs E_2	5.21 5.19	0.65 0.67	0.02	0.17
	C vs E_2	0.73 5.19	0.57 0.67	4.46	35.33*
Pretest vs Posttest	E_1 (Pretest) vs E_1 (Posttest)	0.65 5.21	0.60 0.65	4.56	35.24*
Differences	C (Pretest) vs C (Posttest)	0.54 0.73	0.54 0.57	0.19	1.64

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 Experimental group 2 (No pretest); C = Control group.

<u>Local Specimens:</u> Table 42 represents the means, standard deviations and t-test values of the subjects with respect to their affective performance when local specimens are used in teaching.

There is a significant difference between the post-test scores of E_1 and C (t_c 38.86 > t_t 2.01), and between E_2 and C (t_c 35.33 > t_t 2.01), hence hypothesis (Ho_2) is rejected.

<u>Labelled Diagrams and Pictures:</u> Table 43 represents the means, standard deviations and t-test values of the subjects with respect to their affective performance in labelled diagrams and pictures.

There is a significant difference between the post-test scores of E_1 and C (t_c 36.96 > t_t 2.01) and between E_2 and C (t_c 39.00 > t_t 2.01), hence hypothesis (Ho_2) can not be upheld.

TABLE 43

Means, Standard deviations and t-test of the Relative Effects of Labelled Diagrams and Pictures on Affective Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.71	0.71		
	vs			0.13	1.14
	C	0.58	0.68		
	E_1	5.67	0.48		
	vs			4.88	36.96*
	C	0.79	0.65		
Posttest	E_1	5.67	0.48		
	vs			0.00	0.00
	E_2	5.67	0.48		
	C	0.79	0.65		
	vs			4.88	39.00*
	E_2	5.67	0.48		
Pretest vs Posttest	E_1 (Pretest)	0.71	0.71		
	vs			4.96	40.44*
	E_1 (Posttest)	5.67	0.48		
Differ-ences	C (Pretest)	0.58	0.68		
	vs			0.21	1.49
	C (Posttest)	0.79	0.65		

No. of cases = 48; df = 47; * = Significant scores
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1, E_2 = Experimental group 2 (No pretest); C = Control group.

TABLE 44

Means, Standard deviations and t-test of the Relative Effects of Inquiry Method on Affective Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.58	0.61		
	vs			0.02	0.23
	C	0.60	0.57		
Posttest	E_1	4.50	1.09		
	vs			3.85	20.22*
	C_2	0.65	0.64		
	E_1	4.50	1.09		
	vs			0.13	0.68
	E_2	4.63	1.08		
	C	0.65	0.64		
	vs			3.98	21.54*
	E_2	4.63	1.08		
Pretest vs Posttest Differences	E_1 (Pretest)	0.58	0.61		
	vs			3.92	22.96*
	E_1 (Posttest)	4.50	1.09		
	C (Pretest)	0.60	0.57		
	vs			0.04	0.36
	C (Posttest)	0.65	0.64		

No. of cases = 48; df = 47; * = Significant scores
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1, E_2 = Experimental group 2 (No pretest); C = Control group.

Inquiry Method: Table 44 represents the means, standard deviations and t-test values of the subjects with respect to their affective performance using the inquiry method.

There is a significant difference in the post-test scores of E_1 and C (t_c 20.22 > t_t 2.01) and between E_2 and C (t_c 21.51 > t_t 2.01) hence hypothesis (Ho_2) is rejected.

Challenging Practical Exercises: Table 45 represents the means, standard deviations and t-test values of the subjects with respect to their affective performance on challenging practical exercises.

There is a significant difference in the post-test scores of E_1 and C (t_c 26.34 > t_t 2.01), and between E_2 and C (t_c 29.01 > t_t 2.01), hence hypothesis (Ho_2) is rejected.

TABLE 45

Means, Standard deviations and t-test of the Relative Effects of Challenging Practical Exercises on Affective Performance of Experimental and Control group subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1	0.73	0.54	0.13	1.35
	vs				
	C	0.60	0.57		
	E_1	3.58	0.50	2.92	26.34*
	vs				
	C	0.67	0.52		
Posttest	E_1	3.58	0.50	0.02	0.22
	vs				
	E_2	3.56	0.50		
	C	0.67	0.52	2.90	29.01*
	vs				
	E_2	3.56	0.50		
Pretest vs Posttest	E_1 (Pretest)	0.73	0.54	2.85	28.92*
	vs				
	E_1 (Posttest)	3.58	0.50		
differences	C (Pretest)	0.60	0.57	0.07	0.55
	vs				
	C (Posttest)	0.67	0.52		

No. of cases = 48; df = 47; * * Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

TABLE 46

Means, Standard Deviations and t-test of the Relative Effects of Physical Characteristics on Affective Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1 vs C	0.75 0.71	0.64 0.58	0.04	0.39
	E_1 vs C	4.75 0.83	1.00 0.60	3.92	21.67*
Posttest	E_1 vs E_2	4.75 4.75	1.00 1.00	0.00	0.00
	C vs E_2	0.83 4.75	0.60 1.00	3.92	23.69*
Pretest vs Posttest	E_1 (Pretest) vs E_1 (Posttest)	0.75 4.75	0.64 1.00	4.00	23.39*
difference	C (Pretest) vs C (Posttest)	0.71 0.83	0.58 0.60	0.13	1.06

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

<u>Physical Characteristics:</u> Table 46 represents the means, standard deviations and t-test values of the subjects with respect to their affective performance on the textbooks physical characteristics.

There is a significant difference in the post-test scores of E_1 and C (t_c 21.67 $>$ t_t 2.01) and between E_2 and C (t_c 23.69 $>$ t_t 2.01), hence hypothesis (Ho_2) is rejected.

Psychomotor Performance

Table 47 represents the means, standard deviations and t-test values of the subjects with respect to their psychomotor performance on the communicational strategies used by the textbooks.

There is a significant difference between the post-test scores of E_1 and C (t_c 31.37 $>$ t_t 2.01), and between E_2 and C (t_c 30.74 $>$ t_t 2.01), hence hypothesis (Ho_2) is rejected.

Hypothesis 3 (Ho_3)

There is no significant difference in the readability indices of the four textbooks: Mackean, Ewusie, Stone and Cozens and STAN Biology used for the study.

This hypothesis was tested using analysis of variance and Tukey's post-hoc test.

TABLE 47

Means, Standard deviation and t-test of the Relative Effects of Communicational Strategies on Psychomotor Performance of Experimental and Control group Subjects

Test	Group	Mean	Standard Deviation	Mean Difference	t
Pretest	E_1 vs C	2.58 2.48	2.21 2.25	0.10	0.21
Posttest	E_1 vs C	17.04 3.00	2.09 2.22	14.04	31.37*
	E_1 vs E_2	17.04 18.06	2.09 7.56	1.02	0.87
	C vs E_2	3.00 18.06	2.22 7.56	15.06	30.74*
Pretest vs Posttest	E_1 (Pretest) vs E_1 (Posttest)	2.58 17.04	2.21 2.09	14.46	35.05*
Difference	C (Pretest) vs C (Posttest)	2.48 3.00	2.25 2.22	0.52	1.13

No. of cases = 48; df = 47; * = Significant scores.
ttable (Critical value) = 2.01; Confidence level = 0.05.
Key: E_1 = Experimental group 1; E_2 = Experimental group 2 (No pretest); C = Control group.

TABLE 48

Means, Standard deviation of Readability Scores for the Four Biology Textbooks

Textbooks	Pages	Mean	Standard Deviation
ST	20	72.50 (Easy)	1.69
MK	20	74.19 (Easy)	1.72
EW	20	52.03 (Standard)	1.98
SC	20	55.53 (Standard)	0.73

Key: ST = STAN BIOLOGY: MK = MACKEAN

EW = EWUSIE: SC = STONE AND COZENS.

TABLE 49

Readability Value Interpretiation of the Four Biology Textbooks (Using Wahome (1979) Interpretiation Data

Readability	70–79	60–69	50–59	40–49
Average Sentence Length	14	17	21	25
Syllables Per 100 Words	139	147	155	167
Description of style (4th Year students)	Easy	Fairly easy	Standard	Fairly Difficult

Table 48 represents the mean readability values of all the textbooks. Table 49 provided is for the interpretiation of values in Table 48. It is an adapted Wahome (1979) interpretiation data relative to Nigerian schools for 4th year biology students.

As shown in Table 48, Mackean has the highest readability index of 74.19, followed by STAN Biology 72.50, then Stone and Cozens 55.56 and lastly Ewusie 52.03.

The mean readability values were consequently interpreted using Table 49 for each textbook appropriateness to the subjects involved in the study. Consequently, Mackean was found to be easy, so also was STAN Biology. Stone and Cozens and Ewusie were also found to be standard textbooks.

This interpretation of the textbooks average readability indices shows that all the textbooks would be adequate for some of the Form Four students in Nigerian Secondary Schools. However, when the readability indices were subjected to the analysis of variance and Tukey's <u>a posteriori</u> test a better picture of the textbooks adequacy to biology learning is revealed.

TABLE 50

Summary of the Analysis of Variance of the Four Biology Textbooks Readability Values

Measure	Source	SS	df	MS	F
Readability	Between	7382.09	3	2460.70	9.72*
	Within	19252.35	76	253.52	
	Total	26634.44	79		

Textbooks: STAN BIOLOGY: MACKEAN: EWUSIE: STONE AND COZENS

Ftable (Critical value) = 4.13; α-Level = 0.001.

* = Significant Scores.

The summary of the analysis of variance on the textbooks readability values is provided in Table 50.

On the basis of the F-values, it has been established that there are significant differences in the mean readability values of the four textbooks ($F_{3, 76} = 9.71$, $p < 0.001$).

TABLE 51

Summary of Tukey's a posteriori procedure on Readability Values of the Four Biology Textbooks

Measure	Range of Significant Values
Readability	MK(73.51) > ST(72.13) > SC(55.38) > EW(52.04)

Key: ST = STAN BIOLOGY: MK = MACKEAN

EW = EWUSIE: SC = STONE AND COZENS.

These significant differences were further subjected to <u>a posteriori</u> contrasts test. The application of Tukey's test indicates that these 'Honestly Significant Differences' lie as shown in Table 51.

Mackean was found to be significantly better than STAN Biology. Others were in the order of Stone and Cozens and lastly Ewusie.

The performance of the textbooks was in the order of;
MK > ST > SC > EW.

CHAPTER SIX

DISCUSSION OF RESULTS, CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

Discussion of Results

In this section, the several interesting findings which have emerged as a result of the present investigation are placed within the framework of previous studies. Additional insights that are provided about the relative effects of communicational strategies in biology textbooks on learning are discussed.

It has been considered logical to approach the discussion of the results in line with the hypotheses posited in the study.

As indicated in Chapter 3, the Solomon -3 Group Design was used. That is, the same treatment was used for experimental groups 1 (E_1) and experimental group 2 (E_2). Since there was no significant difference between E_1 and E_2 on all the variables contrasted, the discussion henceforth wi will be done in terms of similarities or differences between the two experimental groups (that is E_1 and E_2) on the one hand and the control group (C) on the other. The various categories compared as well as the conclusion, implications and recommendations are presented below based on the following categorisation:

(a) Questioning styles relative to cognitive, affective and psychomotor performances of students.

(b) Defined technical terms, local specimens labelled diagrams and pictures, inquiry method and challenging practical exercises relative to students cognitive, affective and psychomotor performances.

(c) Readability of textual materials.

(d) Conclusion.

(e) Implications.

(f) Recommendations.

Questioning styles relative to cognitive, affective and psychomotor performance of students

A question raised in the study is whether or not there are any significant differences in the frequency of questioning styles used by the four biology textbooks involved in the study.

An examination of the findings of the present study shows that there are significant differences in the textbooks with respect to the status of factual, probing, leading, introductory and terminal questions. It was also found that contextual questions were present only in Mackean, while the other textbooks contained none. However, more of the textbooks contain rheotorical questions.

The analysis of the questioning styles in the study revealed that Mackean tends to excel other textbooks in its use of questions. Mackean contained more factual, leading, probing and terminal questions than the rest of the textbooks examined in this study. This is however not to say that Mackean has attained the required standard in question asking, or that it is superior in every case where certain types of questions have been warranted.

Although frequency per se does not necessarily determine the quality of a given text, in certain cases - especially where questions are hard to come by as in this study, a high number or level of questions asked might serve as a useful indicator of textual quality.

As discussed in Chapter 2 and in view of current emphasis in science education, a meaningful inquiry can not be achieved without the use of appropriate questions. While the texts (apart from STAN Biology which is new) have made some improvement over their former editions with regards to questions (Ogunniyi, 1982), they are still far short of expectation as far as high-order questions are concerned.

The responses of producers and consumers of biology textbooks, showed that there are significant differences in the views of authors, publishers, ministry officials, teachers and students about questioning styles used in the biology textbooks examined in this study. Students, officials and publishers on the one hand tend to share a similar viewpoint, while authors and teachers on the other tend to express a viewpoint that is different from the former. This disparity of viewpoints certainly has great implications for science teaching and learning. It seems that while the authors and the teachers who use their product are agreed, the sellers (publishers) and the consumers (students) and those saddled with the responsibility of planning the right type of education (officials) are operating on a different premise. This should not be the case. The communication gap between the two sets of groups requires a closer attention to ameliorate the situations.

A question also raised in the study is whether or not there is any significant difference in the cognitive, affective and psychomotor performance of high school students exposed to selected questioning styles and those not exposed.

The cognitive consequences of such questioning styles as leading, probing and contextual, indicate significant differences between the experimental and control groups. The experimental groups performed better than the control group after they have been exposed to leading, probing and contextual questions.

With respect to affective and psychomotr performances, there are significant differences between the experimental and control groups. The experimental groups performed better than the control group.

The findings in this study bear some relationship to previous research efforts on the merit of questions to learning. The analysis of the textbooks as reported in the earlier chapter, showed that they contain mostly factual questions. This finding is in agreement with earlier findings in the area (e.g. Carrick, 1977; Lowery and Leonard, 1978; Ogunniyi, 1982). Good as factual questions are for recall purposes, they do not seem to be suitable for high cognitive activities. Generally, they tend to encourage rote or superficial learning at the expense of deeper intellectual thought (Gall, 1970; Ogunniyi, 1981; 1982; 1983; 1984).

There is a striking similarity on leading and introductory questions in STAN Biology and Ewusie. The affinity of these two textbooks is an apparent deviation from Ogunniyi's (1983) finding that the nationality of the authors did not affect the communicational styles in the four textbooks he examined. Perhaps the situation is that the nationality of an author does affect his style of communication. This is more so when the content of the science under study (in this case biology) has a considerable amount of local in-put. Certainly, more studies are required to determine the effect of cultural background on an author's style of communication.

Another important issue is the fact that Mackean was the only textbook that contained contextual questions. This is dissappointing considering the merit that have been associated with this type of questions. Carrick (1982) and

Ogunniyi (1982) have asserted that contextual questions tend to promote the development of: (1) problem-solving attitude, (2) observational and mental recognition of critical ideas of a given subject matter, (3) focussing the reader on the issues at stake, and (4) reinforcement of learning etc. If these values and merits of contextual questions in biology learning is to be realised, there is the need for more of these questions in biology textbooks.

The crucial question, however, is to determine which of the questioning styles is the most adequate in promoting biology learning. A comparative study of these questioning styles might help to determine what question is more suitable for a given context. At this exploratory stage, all that can be said is that the textbooks analysed in this study do not seem to place sufficient emphasis on the so-called high-order questions such as probing, leading and contextual questions.

The variation in the responses of authors and teachers on one hand, and officials, publishers on the other may be related to their role perception in the education enterprise. Since the individual group experiences and expectations largely depend on the roles they are suppose to play, they are likely to percieve situations and tasks varyingly. It is a likely premise to expect authors and teachers as initiators and facilitators of learning to be concerned with the place of questioning in the learning process and learning outcomes. On the other hand, students and officials may often assume questions in the evaluatory process of testing learning outcomes.

The better performance on the cognitive and affective instruments by the experimental groups than the control group agrees with De Cecco (1964) and Balogun (1974) that questioning styles as mediators in learning, can also serve as a crucial evaluation tool in assessing learning. The significant difference exhibited by the experimental and control groups is a further demonstration of the relative advantage of well sequenced questions in a learning episode over the 'chalk and talk' lecture method devoid of stimulating questions - a situation akin to what Nuthall and Lawrence (1968) refer to as the superiority of the direct mode over the indirect mode of teaching.

The better performance of the experimental groups can also be attributed to the fact that questions generally influence learning not only by their position and type in a textual material, but also by their contiguity to related content materials (Balogun, 1974; Leonard and Lowery, 1978; Carrick, 1982). The value of leading and probing questions as stimulators of inquiry behaviours (Carrick, 1982; Ogunniyi, 1982) has once again been confirmed in the present study. That is, the differential performances between the experimental and control groups may not be unrelated to the variety of stimulating questions used in teaching the experimental group subjects as compared to the traditional styles used for the control group.

While factual questions could lead to higher order questions, their overuse tend to trivalise learning (Ogunniyi, 1982). To Gall (1970), instruction in facts can also be achieved through programme instruction. Since all authors claim to emphasize inquiry in their prefaces, one would have expected more thought-provoking questions than was encountered in their actual reading content. A probable reason for the overuse of factual questions is that the final School Certificate Examination still emphasizes mainly factual questions. Weaver (1964) contends that students are prepared for examination rather than life after school.

This situation has been shown to be true in this study.

Defined technical terms, local specimens, labelled diagrams/pictures, inquiry methods and challenging practical exercises relative to students cognitive, affective and psychomotor performances

The question was raised in this study with respect to whether or not there are any significant differences in the way that the textbooks use technical terms, major themes, diagrams/pictures, specimens and practical exercises. Also, the preferences of publishers, authors, ministry officials, teachers and students for these strategies were examined. Another area of interest was to analyse the performance of students who have been exposed to the same set of strategies and those who have not had such exposure. In the subsequent sections, we shall examine each of the strategies in greater detail.

Technical Terms

The findings in the study show that there were significant differences in the way the textbooks define technical terms. The study established that Mackean had the highest representation of technical terms. There were significant differences in the way the four textbooks use technical terms.

It is gratifying to note that there were no significant differences in the views of authors, publishers, ministry officials, teachers and students with respect to the way technical terms should be defined. This shows that the producers and consumers of these biology textbooks share basically the same view in the area.

The study also revealed that the experimental groups who were exposed to well defined technical terms performed better in the cognitive, affective and psychomotor tasks than the control group who were denied of such an exposure.

The better performance of the experimental groups lends support to Evans' (1976) assertion that technical terms should be defined so that they can be of value to learning. This is because definitions of technical terms eliminates the ambiguity often associated with language, since every definition can be identified, isolated and recognised as clarifying meaning in the learning process. As Ogunniyi (1982) and Carrick (1983) have noted, well defined technical terms help to eliminate ambiguity, and to pave way for meaningful communication.

Unlike Evans' (1976) and Ogunniyi's (1982) suggestion that technical terms be defined at their first occurrence, the producers and consumers of biology textbooks involved in this study are not definitive as to when technical terms should be defined in a given textbook. It is desirable that further studies be carried out to ascertain the relative impact of the timing in which technical terms are defined.

Fortunately, all the four textbooks made attempts to define technical terms as soon as they occur. There are occassions, however, when they delayed in doing so. Ogunniyi (1982) had earlier enumerated the advantages and disadvantages of defined technical terms. He observed that defined technical terms at its first occurrence reduces ambiguity, stimulates and sustains reading interest. On the otherhand, undefined technical terms increases reading difficulty and reduces attention and comprehension. Sometimes, however, a delayed definition may encourage suspense and reflection on the part of the reader. Where students are used to rote learning, they have a tendency to cram definitions rather than try to find out the meaning of an unfamiliar technical term.

As with questioning styles, one observes that there were significant differences in the four biology textbooks in the way they present technical terms. Observably however, is the affinity between STAN Biology and Ewusie on one hand, and Mackean and Ewusie on the other in the way they present technical terms. The similarity can be associated with the authors country of domicile in addition to their interests, values, experience and training.

Local Specimens

There are significant differences in the specimens contained in the four textbooks. This difference may be a reflection of quantity than anything else. But despite this, the textbooks contained mostly local specimens. Comparatively, STAN Biology contained a greater number of local specimens than the others.

There were also significant differences in the views expressed by authors, teachers, students, publishers and ministry officials about specimens used in biology textbooks. However, as expected, authors and teachers have similar responses different from the others. Although the reasons for this disparity of viewpoints are not evident at this exploratory stage, further inquiries are necessary before a clearer picture can be obtained. It should however be possible to identify valid criteria for determining a range of local specimens to be included in a given textbook. For example, a biology text as STAN Biology containing between 95-90% local specimens may be judged adequate. Certainly, more studies are needed to establish what range would be suitable in terms of specified objectives.

The experimental groups exposed to local specimens performed significantly better than the control group subjects whose attention was not specifically directed to the same specimens.

The place of local specimens in biology teaching can not be over-emphasized. The better performance exhibited by the experimental group subjects has further confirmed Ogunniyi's (1982) view that local specimens when used in biology teaching can promote learning and enhance students understanding.

This fact seems to have been appreciated by all the authors of the biology textbooks examined in this study.

They all used local specimens quite generously. Since these specimens are located in the students' environment, they can be obtained easily, explored sufficiently and studied adequately than foreign specimens which are rarely available or too costly to obtain. Their availability when needed makes teaching and learning of biology less tedious, interesting and relevant.

Labelled diagrams and pictures

There were significant differences in the frequency of diagrams and pictures contained in the biology textbooks. The textbooks contained mostly diagrams - particularly labelled diagrams. The few pictures in the textbooks were generally unlabelled. Generally, Mackean contained more labelled diagrams than the other textbooks.

There were also significant differences in the views of authors, publishers, ministry officials, teachers and students with respect to diagrams and pictures in biology textbooks. As probably expected, authors and teachers have similar responses, quite different from those of students, publishers and officials. This is not a surprising finding because one probably expects that it is a known fact that pictures and diagrams in the teaching-learning process aid in conveying meaning. Particularly, they are capable of explaining concepts, features and physiological functioning in biology without using language that may distort learning. Their importance underscores the great need to bridge the gap between instructors and learners on their merits and demerits in learning.

The study also revealed that the experimental groups performed better than the control group with respect to labelled diagrams and pictures.

The better performance exhibited by the experimental groups has affirmed the merit of labelled diagrams and pictures in biology learning. According to Ogunniyi (1982), pictures and diagrams can through their form, clarify, colour and adequacy enhance communication and complement written and verbal instructions. Also, the study lends support to Reid's and Miller's (1980) assertion that pictorial representations facilitate learning, makes learning interesting, sustains the learner's interest and enhance the students power of observation.

The better performance of the experimental groups demonstrates that labelled diagrams and pictures are indispensable memory aids. According to Evans (1976), labelled diagrams are essential in biology in explaining an anatomical and merphological featur , while inadequate and unlabelled diagrams often create communication gaps.

However, Egbugara (1983) asserted that pictures when used as advance organisers are effective in enhancing students achievement. The issue therefore is to determine if diagrams, pictures or their combination are adequate in enhancing students performances. This is an area that could be further explored.

<u>Inquiry Method</u>

Although virtually all the themes were well represented in the textbooks (the only exception is the traditional world-view present only in STAN Biology) there are significant differences in the major themes used in the textbooks. STAN Biology however contained the highest number of themes.

In addition, there are also significant differences in the views of authors, teachers, publishers, ministry officials and students on major themes used in biology in the textbooks. Only students and publishers have similar responses.

Furthermore, the experimental group subjects performed significantly better than the control group subjects relative to the inquiry method used in the study. This finding has come to justify the potential of inquiry techniques for the teaching and learning of biology.

For the past two decades, science educators have emphasized the presentation of biology as a form of inquiry. Cooper and Petroskey (1974) emphasized that science subjects should be presented in an inquiry model to make the subject interesting to students.

However, science educators have observed that there are other themes that are significant to biology learning. De Maris (1965) study supports the use of historical themes in the presentation of learning materials to enhance students understanding. Good as a historical approach may be, however, it is important that biology teaching and learning be tailored to meet societal prevailing needs.

This is perhaps the reason why Ogunniyi (1982) has recommended a greater emphasis on "ecological" and "economic importance" themes especially in view of the prevailing economic problems in Nigeria coupled with the mounting ecological problems facing the nations flora and fauna.

In addition, although evolution is a central issue in biology, because of the role and place of religion in traditional African settings, teachers should be cautious in teaching evolutionary themes. Religion has come to be respected as a way of life, and nothing should be done to cause learners' disaffection towards the study of biology.

Researchers have also recognised the role of myth as critical component of African cosmology in relation to modern science. Idowu (1962; 1967), Horton (1964; 1971), Abraham (1967) and Fernandez (1972) have noted that myths are exploratory mechanisms and organising metaphors used by Africans to solve the puzzles of nature. Idowu (1962), specifically observed that, "myths serve the manifold purposes of statements of doctrinal beliefs, confirmation of faith in mind, lithurgical credo and simple metaphysics". Bascom (1965), perhaps has put the situation clearer for the traditional African culture. He observes that myths account for the origin of the world, of man, of death, and they may account for the founding of a tribe, an ethnic group or a clan or lineage. Therefore, to teach science without paying attention to the critical cultural variable of myth is to present an unwholesome world-view to the students.

Horton (1962) however, observed that the difference between the scientific and African thought system is that the latter lacks a body of explicitly stated 'acceptance/ rejection criteria. While the former chooses things, the latter tends to choose people as the basis for its explanatory models. While the latter position is true, Ogunniyi (1984) contends that the former can not be true since even within a tribe, there are several versions of the same myths depending on the locality. These various versions are the products of certain forms of "acceptance/ rejection criteria".

As Ogunniyi (1984) contends, the African and the scientific thought systems are explanatory mechanisms or organising metaphors used for interpreting natural phenomenon and to order human activities. To Ogunniyi, modern science can be meaningfully introduced to the African, only if his cosmological viewpoint is borne in mind. Idowu (1970) cautioned, that any one aspiring to bring social benefits to the African should be aware of his cultural beliefs and practices. These studies underscore the importance of traditional world-view in biology teaching. The teachers should be aware of the central issues involved in traditional African cultural beliefs and practices and explore these to explain scientific concepts and findings. He should be able to tease out the similarities and the differences of the two viewpoints of the world. As previously observed, themes in biology learning should be a way of disseminating knowledge and clarifying meanings. But this objective can not be achieved unless the themes used are properly organized and are relevant to the learners' environment.

Challenging practical exercises

Although all the different categories of practical exercises examined were well represented in the textbooks, there are significant differences in the way they are represented in the textbooks. Stone and Cozens had the largest number of challenging practical exercises.

With respect to practical exercises contained in biology textbooks, the views expressed by authors, publishers, ministry officials, teachers and students were significantly different. However, teachers and authors expressed similar responses quite different from the other respondents.

Further inspection of the data, shows that the experimental groups subjects performed better than their control group counterparts with respect to challenging practical exercises.

These findings are a confirmation of earlier findings that there is a positive correlation between practical exercises and students performance in science (Hurd, 1969; Tamir, 1978; Ogunniyi, 1977). The place of practical work in biology teaching is very crucial. According to Rai (1963), practical work provides first-hand experience and is far more important than lectures, discussion, questions and course content. It stimulates students' interest in science as well as develop in them the spirit of inquiry. To Ogunniyi (1986) a practical work is an indispensable aspect of science teaching. As the students perform experiments they improve their manipulative and observational skills. Ausubel (1968) and Hurd (1969) assert that in the classroom setting, the main goal of practical exercises is the provision of opportunities for students to investigate so as to develop essential practical skills.

As pointed out by Schwab (1962) and Ogunniyi (1983), practical exercises by their nature, provide students with opportunities to investigate and to study abstract concepts through concrete materials and consequently aid learning. Indeed, the overall teaching of science can not be broad-based without the inclusion of relevant practical exercises (Rai, 1963). There are simple, specific, general or challenging practical exercises that can be employed in a biology lesson. The choice largely depends on the task in question, age and experience of the learner. The type and the timing of practical exercises need further studies. The data generated from such inquiries would aid teachers in selecting and sequencing practical exercises in a meaningful way. Similarly, Examination bodies like the W.A.E.C. might find such data useful in their task of evaluating students. The present gambling procedure by teachers and examiners in the selection of practical exercises is unsatisfactory for the meaningful study of biology.

Another area of interest in this study relates to the physical appearance of the textbooks involved in the study. STAN Biology was found to contain the greatest varieties of cover and text colours, in addition to a wide variety of characters.

Physical features are an often neglected attribute of most biology textbooks. For example, it might be impossible to obtain the real materials or their models. In such a case, beautiful pictures and type sizes might be the closest resemblance of what is needed. There is, however, the need to empirically determine the merit of textbooks physical features to biology teaching and learning.

<u>Readability of textual materials</u>

One of the questions addressed in this study is whether or not there is a significant difference in the readability indices of the biology textbooks involved in this study. An examination of the result shows that there are significant differences among the textbooks with respect to readability indices. On the whole, only Mackean and

STAN Biology can be regarded as easy textbooks for the subjects involved in the study. Ewusie, Stone and Cozens need to be reviewed to meet the comprehension levels of the subjects involved in the study. It is worthy to bear in mind that English is a second language for the students. The easier a textbook is, the better for the students. The appauling state of English in our schools is common knowledge. Besides, most of the students rely almost completely on the textbooks for obtaining scientific information. Therefore, unless the language of a text-book is easy enough, it becomes the very barrier to students understanding of science (Ogunniyi, 1986).

Various studies have established that readability indices is a measure of the comprehensibility of a textual material (Yoloye, 1975; Uche, 1979; Wahome 1979). In line with the findings of Jegede (1982) and Okpalla (1982) on physics textbooks, this study shows that only Mackean and STAN Biology are adequate and easy enough to be understood by Form Four students - and by extension Form Five students (that is only students preparing for the WASC examination. All the textbooks by interpretation of the readability data (Wahome, 1979) are inadequate for

Form Three students who are just beginning the study of biology. The irony of the situation is the fact that these books are supposed to be used for Forms Three, Four and Five students. This is why authors need to review science textbooks not just in terms of meeting examination requirements, but also taking care of the learners knowledge, needs, interests, grade and age. Of course, the implementation of the 6-3-3-4 programme would warrant the review of all the textbooks to meet the senior secondary school needs.

It should be pointed out here that readability values are not necessarily the only measure of textbooks adequacy. Earlier, we examined such things as; questioning styles, technical terms, practical exercises, specimens, pictures/diagrams, major themes and physical features of biology textbooks. All these are critical to the quality of any science textbook.

Generally, almost all readability formulae in use have been variously criticised by researchers. As alluded to earlier, Flesch's (1948) readability formulae used in this study was seriously criticised by Dale-Chall (1948) as being very cumbersome to use. It was found desirable for this study because as Yoloye (1975) pointed out, it does not make use of difficult words as an index, and it is not culture-bound.

The easily identifiable limitations of readability formulae include their inadequacy as predictors of elements of comprehension such as graphs, characters of print and diagrams (Okpalla, 1982). This has made it necessary for researchers to provide additional explanation on the merit of reading materials for identified differences in students comprehension, abilities and reading efficiency. Research efforts should also be directed towards examining the relationship, if any, of students age, sex, socio-cultural background and previous experiences to their ability to comprehend classroom reading materials.

<u>Conclusion</u>

This investigation represents an extension of research on the relative effects of textual communicational strategies to learning. The focus has been on the role of textbooks in biology teaching and learning. The aim has been to identify the communicational strategies in four commonly used biology textbooks. These strategies were consequently used in teaching selected topics in biology to Form Four students.

In seeking an effective use of communicational strategies in biology teaching, the selected strategies were found to have produced better cognitive, affective and psychomotor performances in the students exposed to them.

It was also found that the textbooks used in the study had varying types of communicational strategies. Of the seven major (made-up of 32 subgroups) communicational strategies, the textbooks were isolated in terms of the strategies in which they excel. Since no one textbook had an overall advantage over the others, the findings of the study is in support of using as many textbooks as are available in biology teaching/learning, as this would provide teachers and students with greater variety of communicational strategies.

The variety in the viewpoints of the producers and consumers of biology textbooks also demonstrate the same point of providing teachers and students with wide variety of biology textbooks. In addition, the respondents' recognition of the vital role of communicational strategies in biology is significant.

This study seems to suggest that secondary school students exposed to a variety of communicational strategies will perform better than those not so exposed. Findings in the different states in the country would help to ascertain the merits or otherwise of the present study.

In addition, the present socio-economic realities of our time, demand that we should utilize the limited resources at our disposal for maximum benefit. The present system in which all the schools in a state are made to use a single textbook in a subject area is grossly inadequate and unacceptable. This study has shown that efforts should be made to provide enough textbooks in our school libraries so that teachers and students can have the opportunity of the varying strategies offered in these textbooks. Community libraries for selected schools in contiguous localities grouped into units can be viable alternatives. In this way, the available scares resources can be made available to a greater number of learners.

From the foregoing, the following conclusion has been reached with respect to the relative effects of communicational strategies in biology learning:

1. Mackean is the most adequate for contextual, factual, leading, probing and terminal questions.
2. For technical terms defined at first occurrence, Mackean is the most adequate.
3. STAN Biology is the most adequate textbook on local specimens.
4. Mackean is the most adequate for labelled diagrams/ pictures.
5. STAN Biology is recommended for teaching evolutionary, ecological, inquiry and traditional world-view themes.
6. For teaching challenging practical exercises, Stone and Cozens appears to be the best.
7. Students exposed to a variety of communicational strategies perform better than those not so exposed.
8. Authors and teachers appears to have similar views of the use of communicational strategies in biology textbooks.
9. With the exception of the use of challenging exercises, Mackean and STAN Biology seem to be the best texts among the popular biology textbooks available in

Nigeria. The other texts require an urgent review.

It is hoped that the experiences gained in this study would contribute positively towards efforts aimed at finding ways and means of making science textbooks of better quality. A replication of this study with larger samples in the different states of Nigeria is recommended.

Implications

The overall poor performance of the control group in this study, has demonstrated the weakness of some teaching methods as they affect biology teaching and learning. The often monotonous, unspecialised method of teaching in our schools has made the study of biology largely related and associated to only the passing of prescribed examination. This position is unacceptable, and the search for alternative methods is therefore crucial and necessary.

This study has been able to suggest more promising strategies of organising and executing biology lessons. The selected communicational strategies used in the study have been shown to promote students cognitive, affective and psychomotor performances. The study also showed that the authors of the biology textbooks used in the study have recognised those strategies and have to some extent incorporated them in their books. Furthermore, evidence has been provided to show that producers and consumers of biology textbooks recognise and appreciate the significance of communicational strategies in biology textbooks and their consequent merits in biology teaching and learning. Although the various groups do not always agree on these strategies, this is how it should be. Varieties of textbooks on a given subject can be used to advantage, since no one text is good in every area of communicational strategies.

The advantages of this finding centre on two issues. First, is the relevance to teaching and learning of biology. For sometime, readability indices have been regarded as the central issue in students comprehension of textual materials. The findings in this study have shown that although readability is important, it is has been considered only in its narrower meaning. In other words, readability is much more complex than the written materials per se. It also entails the context in which the written materials as well as the pictures, diagrams, technical terms, themes and other communicational strategies fit together to engender comprehension. The communicational strategies selected for this study has been found to contribute quite significantly to the effective comprehension of biology textual materials.

Second, is the identification of the merits or otherwise of communicational strategies in the cognitive, affective and psychomotor performance of students in biology. In addition to isolating specific strategies for biology teaching and learning, the findings in the study have shown that there are communicational strategies requiring further differentiation, specification and experimentation in the teaching and learning of the subject.

The crucial issue involved is that teachers of biology should be familiar with the textbooks available in the market. They should be able to recognise and be aware of the merits and demerits of these textbooks in terms of communicational strategies they use in the presentation of learning materials.

Another implication of the study, is that while it is not possible nor desirable to purchase all the books available on a subject, the teachers and school authorities should ensure that the school library have most of the textbooks needed for reference purposes. The advantage of this is that students can avail themselves with the various advantages that such a variety can produce. With a fairly well-equipped library containing several biology textbooks with a variety of communicational styles of presentation, the teachers are left with the responsibility of dinstinguishing, isolating and utilizing the best communicational strategies in the classroom setting. This will consequently make teaching interesting, meaningful as well as enhance the students performance in biology, in addition to providing teachers with challenging tasks for the overall benefit of the teaching-learning objectives.

Recommendations

In the light of the findings in this study, the following recommendations have been made for proper consideration.

(a) Biology Teachers: In order to promote cognitive, affective and psychomotor performance of students, biology teaching should involve;

(i) An identification of the merits of biology textbooks in relation to the communicational strategies they contain, and sieve out how these can be effectively used in promoting learning. It should be noted that while the students can be made to buy the best book (as determined by the teachers and ministry officials) the teachers and the school library should ensure that other books in the same subject area are available for reference purposes. The teacher as a facilitator of learning should from time to time refer the students to specific textbooks depending on the desired strategies.

(ii) In preparing the lesson note the biology teacher should bear in mind the communicational strategies that he has isolated, and which he considers to be best suited for the learning tasks. Each strategy should be well listed out, with specific objective and time interval envisaged. With practice, the strategies can be used as and when necessary in the teaching phase. This no doubt calls for adequate planning and preparation on the part of the teachers. The preparation will necessarily include in addition to getting a specialised note of lesson, adequate reference books, diagrams and specimens that will be needed during teaching. Teacher training Institutions can be of great help in equipping teachers with the necessary skills needed for this task.

(b) Authors: To promote the teaching and learning of biology, authors of biology textbooks should be conscious of the increasing role of textbooks in biology. In preparing and writing textbooks (or revised editions), they should endeavour to use varying communicational strategies to convey meaning of difficult concepts, and aid comprehension of students.

Since there are numerous communicational strategies, authors should select and use those ones that have been identified by research to be valuable to students comprehension and interest. The objective should not only be to provide books for examination purposes, but that book which will promote a scientific literate citizenry.

(c) Publishers: As the producers of textbooks, publishers should be aware of the significance of textbooks in science. Although publishers' consideration is strictly commercial, they have a moral obligation to ensure that the textbooks they produce can contribute significantly to the cognitive, affective and psychomotor performance of the learners.

Consequently, in the conceptualisation and writing periods, publishers should identify suitable communicational strategies, discuss with their authors and delibrately ensure that the strategies are incorporated into the textbooks. In this way, the publishers would be contributing their quota to the development of biology teaching and learning. A constant review of their textbooks is recommended.

(d) <u>Ministry Officials:</u> Prevailing political and economic realities, have made the role of Ministry of Education officials crucial in the teaching and learning of biology. Today, the officials often times single-handedly determine the books to be used in the schools without reference to the teachers who would eventually use them. The aim here is not to critize the system, but their function underscores their importance in the school system. It seems that they can not play a meaningful role that they are expected to play unless they are well acquainted with the criteria that determine the quality of a given text. It is recommended that workshops organised by ministry officials should place adequate emphasis on the selections,identification and utilization of science textbooks.

Furthermore, this study has shown the need to have a committee comprising Ministry officials, authors, teachers and students who would be involved in textbooks selection. The advantage of this, is that these individuals with varied experiences, knowledge, training and expectations are better placed to select the textbooks that are interesting and appropriate for students learning.

(e) Ministry of Education: To maximise resources, the ministry of education need to consider the following recommendations;

(i) Pre-service, in-service and workshop sessions should be designed for teacher **trainees**, new and serving teacher trainers to develop their skills in identifying the merits and demerits of strategies in textual materils.

(ii) District or Community libraries are recommended to supplement or serve as alternatives as it is not uncommon to find some schools without a library.

(iii) All those involved in the sacred duty of training the young (publishers, officials, authors and teachers) should have a regular forum (e.g. seminars and workshops) for exchange of ideas on biology textbooks in classroom teaching and learning.

(f) For Further Research: Since this study is explanatory, it is necessary that further research be carried out in the area to explore the following:

(i) What other strategies other than those identified in this study can promote cognitive, affective and psychomotor performances students in biology?

(ii) What other criteria (apart from those identified in this study) are necessary in determining how one or more communicational strategies should be used in a science lesson?

(iii) What is the nature of communicational strategies used in other biology textbooks as well as textbooks in Physics, Chemistry, Integrated Science and Agricultural Science?

(iv) What are the effects of selected communicational strategies on students' learning in Integrated Science, Physics, Chemistry and Agricultural Science?

(v) In the spirit of the 6-3-3-4 system, how can communicational strategies be effectively utilized to make textbooks adequate for third, fourth and fifth form students?

REFERENCES

Abdullahi, A.: Science Teaching in Nigeria, Ilorin Atoto Press Ltd., 1982.

Abubakar, I.: The role of science and technology in national development. West African Journal of Education, 1970 XIV, 30-36.

Adelekan, A.I.: Attitudes and achievement of students in the Nigerian Integrated Science and the General Science Programmes. An unpublished Master Dissertation. University of Ife, 1983.

Akintola, J.M.: In-service training. Report of the National Workshop on Primary Education. Nigeria Educational Research Council, 1971, II.

Akpata, T.: Science methods, attitudes and social phenomenon. Journal of STAN, 1974, Vol. 12, No. 4, pp. 7-13.

Anderson, O.R.: Structure in Teaching - Theory and Analysis. Teachers' College Press, 1970. Columbia University, New York.

Alatas, S.H.: Intellectuals in Developing Countries. London: Frank Cass and Co. Ltd. 1977.

Allen, D.I.: (Lowery and Leonard, 1978, op. cit. p. 9).

Alonge, E.I. (ed.): Proceedings of the Inaugural Conference. All African Association of Science Teachers, Lagos. 1980.

Aschner, M.J.: Asking questions to trigger thinking. NEA Journal, 1961, 50, No. 6, 44-46.

Bailey, H.S.: Scientific Books, Science, 1952 CXV, pp 2-6.

Balogun, T.A.: A Study of Mathegenics: An Investigation of a Topography of Learning Control in A Science Subject, 1974.

Balogun, T.A.: Some current science curriculum development levels and global rationale. Unpublished mimeography, University of Ibadan (Nigeria), 1975.

Balogun, T.A.: Biology textbooks and percentages of schools recommending these in Ibadan and environ. An unpublished paper. University of Ibadan, Nigeria, 1978.

Balogun, T.A.: Development in science education in Nigeria. An over-view. Journal of STAN, Vol. 4, 1972.

Bajah, S.T.: Preparation of the secondary school teacher of physical sciences for the African environment. West African Journal of Education, 1975, EIE, 85-96.

Barker, J.A.: Comment: Biology textbooks in Britain. Journal of Biological Education, 1977, , 11, 161.

Behr, A.N.: Achievements, aptitude and attitude in Mathematics. Two Year College Mathematics Journals, 1970, (4), pp. 72-74.

Berlyne, D.E.: A theory of human curiosity. British Journal of Psychology, 1954, 45, 180-191.

Bernstein, A.L.: Motivation in mathematics. School Science and Mathematics. 1964, 64, pp. 749-754.

Blau, P.M.: Cooperation and competition in a bureaucracy. American Journal of Sociology, 1954, 530-535.

Bloom, B.S.: Human characteristics and School Learning. New York. McGraw-Hill, 1976.

Bloom, B.S.: Testing Cognitive Ability and Achievement, 1963. Handbook of research on teaching. Chicago Rank McNally and Co. Chicago.

Bloom, B.S.: Taxonomy of education objectives, Handbook I:

Cognitive Domain. New York; David McKay Co. Inc., 1956.

Bossing, W.L.; Progressive methods of teaching in secondary schools. Houghton-Miftlin, 1942. New York.

Brunning, R.H.: Effects of review and testlike events within the learning of prose materials. Journal of Psychology, 1968, 59, 16-19.

Campbel, P.T. and Stanley, J.C.: Experimental and quasi-experimental designs for reseafch. Chicago, Rand McNally, 1963.

Carrick, T.: A comparison of recently published textbooks for first year examinations. Journal of Biological Education, 1977, 11, (3) 163-175.

Carrick, T.: Problems of assessing the readability of biology textbooks for first examinations. Journal of Biological Education, 12 (2), 113-122, 1979.

Carrick, T.: More new textbooks for first examination in biology. Journal of Biological Education, 16 (4), 243-262, 1982.

Cessac, J.: Science teaching in the secondary schools of tropical Africa. Firm-Didet, Mesnilsur-L'Estree, Paris, 1963.

Chapman-Taylor, Y.: The reading difficulties of university students and their significance for teaching. Unpublished Manuscript, 1965, University of Ibadan Reading Centre.

Chaytor, D.E.B.: Shaping science education in the eighties. Edited by Alonge, E.I., op. cit. 1980.

Clifford, M.M.: Motivational effects of competition, reward, nonreward conditions. Journal of Experimental Education, 1971, 39, 11-16.

Cole, M.A.: Science teaching and secondary curriculum development in a supposedly non-scientific culture. West African Journal of Education, 1975, XXIX, 313-332.

Cox, D.R.: Planning of Experiments, New York, John Wiley and Sons, 1958.

Dale, E. and Chall, J.S.: A formula for predicting readability, Educational Research Bulletin, 1948, Ohio, Ohio State University Press.

Daugs, R.D. and Daugs, F.: Readability of high school Biology materials. Science Education, Vol. 58, No. 4, 1974.

DeCecco, J.P. (ed.): Human learning in the school. Readings in Educational Psychology. 1964, Holt Rhinehart and Wilston.

Demars, R.J.: A comparative study of seventh grade low achievers attitude and achievement in mathematics under two approaches, UICSM and traditional (Unpublished Doctoral dissertation, University of Alabama, 1971).

Devine, D.F.: Students attitudes and achievement. A comparison between the effects of programmed instruction and conventional classroom approach in testing Algebra at Rich Township Schools. (Doctoral dissertation, Colorado State College).

De-Maris, R.E.: Reading in science and technology, Charles E. Merril Publ. Co. Columbus, Ohio, 1966.

Duchastel, P.C. and Merrill, P.F.: The effects of behavioural objectives on learning. A review of empirical studies. Review of Educational

Research, 43 (1).

Eboda, F.M.: Some correlates of low enrolment in physics in Western State of Nigeria. Unpublished M.Ed. Thesis, University of Ibadan.

Edwards, A.L.: Techniques of attitude scale construction. Appleton-Century-Crofts, New York, 1957.

Egbugara, U.O.: Effects of three levels of advance organisers on achievement of some Nigerian secondary school physics students. Unpublished doctoral dissertation, University of Ibadan, 1983.

Eglen, J.R. and Kempa, R.F.: Assesing manipulation skills in practical chemistry, School Science Review, 1974, 56, 261-273.

Elaive, J. and Deyamira, H.B.: Inventory of attitudes towards science and scienfitic careers. Journal of research in science teaching, 1976, 3(1), pp. 45-47.

Ellich, A.D.: The effects of attitude on academic achievement. Dissertation Abstracts, USC 29/01A/9957, 68-10, 277, 1968.

Evans, J.D.: The treatment of technical vocabulary in textbooks of biology. Journal of Biological Education, 1976, 10 (1), 19-30.

Ewusie, J.Y.: Tropical Biology for O'level and School Certificate. African University Press in Association with Harrap, London, 1982.

Fafunwa, A.B.: New Perspective in African Education. Macmillan Educational Ltd., 1967.

Faist, C.R.: Achievement, attitudes and resources usage in a mathematics programme in high school: Traditional versus Flexible. (Doctoral dissertation, North Western University, 1972).

Flesch, R.A.: A new readability yardstick. Journal of Applied Psychology, Vol. 32, No. 3, 1948.

Flesch, R.A.: Marks on readability style: A study of Adult Education, 1943, New York, Teachers College, Columbia University.

Forum of Africa. Science Educators (FASE) Report of first international conference. Harare: Aug. - Sept., 1982.

Report, International Council of Associations of Science Education (ICASE).

Frase, L.T.: Learning from prose materials: Length of passage, knowledge of results and position of questions. Journal of Educational Psychology, 1967, 58, 5, 266-272.

Frase, L.T.: Some unpredicted effects of different questions upon learning from connected discourse. Journal of Educational Psychology, 1968, 3 59, 197-29.

Frase, L.T.: Effect of question location, pacing and mode upon retention of prose materials. Journal of Educational Psychology, 1968, 59, 4, 244-249.

Frase, L.T.: Boundary conditions for mathemagenic behaviours. Review of Educational Research, 1970, 40, 337-348.

Frase, Patrick and Schumer,: Effect of question position and frequency on learning from text under different levels of incentive. Journal of Educational Psychology, 1970, 61, 52-56.

Fricks, T.: Observer agreement and reliabilities of class-room observational measures. Review of Educational Research, 1978, 48, 157-184.

Gagne, R.M.: The conditions of learning. 1968, New York, Holt Rhineheart and Wiston Inc.

Gall, M.D.: The use of questions in teaching. Review of Educational Research, 1970, 40, 5, 707-721.

Gardner, P.L.: Attitudes to science: A review. Studies in Science Education, Vol. 2, 1975.

Gardner, P.L.: Attitude measurement: A critique of some recent research. Educational Research, Vol. 17, No. 2, 1975.

Gilbert, P.G.S. and Lovegrove, N.M.: Science Education in Africa, London: Heinemann Educational Books Ltd., 1972.

Gilland, J.: Readability, 1972, UNIBOOK.

Gilland, J.C.: (Carrick, T. op. cit, 1977, p. 156.

Gilland, J.C. (Carrick, T. op. cit, 1978, p. 119.

Guthrie, J.T.: Learnability versus readability of texts, The Journal of Educational Research, 1978, Vol. 65, No. 6.

Gould, C.D.: The readability of school biology textbooks. Journal of Biological Education, 1977, 11 (4), 248-252.

Gyuse, E.Y.: Questioning patterns of physical science teachers in secondary schools. Journal of STAN, 1982, 21, 1, 123-133.

Haggis, S.: Integrated Science World-wide. Edited by Alonge, E.I. op. cit, 1980.

Haladyna, T. Olsen, R. and Shaughnessy, J.: Relations of student, teacher and learning variables to attitude towards science. Science Education, Vol. 66, No. 5, 1982.

Haladyna, T. and Shanghnessy, J.: Attitudes towards science: A quantitative synthesis. Science Education, Vol. 66, No. 4, 1982.

Hearney, Sally: Problems involved in an educational and experimental research programme. Journal of Biological Education, 1969, Vol. 3, No. 2.

Holt, C.E.: Investigative Laboratory Programme in Biology. Bio-Science, 1104-1107, 1969.

Hungerman, A.D.: Achievement and attitude of sixth grade pupils in conventional and contemporary mathematics programmes. The Arithmetic Teacher, 1967, 34.

Hurton, R. : African Traditional Thought and Western Science. In knowledge and control. New Directions for the Sociology of Education. Young, F.D. (ed). Collier - Macmillian Publishers, 1971

Humphrey, B. Johnson, R.T. and Johnson, D.W.: Effects of cooperation and individualistic learning on students achievement science class. Journal of Research in Science Technology, 1982, 5, 351-356.

Hurd, P.D.: New directions in teaching secondary school science. Rand McNally, Chicago, 1969.

Hofstein, A and Lunetta, V.N.: The role of laboratory in Science Teaching: Neglected aspects of research. Review of Educational Research, 1982, 52, 201-267.

Indge, W.J.E.: The potential for local manufacture of school science equipment and related problems. Report of a Commonwealth Regional Seminar Workshop, Nassau, Bahamas, Nov. 1976, 26-30.

Jegede, P.T.: An evaluation of the Nigerian Integrated Science Project (NISP) after a decade of use in the classroom. International Review of Education, Vol. 28, No. 3, 1982.

Johnson, J.: Attitudinal differences in laboratory exercises. School Review, Vol. 12, No. 2, 1965, pp. 60

Idowu, E.B.: African Traditional Religion: A Definition. SCM Press Ltd. 1973.

Johnson, R.T.: The relationship between cooperation and inquiry in science classroom. Journal of Research in Science Teaching, 1976, 13, 1, 55-63.

Johnson, D.W. and Johnson, R.T.: Effects of cooperative and competitive ventures on learning. Journal of American Sociology, 1981, 16-30.

Johnson, D.W., Johnson R., Johnson, J. and Anderson, D.: The effects of cooperative versus individualised instruction on student pre-social behaviour attitudes towards learning and achievement. Journal of Educational Psychology, 1976, 68, 446-452.

Kalamananthan, K.: An investigation into problems involved in science teaching in secondary schools in the six northern states of Nigeria. Journal of STAN, 10: 3, 1970, 60-62.

Krugman, J.F.: Cooperation versus individual efficiency in problem-solving. Journal of Educational Psychology, 1944, 35, 91-100.

Kerr, J.F.: Practical work in school science. University of Leicester Press, 1963.

Lewy, A. (Ed.): Handbook of Curriculum Evaluation, 1977, Longman Inc. New York.

Likert, R.A.: The technique for the measurement of attitudes. Achieves of Psychology, 1932, 140, 55-60.

Lowery, L.F. and Leonard, W.H.: A comparison of questioning styles among four widely used high school biology textbooks. Journal of Research in Science Teaching, 15 (1), 1-10.

Mackean, D.G.: Introduction to Biology. West African Edition. Heinemann Educational Books (Nig.) Ltd., 1982.

Mager, R.F.: Developing attitudes towards learning. Pale Atto, California, 1968.

Major, A.G. and Colletes, A.T.: The readability of college general biology textbooks. Science Education, Vol. 46, No. 4, 1962.

Marshall, J.E.: Comprehension and alleged readability of high school physics textbooks. Science

Education, Vol, 46, No. 4, 1962.

McAllister and Hanna. Evaluating Books For Young Children. International Reading Ass., 1971, Delaware.

McClelland, M.: Motivation and Learning. New York, Macmillian Co., 1953.

McKillop, A. and Yoloye, E.A.: The reading of University students. Teacher Education, 1963, 3, 2.

Messick, S.: The standard problem: The meaning and values in measurement and evaluation. Journal of Psychology, Vol. 30, 1978.

Morasky, L. and Wilcox, H. (Lowery, Leonard 1978, op. cip, p. 9).

Natkin, G. and Stahler, E.: The effects of adjunct questions on short and long-term recall of prose materials. American Educational Research Journal, 1969, 3, 425-432.

Nwana, O.C.: Cooperation among science teachers associations in Africa. Edited by Alonge, E.I. op. cit., 1980.

Nomvete, T.: Establishing readability indices for selected integrated science curriculum materials.

Unpublished M.Ed. Thesis. University of Ibadan, Nigeria, 1979.

Obanya, P.: Research and Development in Science education. Paper presented at the 24th annual conference of Science Association of Nigeria, April, 1983.

Ogunniyi, M.B.: Understanding Social Science Research. (In Press)

Ogunniyi, M.B.: An analysis of laboratory activities in selected Nigerian secondary schools. European Journal of Science Education, 1983, 5 (2) 195-201.

Ogunniyi, M.B.: Two Decades of Science Education in Nigeria. (In Press).

Ogunniyi, M.B.: A Comparison of Communicational Strategies among four widely used biology textbooks in Nigeria. Journal of STAN, 1982, 21, 1, 111-123.

Ogunniyi, M.B.: Classroom interactions relative to teacher-student questioning behaviours. Journal of STAN, 1981, 19, (2), 116-122.

Ogunniyi, M.B.: African Traditional World-view and Modern Science. Working Paper 1 submitted to IDRC, Ottawa, Canada, September 1984.

Ogunniyi, M.B.: Status of practical work in ten selected secondary schools of Kwara State. Journal of STAN, 16: 1, 1977, 35-36.

Ogunniyi, M.B.: Meanings associated with science concepts and generalizations by scientists and students. African Journal of Educational Research; 2:2, 1979, 175-183.

Ogunyemi, E.O.: Selecting appropriate instructional strategies for high school biology teaching. Paper presented at the annual conference of STAN. August, 1971.

Ogunyemi, E.L.: Science curriculum design in a developing country. West African Journal of Education. 1969, XII, 104-114.

Okebukola, P.A.O.: Effects of cooperative, competive and individualistic laboratory interaction pattersn on students performance in Biology. Unpublished Ph.D. Thesis, University of Ibadan, 1984.

Okpalla, P.N.: Readability of Physics textbooks used in secondary schools in Oyo State. Journal of

STAN, 1982, 21, 1, 102.

Olanrewaju, A.: Effects of hierachial presentation of Learning tasks and objectives on students performance in integrated science. Unpublished Ph.D. Thesis, University of Ibadan, 1984.

Omolewa, M.: Some earliest problems of science education in Nigeria, 1859-1932. Journal of STAN, 1975, 15, 72-84.

Onabamiro, S.D.: School science: Report of an expert conference. University of Ceylon, Paradeniya, 1963.

Orisaseiyi, S.: A critical look at the attitude of secondary school students to physics. Journal of STAN, 16:1, 1977, 49-55.

Pearl, R.E.: The present status of science attitude measurement: History, theory and availability of measurement instruments. School Science and Mathematics, Vol. 73, 1973.

Peterson, R.W. and Carlson, G.R.: An analysis of research in Science Education - 1977. Science Education. Vol. 63, 1979.

Piltz, A.: Review of Science Textbooks Currently Used. School Science and Mathematics, 1961, 61.

Priere, P.: Pedagogy of the Oppressed, 1970, Hender and Hender, New York.

Rai, R.M.: The place of practical work in the school science course. Report of an expert conference, University of Ceylon, Panuteniya, 53-54, 1963.

Ramalingam et. al.: Modern Biology for Secondary schools. FEB. International Private Ltd., 1979.

Ramsay, G.A. and Hower, R.W.: An analysis of research on instructional procedures in secondary school science. Part II - Instructional procedures. Science Teaching, Vol. 36, No. 4, 1969.

Reid, P.J. and Miller, G.J.A.: Pupils perception of biological pictures and its implications for readability studies of biology textbooks. Journal of Biological Education, 14 (1), 59-69.

Renner, J.W. Abraham, M.R. and Stafford, D.G.: A summary of research in science education, Science Education, 1976.

Rothkopf, E.Z.: Learning from written instructive material: An exploration of the control of [illegible] inspection behaviour by test-like events. American Educational Research Journal, 1966, 3, 4, 241-249.

Rothkopf, E.Z. et al. Selective facilitative effects of interspersed questions on learning from written materials. Journal of Educational Psychology, 1967, 58, 1, 56-61.

Rowe, M.B.: Wait time and rewards as instructional variables, their influence on language, logical and fate control: Part I. Journal of Research in Science Teaching, 2 (2), 1974, 91-92.

Ryman, D.: Teaching methods, intelligence and gender factors in pupil achievement on a classification task. Journal of Research in Science Teaching, 14 (5) 401-409, 1977.

SEPA: Report of the teacher training materials workshop, Nairobi, Kenya, 1971. Science Education Programme for Africa, Accra, Ghana.

Schwab, J.J.: The teaching of science: An enquiry. Cambridge, Mass. 1962. Harvard University Press.

Scott, N.C. Jr.: The strategy of inquiry and styles of categorisation. Journal of Research in Science Teaching, 1966, 4, 143-153.

Scheriber, J.E.: Teachers questions-Asking techniques. Unpublished Ph.D. dissertation. 1967, State University of Iowa.

Skinner, B.F.: Science and human behaviour. Macmillian, New York, 1980.

Skon, L. Johnson, D.W. and Johnson, R.T.: Cooperative peer interaction versus individual competition and individualistic efforts: Effects on the acquisition of cognitive reasoning strategies. Journal of Educational Psychology, 1981, 73, 1, 83-93.

Slavin, R.T. and Tanner, A.M.: Effects of cooperative reward structure and individual accountability on production and learning. Journal of Educational Research, 1979, 72, 5, 294-298.

STAN: STAN Curriculum Newsletter, 1970.

STAN: STAN Biology. Addison Wesley, Pub. London, 1983.

STAN: Nigerian Integrated Science Project Curriculum Development. Newsletter, Vol. 1, 1970.

Stevens, R.: The question as a measure of efficiency in instruction: A critical study of classroom practice. Teachers College Contributions to Education, No. 48, 1912.

Stone, R.H.: A survey of science teaching in Nigerian grammar schools. Occassional publication No. 1. Institute of Education, University of Ibadan, Nigeria, 1960.

Stone, R.H. and Cozens, A.B.: New Biology for West African Schools, Longman Group Ltd., London, 1982.

Suchman, J.R.: Inquiry: The conditions for Inquiry. Instructor, 1965.

Sumner, W.L.: Curriculum development theory and practice. Harcourt Brace and World Inc. New York, 1955.

Tamir, P.: Inquiry and curiosity in the laboratory. Journal of Biological Education, 12 (3) 1978, 215-223.

Tamir, P.: The practical mode: A dinstinct mode of performance: Journal of Biological Education 1972, 6, 175-182.

Tamir, P.: An inquiry-oriented laboratory examination.

Journal of Educational Measurement, 1974, 11, 25-33.

Tamir, P. and Glassman, F.: A practical examination for BSCS students. Journal of Research in Science Teaching. 1970, 7, 107-112.

Tamir, P. Nussinovitz, R and Friedler, Y.: The design and use of a practical test assessment inventory. Journal of Biological Education, 1982, 16, 42-69.

Tamir, P. and Zaccharides, S.: Assessing practical skills in the laboratory. Unpublished research report. Hebrew, University of Jerusalem, 1980.

Teibo, B.O.: An investigation into the problems encountered by Nigerian Secondary School Pupil in learning Chemistry. Journal of STAN, 13, 3, 1975, 71-76.

Thomas, J.L.: The influence of pictorial illustrations with written texts on reading comprehension. Journal of Research in Science Teaching, 1978, 15, 5.

Thurnston, L.: Motion pictures and attitudes of children, 1933, University of Chicago Press, Chicago.

Tjosvold, D.: Marine, P.M. and Johnson, D.W.: The effects of cooperation and competition on students reaction to inquiry and didactive science teaching. Journal of Research in Science Teaching, 1977, 14, 181-288.

Uche, S.C.: Readability of Nigerian Secondary School Biology Textbooks. Unpublished M.Ed. Dissertation, 1979, University of Ibadan, Ibadan.

Walberg, H.J. (Ed.): Educational environment and effects: Evaluation, research and policy. Chicago: National society for the study of education Berkeley: McCutchan, 1979.

Washburne, J.N.: The Use of questions in social science materials. Journal of Educational Psychology, 1929, 20, 321-359.

Weaver, E.K.: Science education in Nigeria. Science Education, 48:4, 1964, 351-361.

Wilson, J.H.: The New Teachers Are Asking More and Better Questions. Journal of Research in Science Teaching, 1969, 6, 49-53.

Wheeler, R. and Ryan, F.L.: Effects of cooperative and competitive classroom environment on the attitude and achievement of elementary school. students engaged in social studies inquiry activities. Journal of Educational Psychology, 1973, 6, 402-407.

Whittle, P.A.: Activity methods for student science teachers. Journal of STAN, 1974, Vol. 12, No. 3, pp. 12-15.

Yeghia, B.: An empirical investigation to determine the relative effectiveness of discovery, laboratory and expository methods of teaching science concepts. Journal of Research in Science Teaching, 1971, 8, (3).

Yoloye, E.A.: Readability indices in the evaluation of curriculum materials. Journal of Curriculum Studies, 1975, 7, 1.

Yoloye, E.A.: Readability: A report of the Commonwealth Africa - Book Development Seminar. Commonwealth Secretariat, London, 1975.

Yoloye, E.A. and Bajah, S.T.: Science Education for Africa. Vol. 1: A report of twenty years of science education in Africa, SEPA, 1981.

APPENDIX 1

READABILITY INDEX

(R. I.)

READABILITY DETERMINATION

The readability of the four textbooks used in the study were determined using Flesch's (1948) readability formulae. The books examined were Mackean, Stone and Cozen, Ewusie and STAN Biology.

PURPOSE

The purpose of the readability determination was to determine the difficulty levels of the textbooks and determine their suitability for the comprehension level of the students.

INSTRUMENT

Flesch's (1948) readability formulae and its interpretation data relative to Nigerian schools was used for the study. The formula has been used extensively by Major and Collette (1961), Marshall (1962), Wahome (1979) Jegede (1982) and Okpalla (1982). Although the readability formulae can not measure elements such as graphs and diagrams which are capable of influencing the reading comprehension of Biology textbooks, it has a number of advantages. It's suitable for this study for the following reasons:

(a) It does not employ word list.

(b) It utilizes measurement of sentence length and syllable count.

(c) It utilizes measurement of sentence complexity (count of word length and number of syllable per hundred words), is a reliable measure of abstraction (Marshall, 1962).

PROCEDURE

The procedure adopted in the readability determination included;

1. The textbooks to be used are the four used in the study.

2. Selection of a paragraph each from every sampled page (every tenth page, as in the textbook analysis).

3. Each paragraph should have about 100 words.

For each sampled paragraph, the following data will be collected;

(i) Number of words in the sample.

(ii) Number of syllable in the sample.

(iii) Number of sentences in the sample.

(iv) Average sentence length (ASL).

=

(v) =

$$ASL = \frac{\text{Number of words in a sample}}{\text{Number of sentences in a sample}}$$

(v) Word length (WL) = Number of syllables in 100 words.

From the above data, the Flesch's readability score (RS) is given as:

$$RS = 206.835 - 0.846\ WL - 1.015\ ASL$$

This was done for all pages sampled. The average is the readability score of the book.

Flesh's interpretation of the readability data relative to Nigerian schools (Wahome, 1979) was used in interpreting the readability scores computed for the four books.

Flesch's Interpretation of Readability Data Relative to Nigerian Schools

Readability Score	70–79	60–69	50–59	40–49
Average Sentence Length	14	17	21	25
Syllables Per 100 Words	139	147	155	155
Description of styles (4th year students)	Easy	Fairly easy	Standard	Fairly Difficult

APPENDIX 2

Communicational Strategies Survey

(CSS)

Communicational Strategies Survey

(CSS)

Dear Respondents,

This survey is to seek your candid opinion on the status and your preference for the strategies examined in this survey.

The survey is not a test and information shall be treated in confidence.

Name:

Sex:

Occupation:

The questions that follow, relate to various communicational strategies that can be found in a Biology textbook.

You are to rate these strategies from 1 to 5 by ticking in the column provided, if you prefer a strategy best, you rate it as 5 by ticking the column for 5, and the least preferred is rated 1 by ticking 1 in the column.

Please express your candid preference for any of the strategies.

Key for Rating

5 = Very Essential

4 = Essential

3 = Sometimes essential

2 = Hardly essential

1 = Not essential

Now, answer the questions

	5	4	3	2	1
Use information below to answer question 1 - 4;					
Biology textbooks should use questions that are:					
1. Factual (recall of facts)...					
2. Rhetorical (require no answer)					
3. Leading (directed to a later answer)					
4. Probing (require evaluation and giving personal opinions)..					
For questions 5 - 8 use the following information;					
The questions in a Biology textbook should be.....................					
5					

	5	4	3	2	1
5. Introductory (at the beginning to arouse interest)					
6. Contextual (within the meaning of a subject matter)...					
7. Terminal (at the end to evaluate understanding)					
8. Captional (used in reference to a heading, table, graph, illustration)					
Answer questions 9-12 using the statement below:					
Technical terms used in a Biology textbook should be...............					
9. Defined when used............					
10. Earlier defined (before in introducing the term).....					
11. Later defined.................					
12. Should be undefined...........					
The statement below is for questions 13 - 15;					

	5	4	3	2	1
When specimens are mentioned or suggested for practical exercises, the specimens should be........					
13. Local specimens............					
14. Foreign specimens..........					
15. Preserved specimens........					
Answer questions 16-25 using the statement;					
A good biology textbooks should have.........					
16. Pictures only...............					
17. Diagrams only...............					
18. Both pictures and diagrams...					
19. Good descriptions only......					
20. Pictures and diagrams should be labelled...............					
21. Pictures and diagrams should not be labelled............					

	5	4	3	2	1
22. Pictures and diagrams should be sometimes labelled..................					
23. Pictures and diagrams should be in colours.............					
24. The pictures and diagrams should be in black and white.....................					
25. The pictures and diagrams c-r can be shaded..............					
For questions 26 - 29, use the following statement.................					
In a biology textbook, the practical exercise suggested should be.....................					
26. Simple (casual observation)..					
27. Specific (individual laboratory work)...........					
28. General (student/or group project)......................					

	5	4	3	2	1
29. Challenging (student/group or teacher demonstrate specialised knowledge or skill).....................					
Use the statement below for questions 30-36.					
A good Biology textbook should emphasize major themes of importance to the student and the society.					
Important themes should include:					
30. Evolution (development trends in Biology systems)........					
31. Ecology (inter-relationship of organisms and environment)					
32. Economic importance ([illegible] (benefits to man)..........					
33. History (stories of discovery)............					

	5	4	3	2	1
34. Inquiry (finding out more about things)...........					
35. Knowledge (factual presentation of topics)..........					
36. Traditional world-view (views influenced by cultural beliefs).........					
The following statement is for questions 37-39.					
The cover of a Biology textbook should be.................					
37. Be of plain cover...........					
38. Cover should have coloured pictures and diagrams.......					
39. The cover should be in black and white illustrations.....					
Questions 40-43 concern what should be the qualities in the main text of a Biology textbook.					

	5	4	3	2	1
40. The main text should have colours for distinguishing sections.................					
41. The characters in the main text should be in black only....................					
42. The characters in the main text should be in different sizes (as in subsections)...					
43. The characters should all be in the same size..........					

APPENDIX 3

Text-Books Analysis Index

(TEA)

TEXTBOOKS ANALYSIS (TPA) INDEX

The four textbooks (Most popular - Balogun 1979) analysed were:

1. Mackean, D.G. - Introduction to Biology. West African Edition, Heinemann Educational Books (Nig.) Ltd., 1982.
2. Ewusie, J.Y. - Tropical Biology for 'O' Level and School Certificate, African University Press In Association with Harrap, London 1982.
3. Stones, R.H. and Cozens, A.B. - New Biology for West African Schools. Longman Group Ltd., London 1982.
4. STAN Biology - Addison Wesley. London, 1983.

The textbooks were analysed using a modified version of communicational strategies used by Ogunniyi (1982).

For the analysis, sample pages were taken for all the four books.

The analysis involved a slightly modified version of Ogunniyi's (1982) communicational strategies in the following areas:

1. Status of pictures and diagrams
2. Nature of practical suggestions.
3. Physical characteristics of the textbooks.
4. Type and position of questions.
5. Occurrence of major themes.
6. Technical terms.
7. Specimens

1. Questioning Styles:

(a) Type of questions with respect to whether they are:

- Factual
- Rhetorical
- Leading
- Probing

(b) Position of questions with respect to:

- Introductory
- Contextual
- Terminal
- Captional

2. Terms:

- Terms defined as used
- Earlier defined

- Later defined
- Undefined

3. Specimens:
   - Local specimens
   - Non-local specimens

4. Status of major themes:
   - Evolution
   - Ecology
   - Economic importance
   - Inquiry
   - History
   - Knowledge
   - Traditional world-view (superstition)

5. Status of pictures and diagrams:
   - Number of pictures
   - Number of diagrams
   - Number of labelled and unlabelled pictures and diagrams.
   - Number of colours used for pictures and diagrams.

6. Nature of practical suggestions:

- Simple
- Specific
- General
- Challenging

7. Physical characteristics of textbooks:
    - Number of colours on the cover
    - Number of colours in the text
    - Number of characters used in the text (type sizes).

APPENDIX 4

Subjects Selection Test
(S.S.T.)

A. The following are test items based on what you have done previously in Biology.

B. You are expected to read through very carefully and choose from among the alternatives by circling with a pencil or biro the letter A, B, C, D or E corresponding to the correct or most correct answer.

C. If you do not know an answer to a question, move to the next.

1. Air contains about (78%) seventy-eight percent of a gas called.
   (a) Nitrogen
   (b) Water
   (c) Oxygen
   (d) Hydrogen
   (e) None of the above

2. When an amount of water will not dissolve any more salt, the solution is said to be.
   (a) Saturated
   (b) Unsaturated
   (c) Hydrated
   (d) Super-hydrated
   (e) None of the above

3. When a candle is burning, two chemical compounds are formed called.

(a) Carbodioxide and water

(b) Oxygen and carbon

(c) Oxygen and nitrogen

(d) Oxygen and hydrogen

(e) Hydrogen and water

4. Water enters plant root hairs by a physical process called?

(a) Diffusion

(b) Osmosis

(c) Passage

(d) Movement

(e) Assimilation

5. A molecule of water contains:

(a) One atom of oxygen and two atoms of hydrogen.

(b) Two molecules of oxygen

(c) Two molecules of hydrogen

(d) Two atoms of oxygen and one atom of hydrogen.

(e) None of the above

6. Water will boil at the temperature of:

(a) $100^{\circ}C$

(b) $0^{\circ}C$

(c) $0^{\circ}F$

(d) $100^{\circ}F$

(e) $120^{\circ}C$

7. The mass of an object is the quantity of

(a) Matter in it

(b) Weight of it

(d) Volume of it

(d) Height of it

(e) None of the above

8. The relative density of a substance is the ratio of the mass of the substance to:

(a) Mass of equal volume of water

(b) Weight of equal volume of water

(c) Density of water

(d) Weight of substance

(e) None of the above

9. The weight of a floating object is equal to the ..... of fluid displaced.

(a) Weight

(b) Volume

(c) Density

(d) Mass

(e) None of the above

10. All acids turn blue litmus paper to

(a) Red

(b) Pink

(c) Blue

(d) Colourless

(e) No change

11. The chemical name for quickline is

(a) Calcium oxide

(b) Calcium dioxide

(c) Calcium oxygen

(d) Sodium dioxide

(e) Sodium oxide

12. When carbondioxide dissolves in water, it forms a weak

(a) Acid

(b) Base

(c) Solvent

(d) Mixture

(e) Alkali

13. Chlorine is a

(a) Gas

(b) Liquid

(c) Solid

(d) Solution

(e) Mixture

14. When iodine is put into starch the colour got is

(a) Blue black

(b) Black

(c) Blue

(d) Yellow

(e) White

15. The green colour of leaves is called

(a) Chlorophyll

(b) Green

(c) Iodine

(d) Starch

(e) None of the above

16. When two tuning-forks are beaten and brought near each other there is

(a) Resonance

(b) Equilibrum

(c) Touching

(d) Sound

(e) Noise

17. When dilute acids are added to carbonates, they give

(a) Carbon dioxide

(b) Water

(c) Oxygen

(d) Hydrogen

(e) Chlorine

18. Lime-water is a saturated solution of

(a) Calcium hydroxide

(b) Calcium oxide

(c) Lime

(d) Carbon dioxide

(e) Carbon

19. A type of water which does not readily form lather with soap is called:

(a) Hard-water

(b) Dry water

(c) Soft water

(d) Non-lathering

(e) Saturated water

20. Common salt will met at a temperature of:

(a) 850°C

(b) 100^{o}C

(c) 850^{o}F

(d) 100^{o}F

(e) 112^{o}F

21. When sodium chloride is added to hydrogen sulphate the result is the formation of

(a) Hydrogen and sulphate

(b) Hydrogen chloride and sodium sulphate

(c) Chloride and sodium sulphate

(d) Sulphate

(e) Chloride

22. Hydrogen chloride is

(a) Acidic

(b) Basic

(c) Alkali

(d) Amphoteric

(e) None of the above.

23. When a sound is reflected it is called an

(a) Echo

(b) Sound

(c) Noise

(d) Vibration

(e) Boumerang

24. The speed of sound in dry air at $0^{o}C$ is about

(a) 500 meters per second

(b) 1 meter perssecond

(c) 1 kilometer per second

(d) 10 meters per second

(e) 1000 kilometers per second

25. The reproductive part of a plant is the

(a) Flower

(b) Stem

(c) Root

(d) Leave

(e) Nodes

26. An instrument used for measuring temperature is called a

(a) Thermometer

(b) Guage

(c) Meter

(d) Voltmeter

(e) Ammeter

27. Solid, liquid and gas are classified as

(a) Matter

(b) Gas

(c) Solid

(d) Liquid

(e) Solution

28. An animal which can live on land and water is called an

(a) Amphibian

(b) Fish

(c) Animal

(d) Monkey

(e) Water-animal

29. Living things are also called

(a) Organisms

(b) Solid

(c) Liquid

(d) Gas

(e) None of the above

30. A type of energy is called

(a) Light energy

(b) Gas energy

(c) Solid nergy

(

(

(d) Liquid energy

(e) Molten energy

31. A power station in Nigeria which converts Kinetic energy into electrical energy is the

(a) Kainji Dam

(b) School plant

(c) Electricity plant

(d) Plants

(e) Animals

32. Energy on earth comes from the

(a) Sun

(b) Moon

(c) Stars

(d) God

(e) Jupiter

33. The process in which a substance moves through into another is called

(a) Diffusion

(b) Movement

(c) Displacement

(d) Coiling

(e) Respiration

34. Scientists call a statement which has not be tested as

(a) Hypothesis

(b) Formulae

(c) Observation

(d) Experiments

(e) Tests

35. When a solute is dissolved in a solvent the result is the formation of a

(a) Solution

(b) Liquid

(c) Solid

(d) Gas

(e) Acid

36. When substances burn in oxygen, they combine with it to form

(a) Oxides

(b) Hydrides

(c) Carbonates

(d) Water

(e) Solution

37. Animals with backbone are called

(a) Vertebrates

(b) Invertegrates

(c) Amphibians

(d) Solids

(e) Water-birds

38. Flesh-eating animals are called

(a) Carnivores

(b) Herbivores

(c) Plant eater

(d) Scavengers

(e) All of the above.

39. Fertilized ovules of plants result into

(a) Seeds

(b) Leaves

(c) Roots

(d) Stem

(e) Chlorophyll

40. Substances which do not conduct electricity are called

(a) Insulators

(b) Conductors

(c) Salts

(d) Solids

(e) Metals

41. Sound travel as a
    (a) Wave
    (b) Noise
    (c) Vibrations
    (d) Solid
    (e) Gas

42. For healthy growth human beings need a
    (a) Balanced diet
    (b) Vitamins only
    (c) Minerals only
    (d) Water
    (e) Salt

43. Deposited rocks under water beds are called
    (a) Sedimentary rocks
    (b) Igneous rock
    (c) Metamorphic rocks
    (d) Simple rocks
    (e) Complex rocks

44. The earth rotates about an
    (a) Axis
    (b) Plane
    (c) Circle

(d) Horizontally

(e) Vertically

45. When the earth rotates round the sun it results into the formation of

(a) Seasons

(b) Climate

(c) Weather

(d) Rain

(e) Snow

46. A system of bones is called a

(a) Skeleton

(b) Femur

(c) Bones

(d) Cartilage

(e) Humerous

47. Metals are generally regarded as good conductors of

(a) Electricity

(b) Gas

(c) Light

(d) Solids

(e) Water

48. All living things are made up of simple units called

(a) Cells

(b) Organs

(c) Systems

(d) Tissue

(e) Cytoplasm

49. A stored energy in a substance is called

(a) Potential energy

(b) Light energy

(c) Sublimation energy

(d) Solid energy

(e) Liquid energy

50. The removal of liquid waste from the body is called

(a) Excretion

(b) Digestion

(c) Assimilation

(d) Polution

(e) Urinating

EXPERIMENTAL STUDY

TREATMENT CONDITIONS

Treatment was carried out on the experimental and control groups. Before and after the treatment the following instruments were administered.

1. Students Attitudinal Test (SATT)
2. Students Achievement Test (SAT)
3. Students Psychomotor Test (SPT)

COMMUNICATIONAL STRATEGIES FOR THE STUDY

The selected communicational strategies used in the study included; questioning styles, technical terms, specimen, status of diagrams and pictures, major themes and practical exercises.

The treatment conditions included the following communicational strategies;

1. QUESTIONING STYLES

(a) Leading and probing questions

These have been emperically found to be of higher order questions that stimulate inquiry behaviours than other types of questions (Stevens, 1912, Gall, 1970; Rave, 1974; Ogunniyi, 1981; 1983 and Carrick, 1982).

(b) Contextual Questions

They have been determined emperically as very valuable (Ogunniyi, 1981; Carrick, 1982).

2. TERMS

Defined terms (at first occurrence)

As determined by (Evans, 1976) the terms defined at first occurrence facilitate reading and comprehension.

3. <u>SPECIMEN</u>

<u>Local Specimens</u>

Local specimens are valuable to teaching and learning since they are readily available in the teaching environment, and are familiar to the students (Ogunniyi, 1982).

4. <u>PICTURES AND DIAGRAMS</u>

<u>Labelled diagrams and pictures</u>

These are indispensable memory aids unlike the unlabelled diagrams that have little use to the reader. (Ogunniyi, 1982).

5. <u>MAJOR THEMES</u>

<u>Inquiry Method</u>

The current emphasize in science education is the presentation of school science as a form of inquiry (Ogunniyi, 1982; Schweb, 1962).

6. <u>PRACTICAL EXERCISES</u>

<u>Challenging exercises</u>

Practical exercises provide students with unique opportunities to study abstract concepts and generalisations through the medium of real materials.

Kerr (1963) and Ogunniyi (1977) contend that challenging exercises are suitable for upper classes, while simple and specific exercises are suitable for lower forms.

APPENDIX 5

Students Attitudinal Test (SATT)

The students attitudinal test was designed to see how the communicational strategies used during treatment affected the attitudes of the students to Biology.

Categorisation of Items in Attitudinal Test Into Communicational Strategies

Items (Questions)	Communicational Strategies
1 - 3	Questioning Styles
4 - 6	Technical Terms
7 - 9	Specimens
10 - 12	Status of pictures and diagrams
13 - 15	Major Themes
16 and 17	Practical Exercises
18 - 20	Physical attributes of textbooks

Students Attitudinal Test (SATT)

This questionnaire is concerned about your interest in Biology. Please fill in the information required as honestly as possible.

This is not an examination.

Name:

School:

Sex:

Now respond to the questions. You are to indicate in the column provided if you agree or disagree with the statement.

Agree = 2

Disagree = 1

	Agree	Disagree
	2	1
1. Biology is interesting when leading questions are used (This is a question directing to the answer).		
2. I like Biology when probing questions are used (i.e. questions requiring critical consideration of		

	Agree	Disagree
	2	1
personal opinion)		
3. I find Biology interesting when contextual (i.e. the questions are asked within the textual material).		
4. I tend to forget Biology terms very easily.		
5. Biology terms make uninteresting.		
6. I like Biology when the terms are defined when used.		
7. Biology is interesting when local materials are used.		
8. The long names of biological specimens make the subject boring and uninteresting.		
9. I hate Biology because it deals with messy and smelly preserved materials.		

	Agree	Disagree
	2	1
10 I like Biology because of the good diagrams and pictures.		
11. I like Biology because the diagrams and pictures are usually well labelled.		
12. I like Biology when the diagrams and pictures are in different colours.		
13. Biology is interesting to me when the inquiry method (finding out more about things) is used.		
14. The theory of evolution (structures and/or developmental from a common origin) trends in Biology systems contradicts my faith in God as the Creator of all things; hence I do not like to study Biology.		

	Agree	Disagree
	2	1
15. Biology is interesting when the ideas agree with those of my cultural beliefs.		
16. Biology is interesting because the practical exercises are usually challenging i.e. require team work.		
17. I do not like Biology because the practical exercises exposes one to danger.		
18. I like Biology because the cover of the textbooks are coloured.		
19. Biology is not interesting to me because the coloured words used in the textbooks help me to remember the terms.		
20. Biology is very boring to me because the words in the textbooks are in different sizes.		

APPENDIX 6

Students Achievement Test (SAT)

The SAT was designed to see how the strategies used during treatment affected the students cognitive performance in Biology.

Categorisation of SAT Items Into Communicational Strategies

Items (Questions)	Communicational Strategies
1 - 5	Leading questions
6 - 10	Probing questions
11 - 15	Contextual questions
16 - 20	Defined technical terms
21 - 25	Local specimens
26 - 30	Labelled diagrams and pictures
31 - 35	Inquiry method
36 - 40	Challending practical exercises

Students Achievement Test SAT)

Dear Students,

Please answer the questions **honestly** and candidly. If you do not know the answer to a question, do not guess, leave the question and go to the next one.

This is NOT an examination.

Please provide the following information:

Name:

School:

Class:

Sex:

You are to spend one hour on this exercise. Each question has four options of answers, you are to indicate by circling the answer that you think is the most adequate.

1. When an organism needs only inorganic food to synthesise complex organic molecules, it is said to exhibit....
   A. Autotropic nutrition
   B. Saprophytic nutrition
   C. Parasitic nutrition
   D. General nutrition

2. Organisms feeding on organic food substances, exhibit the phonemenon of ......

   A. Heterotropism

   B. Autotropism

   C. Saprophytism

   D. Parasitism

3. Inadequate supply of iron in food can result in a deficiency called ......

   A. Anaemia

   B. Goitre

   C. Blindness

   D. Loss of movement

4. Although trace elements (Zinc, Copper and Manganese) are good for healthy growth in plants, they are required in .....

   A. Minute quantities

   B. Large quantities

   C. Only at night

   D. During the day

5. The gut of carnivores are shorter than herbivores because ......

A. Carnivores food is largely protein which is easy to digest.

B. Carnivores food is largely protein which can not be easily disgested.

C. Herbivores feed on animals.

D. Canivores feed mostly on plants.

6. Why do you think mammals have to store glycogen?

A. So that it can be hydrolysed back to glucose when needed.

B. So that it can be condensed back to glucose when needed.

C. So that it can be stored away.

D. So that the Mammals can feed only on plants.

7. What do you expect to happen if the peristalis movement in the small intestine is distrupted?

A. Movement of bolus of food will stop

B. Movement of bolus of food will be hastened

C. The small intestine will burst

D. Food will pass to the large intestine.

8. Why is the enamel of the human tooth very hard?

A. To prevent early wearing away.

B. So that it could be used to crack hard food substances.

C. To keep the shape of the teeth.

D. For protection against dangerous animals.

9. In carnivores, the temporal muscles are huge, but small in herbivores, why to you think there's the difference?

A. To allow for shearing action of carnassial teeth in carnivores and for only raising the lower jaw in herbivores.

B. To give a greater force to the carnivores against attacks.

C. To allow the carnivores to open their mouth larger than in herbivores.

D. To allow the herbivores enough room to graze the field.

10. In three test-tubes A, B and C, a cube of cooked egg white was put. Into A, sodium carbonate was added, in B distil water and into C hydrochloric acid was added. To the three tubes, pepsin was then added. After 24 hours, the cube in C when put in a warm place was

totally digested. What can you say of A, B and C if nothing happens to B and C.

A. Pepsin requires acid conditions to digest cooked albumen.

B. Pepsin is active in cold water

C. Pepsin is active in sodium carbonate

D. Pepsin is active in distil water when kept in a warm place.

11. In the school farm, an organism like mushrooms were found on dead materials. These mushrooms can be said to exhibit;

A. Heterotrophism

B. Autrotrophism

C. Saprophyism

D. None of the above

12. Since plants can not move, a student set out to analyse their source of energy. In his finding, he found out that when sunlight was present, there was presence of starch in the leaves. By his finding, the plants source of energy is .....

A. Sunlight

B. Minerals

C. Vitamins

D. Respiration

13. In a West African town, a weak man with poor teeth was asked to be taking food enriched with milk, cheese and bread. This it is to prevent ......

A. Brittle bones and teeth

B. Goitre

C. Blindness

D. Bow legs.

14. Why are hydrolysed units of food substances sometimes condensed in the human body?

A. When food needs are to be stored.

B. When food needs are to be used

C. When food is enough

D. When food needs are inadequate

15. In an experiment on digestion, a student discovered that the colon does not contain digestive enzymes. He concluded that the reason is likely to be ....

A. Because all the food substances have been acted upon, digested and assimilated in the earlier digestive system.

B. Because the colon is short.

C. Because the colon is before the stomach and intestine

D. Because the cells in the colon are dead.

16. Organic compounds are defined as ....

A. Complex, carbon - containing compounds

B. Complex polysaccharides

C. Complex carbon and hydrogen compounds

D. Complex nitrogen compounds.

17. The deficiency of iodine present in sea foods and table salts results in ......

A. Goitre

B. Blindness

C. Brittle hones

D. Bow legs.

18. An aggregation of monosaccharides are called .....

A. Polysaccharides

B. Disaccharides

C. Proteoses

D. Glucose

19. The smallest unit of Proteoses is called .....

A. Amino acid

B. Glucose

C. Sucrose

D. Fatty acids

20. The hepatic portal vein in the villi carry blood to the ......

A. Liver

B. Kidney

C. Stomach

D. Small intestine

21. A living organism that is found in Nigeria exhibiting holophytic nutrition is ......

A. Hibiscus flower

B. Amoeba

C. Man

D. Rabbit

22. An organism that is found in the bush in Nigeria and feeds on organic material is the .....

A. Rabbit

B. Palm tree

C. Coconut tree

D. All of the above.

23. To prevent a young Nigerian child from anaemia, he should be fed regularly on ......

A. Liver and eggs

B. Meat and eggs

C. Vegetables and liver

D. Beans and eggs.

24. In Nigeria, a common ectoparasite is ......

A. Mosquitoes

B. Flies

C. Cockroach

D. All the above.

25. A Nigerian food with plenty of protein is the ....

A. Beans

B. Yams

C. Cassava

D. Vegetables.

26 - 30 and 31 - 35

Fig. 1 attached is to be used in answering questions 26 - 30.

Fig. 2 should be used in answering question 31 - 35.

Questions 26 - 30 (Use Figure 1)

26. A is the outer layer in the organ shown, what should be its nature?

A. Thin for easy absorption

B. Thick for easy absorption

C. Thick for protection

D. Thick for peristalsis

27. What type of food materials are carried in B?

A. Water soluble

B. Fat soluble

C. Protein soluble

D. Polysaccharies

28. What type of food substances are carried in C?

A. Fatty substances

B. Protein substances

C. Glucose

D. Proteoses

29. Why is D called the hepatic portal vein?

A. It carries blood to the liver

B. It carries blood to the stomach

C. It carries blood to the intestine

FIG. 1

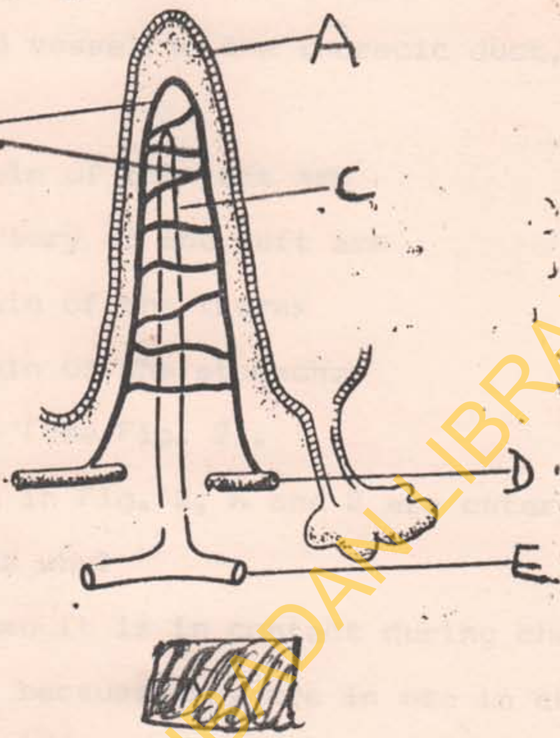
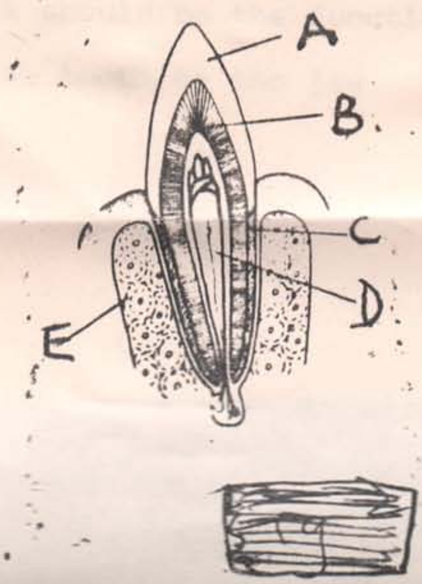


FIG. 2



D. It carries blood to the bile.

30. E is a blood vessel to the thoracic duct, where is it located?

A. Main vein of the left arm

B. Main artery of the left arm

C. Main vein of the thorax

D. Main vein of the stomach.

Questions 31 - 35 (Use Fig. 2).

31. In the organ in Fig. 2, A and B are outer layers, which is harder and why?

A. A because it is in contact during chewing.

B. A and B because they are in use in chewing

C. B because it protects the pulp cavity

D. All of the above

32. Why is layer B very hard?

A. To give protection to the pulp cavity.

B. To protect the cement

C. To protect the enamel

D. To protect the dentine

33. What do you think should be the function of C?

A. To attach the tooth to the jaw

B. To attach the tooth to the enamel.

C. To attach the tooth to living substances

D. All of the above.

34. What substances do you think D contains?

A. Nerves, capillaries and lymph vessels.

B. Nerves and blood

C. Nerves and Flesh

D. Blood and Flesh

35. Which part of the organ is E?

A. Jaw bone

B. Dentine

C. Enamel

D. Pulp cavity

36 - 40: Use the information below to answer questions 36-40.

Class four biology students were engaged in a practical exercise. They were given three boiling tubes, A, B and C with a solution. Using the solution in the tubes, they were asked to follow the following procedure:

(i) In tube A, add blue Benedict's solution and boil.

(ii) In tube B, add conc HCl and boil for 10 minutes.

(iii) To tube C, add iodine solution.

Now answer the questions after the conclusion of the procedures.

36. If the solution in tube A gives an orange precipitate, which food substance do you think is present in the solution?

A. Glucose

B. Protein

C. Fat

D. Sucrose

37. If the solution in tube C turns blue-black, and if a fresh solution is put into another boiling tube D and then hydrolysed. What is the food substance that would be the result of the hydrolysis?

A. Glucose

B. Sucrose

C. Starch

D. Protein

38. The tube C originally contains which food substance?

A. Starch

B. Glucose

C. Sucrose

D. Protein

39. If the solution in tube B gives urine-coloured solution, the solution in B is likely to contain ....

A. Sucrose

B. Fat

C. Protein

D. Glucose

40. If the solution in A consists of small units the process by which the units can result in a complax molecule is called ......

A. Condensation

B. Hydrolysis

C. Hydration

D. Catalysis

APPENDIX 7

Students Psychomotor Test/Students

Psychomotor Assessment Inventory
(SPT/SPAI)

Students Psychomotor Test

Requirements for the exercises;

1. Onion bulb
2. Iodine solution
3. Fehling's solutions I and II (mixed)
4. Test-tubes

Students Psychomotor Assessment Inventory (SPAI)

Scoring Key:

2 = Satisfactory manipulative behaviour

1 = Partially satisfactory manipulative behaviour

0 = Unsatisfactory manipulative behaviour

Criteria Exhibited	2	1	0
1. Sectioning skill (correct plane of section)			
2. Addition of adequate number of iodine drops			
3. Addition of adequate number of Fehling's solution I and II drops			
4. Method of mixture and shaking of mixture.			
5. Heating techniques			
6. Ease of handling apparatus			
7. Accuracy of observation			
8. Drawing skill (accuracy)			
9. Carrying out exercise to time			
10. Accuracy of recording and reporting observation.			

Students Psychomotor (Manipulative Skill)

Test

(SPT)

Students Psychomotor (Manipulative Skill) Test)

This is a test on how well you can use your hands,, equipments and carry-out instructions.

This test is not an examination.

Name:

School:

Sex:

INSTRUCTIONS

On your table is specimen A. Examine the specimen very well and carry-out the following directives.

1. Cut through the specimen vertically to show all the features. Draw and label what you see.

(15 minutes)

2. Add two drops of iodine solution onto the cut surface. Record and explain what you find.

(10 minutes)

3. Add six drops of Fehling's solution I and II (this had been mixed for you) to a freshly cut surface (another surface). What do you observe. Record and explain what you observe.

(10 minutes)

4. Put six drops of Fehling's solution I and II into a test-tube. Heat gently and observe. Record your observation.

(10 minutes)

Total time: 45 minutes

APPENDIX 8

NOTES OF LESSON

<u>Treatment Conditions</u>

The treatment was for 6 weeks.

The communicational strategies, **was as previously** determined with a pre-test and post-test of;

1. Students Attitudinal Test (SATT)
2. Students Psychomotor Test (SPT)
3. Students Achievement Test (SAT)

The communicational strategies **emphasised were** ;

1. Questioning Styles;
   Leading, probing and contextual questions
2. Defined terms at first occurrence
3. Local specimen for illustrations
4. Labelled diagrams and pictures
5. Inquiry method
6. Challenging practical exercises.

As indicated, eight communicational strategies will be used. Since there are bound to be overlapping during teaching, attempt were made to delinate particular time interval when a communicational strategy was used.

Since treatment is for 6 weeks, each of the eight communicational strategies was focussed at for specific time during the treatment period.

TOPICS TREATED

WEEK 1: NUTRITION

1. 1. Food for metabolism

2. Holophytic, holozoic and saprophytic nutrition

3. Mineral salts for mammals and angiosperm

4. Carbohydrates, fats and protein - composition, uses and theoretical description of food tests

5. Vitamins - sources, functions and deficiency diseases.

WEEK 2:

1. Feeding methods of animals - herbivores, carnivores, omnivores, filter-feeders, parasites and saprophytes.

2. Digestion and its consequences - ingestion to assimilation and egestion: physical and chemical digestion.

3. Mammalian teeth and jaws - tooth structure and types of teeth.

4. Herbivores and carnivores teeth and jaws.

WEEK 3:

1. Mammalian alimentary canal

2. Absorbtion of food at villi

3. PRACTICALS

(a) Food test.

(b) Experiment with digestive enzymes.

WEEK 4:

1. Herbivores and carnivores; the gut

2. Storage of food

3. The liver - functions

4. Diet: balanced diet, Kwanschiorkor.

LESSON NOTES APPENDIX I: SHEET I

WEEK I: LESSON I (80 MINUTES)

LESSON	TIME	WHAT TO TEACH	MATERIALS	HOW TO TEACH? - COMM. STRATEGY	STUDENTS ACTIVITIES
FOODS & FEEDING	F 5 Mins.	FOOD 1. Food - Material for building up of proto-plasm is of two types (a) Inorganic: Are simple molecles common to non-living matter e.g. carbon dioxide, mineral salts and water. (b) Organic: Are complex, carbon-containing compounds e.g. carbohydrates, fats, proteins and vitamins. These classes of food, are characteristic of living matter.	Comm. African Food types: 1. Beans 2. Rice 3. Yam 4. Cassava 5. Water 6. Ammonium salts.	Leading question: 3 Mins: What are the characteristics of a living matter? Local specimen: 2 mins: Yams, Beans, Cassava	Examines the materials provided on the side ta ble (Yam, beans ammonium salts) and identify the differences between an organic and inorganic material.
	5 mins.	METHODS OF NUTRITION There are two differentt methods of nutrition. 1. Autotrophic: Are organic isms-plants containing green chlorophyll. They need only inorganic food from which they synthesise organic molecules, using energy trapped from sunlight to drive the reactions.	1. Green plants 2. Fungi grown on bread.	Probing questions: 3 mins.: If moist, bread is left, for 5 days, what would be observed?	Observe on the micro-scope slide; on the morphological features of algae and fungi.

LESSON	TIME	WHAT TO TEACH	MATERIALS	HOW TO TEACH? - COMM. STRATEGY	STUDENTS ACTIVITIES
	5 Mins.	2. Heterotrophic: Are organisms-animals and non-green plants e.g. fungi. They feed on organic f food. From this they derive their energy released by respiration. They also need some inorganic food.			
	8 mins:	AUTOTROPHIC NUTRITION: Holophytic Examples: Typical green plants plants e.g. spirogyra and angiosperms. Type of food: Inorganic only e.g. carbon dioxide, water and mineral salts. How the food is used: (i) Carbondioxide and water are combined in photosynthesis to make carbohydrates. (ii) Carbohydrates are modified and often combined with salts to form other organic molecules e.g. protein Source of energy: Sunlight trapped by chlorophyll during during photosynthesis.	1. Green angiosperms	Terms defined: 2 mins: Holophytic Contextual question: 6 mins: How do plants make their food and what are the uses of food substances for plants?	Move out of the classroom to the school garden and have close look at the green plants.

WEEK I SHEET 2

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? - COMM. STRATEGY	STUDENTS ACTIVITIES
		HETEROTROPHIC NUTRITION Source of energy: Rely on respiration of organic molecles - the bonds of which contain energy. Has no chlorophyll hence no photosynthesis.	1. slides of amoeba	Leading question: 2 mins: What are the sources of energy for heterotrophs?	States likely sources of energy for man.
	8 mins:	HOLOZOIC: Examples: Typical animals e.g. amoeba and mammals. Type of food: organic, water and mineral salts. How food is used: Food organisms are killed; secreted internally; soluble products absorbed; indigested waste egested (eliminated).		Contextual question: 6 mins: When a man takes food, the quantity of the food when compared to the waste egested indicate a decrease. How do one account for the difference?	Examines the movement and feeding of amoeba under the microscope.
	4 mins:	Saprophytic: Examples: Bacteria and fungi of decay e.g. mucor and mushrooms; Type of food: Dead organic matters, water, and mineral salts. How food is used: Dead organ-organisms are digested by enzymes secreted externally onto them and soluble products absorbed.	1. Slides of fungi, mucor and mushroom.	Defined term: 2 mins: Saprophytic. Local specimen: 2 mins. 1. Mucor on bread 2. Mushroom on dead wood	Mucor growing on bread is brought to the class and examined. Thereafter a discussion on their feeding method is done.

WEEK I SHEET $ 4

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
FOODS & FEEDING	£ 5 Mins.	FOOD CHAIN: Organic food can be obtained from living organisms (holozoic) or from dead matter (saprophytic) resulting in a chain of Holophytes live, organic Holozoites food Dead, organic food. Inorganic food Saprophytes	1. Slides of fungi, mucor and mushroom	Defined term: 2 mins: Food chain Inquiry method: 3 mins: If you have a situation where you have man, fish and vegetable, how can you illustrate the relationship between the three during feeding.	Are to trace the relationship between man, fish, water and water plants.
	1 Min.	Inorganic food include; water and mineral salts.		Leading question: 1 Min.: What are inorganic materials?	Identifies inorganic food materials.
		Mineral salts for Mammals and Angiosperms Element: Calcium (Ca) Source: Milk Uses: Bones, teeth, A.T.P. and nicleic acid constitu- [illegible] ents. [illegible] Deficiency: Brittle bones and teeth.	Source of mineral salts. 1. Milk 2. Bread 3. Liver 4. Eggs. 5. Table salt 6. Water 7. Vegetables	Defined terms 1 Mins Mineral salts. Local specimen: 1 min: Milk, Bread. Inquiry method: 2 mins: If a child is seen with brittle bones and teeth what food substance does he need - offer suggestions	State the constituents of bread and milk.

WEEK I: SHEET 5

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
FOODS & FEEDING	4 mins:	Element: Phosphorus (P) Source: Milk, cheese and bread. Uses: Bones and teeth are mainly calcium phosphate. Deficiency: Brittle bones and teeth.		Contextual question: 4 Mins: What are the uses of phosphorus in the human body?	Identifies the constituents of A.T.P. and mucleic acid.
	4 mins:	Element: Iron (Fe) Source: Liver and egg yolk Uses: part of haemoglobin Deficiency: Anaemia		Local specimen: 2 Mins: liver and egg. Probing question: 2 Mins: What do you think can cause anaemia?	State the function of haemoglobin in the human blood.
	4 Mins:	Element: Iodine (I) Source: Sea foods and table salt. Uses: Part of thyroxin Deficiency: Goitre-thyroid swelling in adults.		Local specimen: 1 Min: Table set. Inquiry method: 3 mins: suggest a food substance for an adult with goitre	State the source and use of table salt.
	4 Mins:	Element: Fluorine (F) Source: Fluorinated tooth paste and water. Uses: Ensure hard tooth - the enamel and therefore less tooth decay. Deficiency: Dental causes more likely.	Toothpaste	Local specimen: 1 min: Toothpast. Contextual question: 3 mins: Why do you think drinking water is fluorinated and toothpaste manufacturers add fluorides?	Identifies why toothpaste manufacturers add fluoride to their product.

WEEK I: SHEET 6

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? COMM. STRATEGY	STUDENTS ACTIVITIES
	4 Mins:	Element: Sodium (Na) Source: Table salt (NaCl) Use: In association with potassium for proper functioning of nerves and muscles.	Table Salt	Probing question: 3 Mins: What do you think can aid the proper functioning of muscles and nerves? nerves? Local specimen: 1 Min: Table Salts.	State the uses and functions of the nerves and muscles.
	2 Mins:	Element: Potassium (K) Source: Plant food Use: As sodium		Leading question: 2 Mins: What is the richest source of potassium?	Identify the sources of potassium.
	2 mins:	PLANTS NEEDS Elements: Nitrogen (in Nitrates), Sulphur (in Sulphate). Uses: Protein and nucleic acid synthesis. Deficiency: Poor growth.	1. Sodium nitrate 2. Sodium Sulphate	Leading question: 2 mins: What are the uses and the likely deficiency of [illegible] nitrogen and sulphur.	Relate the role of nitrates and sulphur to their origin and functions.
	2 Mins:	ELEMENT: Phosphorus (P) Source: Phosphates Uses: A.T.P. in photosynthesis, respiration and nucleic acid synthesis. Deficiency: Poor growth.	Potassium Phosphate	Defined term: 2 Mins: Photosynthesis.	Identify the role of phosphorus in plants.
	2 Mins:	Element: Potassium (K) in Potassium salts. Deficiency: Poor growth - dehydration.		Defined term: 2 Mins: Dehydration.	Identify the source [illegible] and use of potassium.

WEEK I SHEET 7

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? COMM. STRATEGY	STUDENTS ACTIVITIES
	4 Mins:	**Elements:** Iron (in Iron salts, and **Magnessium.** Uses: Iron: for enzymes for making chlorophyll. Magnessium: Part of chl-- Chlorophyll molecule. Deficiency: Pale leaves **(chlorosis).**	1. Pale leaves 2. Ferrous sulphate.	Probing question: 4 Mins: If you find the leaves of a plant pale, what do you think the deficiencies will be?	Identify the source and use of Iron salts in plants.
	3 Mins.:	Trace Elements: They include: Zinc, copper and manganese are required in minute quantities for healthy growth.		Contextual question: 3 Mins.: Wat are trace elements and in which quantities are they useful?	Identify trace elements.
		Total TOTAL TIME: 77 Mins. (2 periods).		<u>SUMMARY</u> 1. Leading questions: 10 mins. 2. Probing questions: 12 mins. 3. Contextual questions: 2 mins. 4. Defined terms: 13 mins. 5. Local specimen: 16 mins. 6. Inquiry method: 8 mins.	

WEEK I: LESSON 2 (80 MINS.) SHEET 8

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? - COMM. STRATEGY	STUDENTS ACTIVITIES
2 periods of 80 Mins.	ORGANIC FOOD 1. Carbohydrate. 2. Fat 3. Protein 4. Vits	1 Min.	CARBOHYDRATES Elements: C.H.O.: Ratio of 2:1 as in H_2O	1. Glucose 2. Table sugar 3. Starch 4. Benedict's 5. solution 5. Iodine 6. Hydrochloric acid 7. Six test-tubes 8. Bursen burner	Leading question: 1 min: Give a list of the elements in carbohydrate?	Identify carbohydrate containing Nigerian food.
		1 Min.	Examples: Glucose ($C_{12}H_2O_6$) Sucrose ($C_{12}H_{22}O_{16}$		Leading question: 1 min: Give examples of carbohydrate.	Examines the types of carbohydrates in the laboratory.
		2 mins.	Units: **Monosaccharides** ((Simple sugars like glucoses. These are the **smallest** units that are absorbed after digestion hydrolysis). They can be reasembled into larger molecules again (condensation) when food needs to be stored		Inquiry method: 2 mins. If it is possible to break-down a big molecule to smaller units, how can one get smaller units from a molecule?	Observe and state physical differences between glucose and starch.
		2 mins.	Larger Molecules: Disaccharides e.g. sucrose, maltose and polysaccharides e.g. starch, glycogen and cellulose.		Local specimen: 2 mins: Table sugar, starch.	Taste sucrose and glucose and state differences.

WEEK I: LESSON 2 SHEET 9

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
		3 Mins.	CHEMICAL TESTS: 1. Blue Benedict's solution with reducing sugar when boiled gives orange precipitate. 2. Colourless concentrated hydrocholric acid and sucrose when boiled for ten minutes gives urine coloured solution. 3. Brown iodine solution and starch in cold gives blue-black		Contextual question: 3 mins: If three different solutions are put in three test-tubes to each of this if benedict's solution, conc HCl and iodine solution i. is added, what [illegible] changes would be observed?	Observe teachers demo[illegible] demonstration and state reasons for deductions in the experiment.
		3 Mins.	FUNCTIONS: 1. Energy supply when required; stored as starch (green plants) and glycogen (animals); Transported as sugars. 2. Structural: cellulose, cellwall. 3. Origin of other organic molecules e.g. sugar and nitrate that gives acetic acid.		Inquire method: 3 mins.: Determine the uses of carbohydrate as a food constituent .	State the uses of carbohydrates in the human body.

WEEK I: LESSON 2: SHEET 10

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO EACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		1 Min.	FATS (Solid) OILS (Liquid) Elements: C,H,O. Ratio of H is very very high to O.	1. Mutton fat 2. Paper 3. Suden III 4. Four test-tubes.	Leading question: 1 min: What are the elements present in fats.	Identify the elements present in fat.
		1 Min.	Examples: Mutton fat; $C_{57}H_{110}O_6$)		Local specimen: 1 min: Mutton fats.	Observe mutton fat on the demonstration table.
		1 Min.	Units: Glycerol and fatty acids.			Identify the differences in mutton fat and glycerol.
		3 Mins.	Chemical tests: 1. Translucence: When warmed on paper, makes paper permanently translucent (greese spot). 2. Red Sudan III stains fats intensely, so fat layer floating on watery food extract looks dark red.		Probing question: 3 mins: What would you observe if fat and oil is warm on paper and if to the fat red Sudan III is added?	Observe teachers demonstration and offer explanation for observed phenomenon.
		5 Mins.	Functions: 1. Energy supply: when respired. Used after carbohydrate. Important in flying, migration and liberating animals. (Has more energy (i.e. Fats) per unit mass than glycogen. 2. Heat insulation: As subcutaneous fat in mammals. 3. Waterproofing of skin, fur and feathers. 4. Bonyancy e.g. fish larvae in the sea		Inquiry method: 3 mins: When lots of energy is required, a flying bird discovers that all the carbohydrate energy has been used, what other sources can he get itss energy from? Probing question 2: Mins: State the other functions that you think fats and oils can be used for.	State the sources and functions of fatty food substances in the body.

WEEK I: SHEET 11

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? COMM. STRATEGY	STUDENTS ACTIVITIES
		1 Min.	PROTEINS Elements C,H.O,N and often S.	1. Mutton fat 2. Egg 3. Millon's reagent 4. NaCl 5. CuSo 4 6. Six test-tubes.	Leading question: 1 Min: What are the elements present in proteins?	Identifies the elements present in protein.
		1 Min.	Examples: Haemoglobin, ptyalin and insulin.		Leading question: 1 Min: Give examples of proteinous food substances.	State examples of protenous food.
		1 Min.	Units: Amino acids.		Leading question 1 min: What is the smallest units of protein.	State differences between mono di, and Poly-molecules.
		2 Mins. 9	Larger molecules: Dipeptides (two linked amino acids) Polypeptide (MANY), Peptones (very many), Proteoses (nuch).		Defined terms: 2 mins: Depeptides, Polypeptides, peptones and proteoses.	Identify differences in depeptides, polypeptides, peptones and proteoses.
		3 Mins:	Chemical Tests: 1. Colourless Millions Solution plus protein, boiled willgive brick red colcured protein. 2. Colourless 40% Na OH and Protein extract with 2 drops of blue $Cuso_4$ added will give mauve Biuret colour (Biuret test).		Inquiry method: 5 Mins: How would one relate the structure, units and chemical properties of protein to it's functions in the human body?	State the functions and sources of proteinous food substances for the human body.

WEEK I: SHEET 12

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
		5 Mins.	FUNCTIONS: 1. Energy supply when respired. Important in carnivores. 2. Movement: Muscles contract tendons connect muscles to bones; ligaments connect bone at joints all are protein. 3. Catalyst: Enzymes make metabolism reactions possible. 4. Hormones. Regulate metabolism.		Inquiry method: 5 mins: How would one relate the structure units and chemical properties of protein to it's functions in the human body?	State the function and sources of proteinous food substances for the human body.
		5 Mins:	VITAMINS They are organic substances required in minute amounts to maintain health of heterotrophs. Antotrophs make all they need. Lack of vitamin results in deficiency disease. Vitamins A, D. E and K are fat soluble and are ingested in fats and oil. Vitamins B and C are water soluble and are present in other materials.		Defined term: 5 mins: 1. Vitamins 2. Water soluble vitamins 3. Fat soluble vitamins.	State the characteristic and types of vitamins for the human body.

WEEK I SHEET 13

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIAL	WHAT TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		2 Mins.	Vitamin A: Source: Vegetables, butter, egg yolk and liver oil.		Local specimen: 2 mins: Vegetable, butter, egg and liver	Identify the sources of vitamin A.
		2 Mins.	Functions: (i) Health epithelia. (ii) Part of rod cells in retina.		Leading question: 2 Mins: State the functions of vitamin A.	State functions of vitamin A to man.
		2 Mins.	Deficiency: (i) Susceptibility to invasion by disease organisms, (ii) Poor night vision		Leading question: 2 mins: What are the consequencies of vitamin A deficiency.	Relate what can be observed in a man deficient of Vitamin A.
		2 Mins.	Vitamin D (Sunshin vitamin) Source: Butter, egg yolk. (can be synthesised in the skin from oils irradicted by ultra-violet (right).		Local specimen: 2 mins: Butter and egg yolk.	Identify the sources of vitamin D.
		2 Mins.	Functions: Regulation of calcium and phosphate absorption from gut and their deposition in bone.		Probing question: 2 mins: Can you state the function of vitamin D in the body.	State function of vitamin D.
		2 Mins.	Deficiency: Richets: Poor bone formation, was and often deformed. e.g. bow legs in children.		Contextual question: 2 mins: Relate the likely deficiency of vitamin D.	State the deficiency of vitamin D in children.

WEEK I: SHEET 14

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIAL	WHAT TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
		1 Min.	Vitamin E Source: Butter, whole meal bread	1. Butter 2. Bread 3. Yeast 4. Liver 5. Milk 6. Vegetables 7. Citrus fruits	Local specimen: 1 min: butter bread.	Identify source of vitamin E.
		1 Min.	Functions: Only in rats of reproduction		Leading question: 1 min: What are the functions of vitamin E.	State functions of vitamin E.
		1 Min.	Deficiency: Sterility in rats.		Defined term: 1 Min. Sterility.	State vitamin E Deficiency.
			Deficiency Sterility in rats.		Defined term: 1 Min. **fertility**	State vitamin E Deficiency.
		2 Mins.	Vitamin K Source: Cabbage, spinach, made abundantly by bacteria in intestine		Contextual question: 2 Mins: State the sources where vitamin E can be got.	Identify the sources of vitamin K.
		1 Min.	Functions: Aids blood clothing		Defined term: 1 Min. Blood clotting.	State functions of vitamin K.
		1 Min.	Deficiency: Longer bleeding time.		Probing question: 1 min: If vitamin K is absent in a man's body, what are the consequencies?	State deficiency of vitamin K.

WEEK I: SHEET 15

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIAL	HOW TO TEACH?—COMM. STRATEGY	STUDENTS ACTIVITIES
		2 Mins.	Vitamin B, (Thiamine) Source: Wholemeal bread, yeast extract		Local specimen: 2 Mins: Bread and yeast extract.	Identify sources of vitamin B1.
		2 Mins.	Function: Efficient respiration		Defined term: 2 Mins: Respiration	State functions of vitamin B1.
		2 Mins.	Deficiency: Beri-beri: Inflamed nerves and swollen heart muscles.			Identify deficiencies of vitamin B1.
		2 Mins.	Vitamin B2 complex (9 vitamins) Source: Yeast extract and liver.		Local specimen: 2 mins: Yeast extract and liver.	Relate the consequences of the absence of vitamin B2.
		2 Mins.	Function: A variety of roles in metabolism		Leading question: 2 Mins: State the functions of vitamin B2.	State the functions of vitamin B2.
		2 Mins.	Deficiency: Skin, eye lesions (riboflavin); pellagra: gut problems, paralysis, (nicotimic acid) etc.		Contextual question: 2 Mins: Relate the consequences of the absence of vitamin B2.	State the consequences of the absence of Vitamin B2.
		1 Min:	Vitamin B12 (Cobalamine) Source: Liver		Local specimen: 1 Min: Liver.	Identify the main source of vitamin B12.

WEEK I: SHEET 16

WEEK I LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		2 Mins.	Function: Aids formation of red blood cells.		Probing questions 2 Mins: Why do you think vitamin B12 is important for the body?	State the functions of vitamin B12.
		2 Mins.	Vitamin C Source: Citrus fruit, milk and fresh vegetables		Local specimen: 2 Mins. Citrus fruits, milk and fresh vegetables.	Identify the sources of vitamin C.
		2 Mins.	Function: Tissue-damage repair.		Contextual question: 2 Mins: State the function of vitamin C.	State the functions of vitamin C.
		2 Mins.	Deficiency: Scruvy: Capillary bleeding, poor healing of wounds.		Defined term: 2 Mins: Scurvy	Identify the consequences of the absence of VitaminCC.
			TOTAL TIME: 77 Minutes		SUMMARY: 1. Leading questions: 13 mins. 2. Probing questions: 13 Mins. 3. Contextual questions: 11 Mins. 4. Defined terms: 15 Mins. 5. Local specimen: 15 Mins. 6. Inquiry method: 1[illegible] Mins.	

WEEK 2: LESSON 1: (80 MINUTES)   WEEK 2 SHEET I

WEEK 2 LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH-COMM. STRATEGY	STUDENTS ACTIVITIES
			Animals obtain food in one of the following three ways: 1. As solids: Food organisms that have to be chewed small enough to be digested. For example a. herbivores eat plants b. carnivores eat animals c. Omnivores eat plants and animals.		Defined term: 5 Mins; 1. Herbivores ii. Carnivores iii. Omnivores vi. Solids and liquids.	Identify the character istic of herbivores, carnivores and omnivores.
			2. As solids in suspension Tiny food organisms in water that must be strained out of it. As in plankton-plants and animals. For example filter-feeders.	1. Mussels 2. Slides of phytoplankton 3. Microscope.	Leading question: 3 mins.: In case of water living phytoplanktons and filter-feeders, how do they obtain their food?	State how organisms can recover solid food in suspension.
			3. As liquids: a. Juices extracted from living hosts, without killing them. b. e.g. parasites. b. Liquid nutrients produced by digesting dead food externally and then sucking it up. e.g. saprophytes.	1. Slides of parasites and saprophytes. Microscope	Defined term: 3 mins: Parasites saprophytes and nutrients. Leading question: 2 mins: State how animals obtain their food as liquid forms.	Enumerate how parasites like mosquitoes and saprophytes get their nutrients.

WEEK 2 LESSON 2 SHEET 2

WEEK 2 LESSON 2	LESSON TOPIC	TIME	WHAT TO TEACH	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
			Adaptation for Feeding Methods: 1. Herbivores: Food does not run away but large quantities must be gathered since their food is relatively poor in quality.		Leading question: 2 mins.: How are herbivores adapted for their feeding method.	Identify the nature of herbivores food.
		3 Mins.	2. Carnivores: Have to capture and the prey by cunning as dogs, traps in spiders web, poisons in cobra, and by use of sharp weapons e.g. claws and teeth.	1. Claws of animals. 2. Human teeth.	Leading question: 2 mins: Relate the adaption of carnivores for their feeding method.	Identify the nature and source of carnivores food.
		2 Mins.	3 Omnivores: Adaptations for feeding are intermediate between those of herbivores and carnivores e.g. human teeth. They vary their food according to availability e.g. cockroaches, rats, pigs and man.	1 Cockroaches	Leading questions: 2 mins: How are omnivores adopted for their feeding method.	State the nature and type of omnivores food.

WEEK 2: LESSON 2: SHEET 3

2 LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	Mouthparts of herbivores, carnivores and omnivores. These are basically in 4 parts: i. Labrum: "Upper lip": Are chemoreceptors - the tasting cells.	1. Head of goat. 2. Cockgroach 3. Head of dog.	Defined term: 2 mins: Labrum.	Observed under the microscope the different teeth of herbivores, carnivores and omnivores.
	2 mins.	ii. Mandible ("jaw") Grind-i ing surfaces and chopping surfaces.		Defined term: 2 Mins: Mandible.	Identify the mandible under the microscope.
	2 Mins.	iii. Maxilla ("lower lip") chemoreceptors.		Defined term: 2 Mins. Maxilla	Identify the maxilla under the microscope.
	2 Mins.	iv. Labium ("Lower lip").		Defined term: 2 Mins: Labium	Identify the labium under the mkcroscope.
	2 Mins.	4. Filter Feeders: Require sieves. Some whal whales trap shrimps on frayed edges hanging down in their mouth cavity, open to the sea as they swim.	Diagram of a whale	Defined term: 2 Mins: Filter feeders.	State the nature and chcharacteristics of fil filter feeders.

WEEK 2: LESSON 2: SHEET 4

LESSON TOPIC	TTIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	4 Mins.	5. Parasites: (a) Ectobarasites They bathe in nutritions liquids e.g. blood or digested food in the gut of host, absorbing food directly through the skin or gut e.g. tapeworm.	1. Slide of tapeworm 2. Microscope	Defind term: 2 Mins: Endoparasite. Probing question: 2 Mins: How do you think what endoparasite survive in their environment.	Enumerate the nature characteristics of acid filter feeders.
	2 Mins.	(b) Endoparasites: Pierce their host to suck out nutritoliquids e.g. mosquitoes, flea and aphid.	1. Slide of mosquito 2. Microscope	Defined term: 1 Mins: Endoparasites, Local specimen: 1:	Enumerate the nature , and environment of ectoparasites.
	    2 Mins. 2 Mins. 2.Mins. 2 Mins. 2.	Mouthpart of ectoparasites (mosquitoes) Apart from the antennae there are 4 basic parts in the mouth: a. Labium: for sucking blood up. b. Mandible: Sharp, for piercing skin. c. Hypotharynx: This is the duct that carries saliva down to stop blood from clotting. d. Maxilla: Sharp, for piercing skin. e. Labium: For support of mouthparts during piercing; protection; sensing purse of minute blood-vessel to puncture.	1. Microscope 2. Slides of the various sections of the mouthparts.	Local specimen: 4 Mins: Mosquitoes - mouthparts. Inquiry method: 6 Mins: Looking through the different sections of the ectoparasite mouthparts, how can you relate the structures to the differentf functions.	Observed and identify parts of a mosquito - labium mandible, maxilla, hypopharynx and labium.

WEEK 2: LESSON 2 SHEET 5

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	6. Saproziotes: Need no jaws, only tubes for saliva down and liquid food up with pumps e.g. Housefly.		Local specimen: 2 Mins: Housefly.	Identify the nature of saprozoites
	5 Mins.	DIGESTION: All animals ingest food through the mouth into the gut - except for parasites. In the gut food is digested physically and chemically.		Defined term: 2 Mins: Digestion. Leading question: 3 Mins: Briefly descr-ibe the process of food intake until end of egestion.	Enumerate the basic pro-cess of digestion.
	5 Mins.	a. Physical digestion: This is by chewing or grinding - as in herbi-vores. This increases the surface area of the food and makes it easier for chemical digestion.		Contextual question: 5 mins: Relate the process of physical digestion.	Describe the processes in physical digestion.
	3 Mins.	b. Chemical Digestion: This is by enzymes which hydrolyses large mole-cules into smaller units, so that it can be easily absorbed.		Contextual question: 3 mins: How will you describe the process of chemical digestion?	Describe the processes involve in chemical digestion.

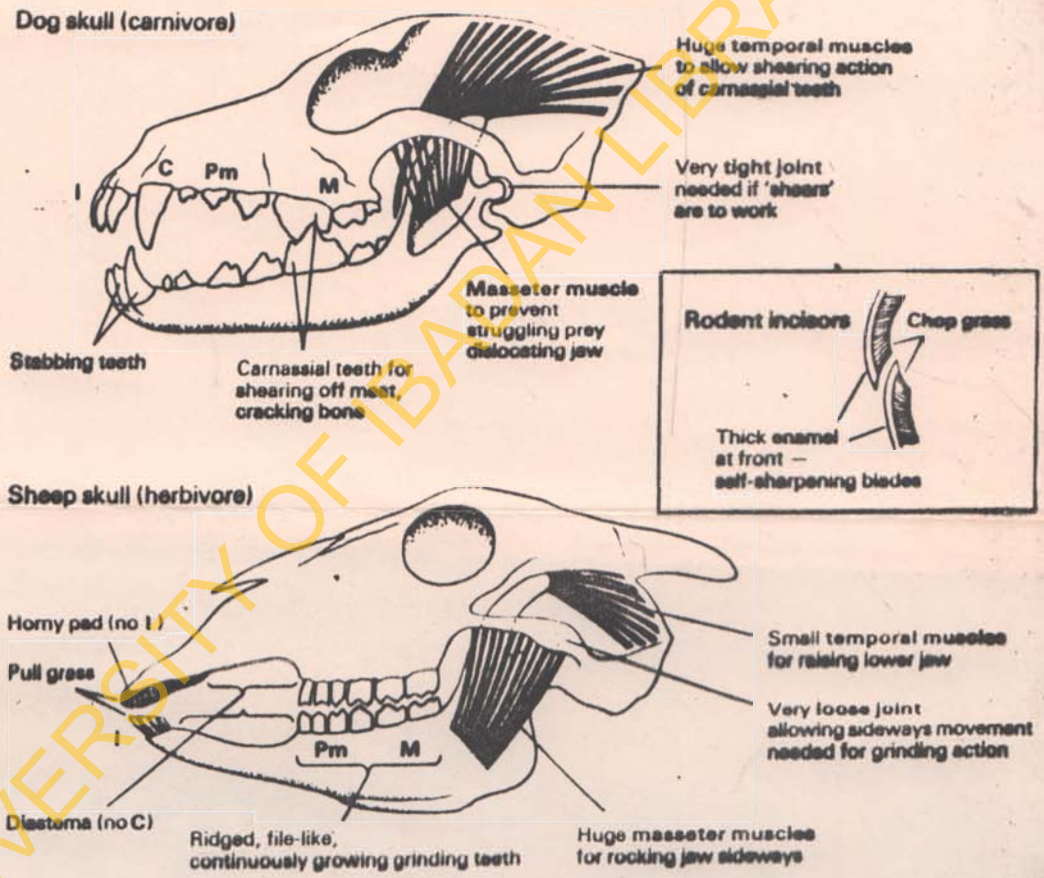


FIG: 1 : Comparison of herbivore and carnivore jaws and teeth

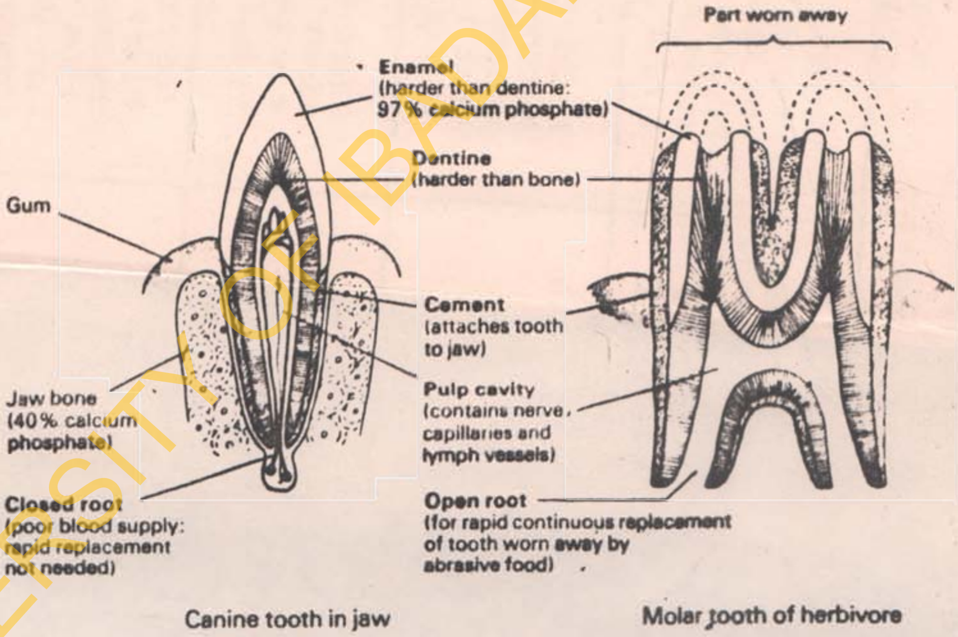


FIG: 2: Vertical section through two kinds of teeth

WEEK 2: LESSON 2: SHEET 6

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
	3 Mins.	Basic Hydrolysis reactions include: Starch and water when hydrolysed by enzymes giv gives monosaccharides	1. Glucose Starch.	Local specimen: 1 mins: Glucose, starch and water. Probing question: 2 mins: What happens in a hydrolysis reaction?	Enumerate the nature of an hydrolysis reaction.
	2 Mins.	1. Fat and water can be hydrolysed by enzymes to fatty acids and glycerol.		Local specimen: 1 Min: Mutton fat. Probing question: 1 Min: What is the result if fat is hydrolysed.	Describe the hydrolysis of fat.
	2 Mins.	2. Protein and water can be hydrolysed by enzymes to give amino acids.		Probing question: 2 mins: What is the result of protein hydrolyses?	Describe the result of the hydrolysis of protein.
	10 Mins.	PROCESSES: Absorbed food is then assimilated - used or started in the body. Storage occurs when enzymes condense the small units of foods into large molecules. This is condensation, the reverse of hydrolysis. Indigested food is egested (eliminated) through the anus. Most animals have no enzymes to digest cellulose - herbivores have special adaptations to digest cellulose.		Inquiry method: 5 Mins Mins: The process of hydrolysis, condensation and egestion are necessary during digestion and absorbtion. How can one describe these processes and when are they necessary? Contextual question: 5 5 mins: What are the roles of enzymes in hydrolysis and condensation?	Describe the basic processes of absorption and egestion.

WEEK 2: LESSON 2: SHEET 7

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		TOTAL TIME: 79 Mins.		SUMMARY 1. Leading questions: 14 Mins. 2. Probing questions: 9 Mins. 3. Contextual questions: 13 mins. 4. Defined terms: 23 minutes. 5. Local specimen: 11 minutes. 6. Inquiry method: 11 minutes.	

WEEK 2: LESSON 2: (80 MINUTES) SHEET 8

WEEK 2	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH? -COMM. STRATEGY	STUDENTS ACTIVITIES
2	MAMMA-LIAN TEETH AND JAW	1 Min.	Only vertebrates have their teeth differentiated - often into 4 types with special uses.	1. Skeleton of man with complete set of teeth.	Defined term: 1 Min: Vertebrates	Describe the nature of the human teeth.
		1 Min.	Types of teeth: 1. Incisors (I) For obtaining mouthfulls.	2. Upper and lower jaw and teeth of human skeleton.	Defined term: 1 min: Incisors.	Identify the incisors amongst human teeth.
		1 Min.	2. Canine (C) For stabbing and holding prey.	3. Upper and lower jaw and teeth of goat.	Defined term: 1 Min: canine	Identify the canine
		1 Min.	3. Premolars (Pm) for [illegible]-grinding.		Defined term: 1 Min: Premolars.	Identify the premolar
		1 Min.	4. Molars (M) for grinding.	4. Upper and lower jaw and teeth of a dog.	Defined term: 1 Min: Molars	Identify the Molars.
		2 Min.	Dental Formula: This is the expression of each type of teeth. The top line for the number in upper half jaw while the lower line is for the lower jaw.		Defined term: 2 Mins: Dental formulae	Describe the number Incisors, canine premolars and molars the human teeth.
		2 Min.	Milk teeth: Are the first set of teeth that are later shed.		Defined term: 2 Mins: Milk teeth.	Enumerate what are milk teeth.

WEEK 2: LESSON 2: SHEET 9

WEEEK 2 LESSON 2	LESSON 2TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		2 Mins.	Back Molars: Are adult set of teeth that are later shed.		Defined term: 2 mins: Back molars	State what back molars
		2 Mins.	Structure of teeth: It consist of layers of modified bone nourised from pulp cavity and shaped according to function.		Leading question: 2 mins: Briefly describe the structure of the human tooth.	Observe the model of the cross section of human tooth.
		10 Mins.	DIAGRAM OF STRUCTURE OF TEETH: See Fig. 2: To be drawn on a portable board.	Sectional model of the human tooth	Labelled diagram: 10 mins: structure of the tooth.	Observe and identify various layers in tooth.
		1 Min.	Description of structure of tooth: Basically there are 8 parts. 1. The Gum	2 Portable board.	Leading question: 1 min: How many parts can you identify in a tooth?	Identify the gum.
		1 Min.	2. Enamel: Harder than dentine.		Leading question: 1 min: What is the nature of the enamel?	Identify the enamel.
		1 Min.	3. Dentine: Attaches tooth to jaw.		Leading question: 1 min: What is the nature of Dentine.	Identify the dentine.

WEEK 2: LESSON 2: SHEET 10

WEEK 2 LESSON	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		1 Min.	4. Cement: Attaches tooth to jaw.		Leading question: 1 min: What is the position of the cement in the human tooth?	Identify the cement.
		2 Mins.	5. Pulp cavity: contains nerves, capillaries and lymph versels.		Probing question: 2 mins: With the posi- tion of the pulp cavit cavity, what would be it's constituents.	Describe the nature and contents of the pulp cavity.
		2 Mins.	6. Open foot (only in herbivore molar tooth) for rapid continuous replacement of tooth worn away by abrasive food.		Probing question 2 mins: What do you think is the function of the open root in herbivores.	Identify the 'open root'.
		2 Mins.	7. Jaw bone: largely of calcium phosphate.		Contextual question: 2 mins: What is the nature of the jaw bone?	Identify the nature of the jaw bone.
		2 Mins.	8. Close root in canine tooth) has poor blood supply since rapid replacement is not needed.		Contextual question: 2 mins: Describe the nature of the close root.	Describe the nature of the close root.

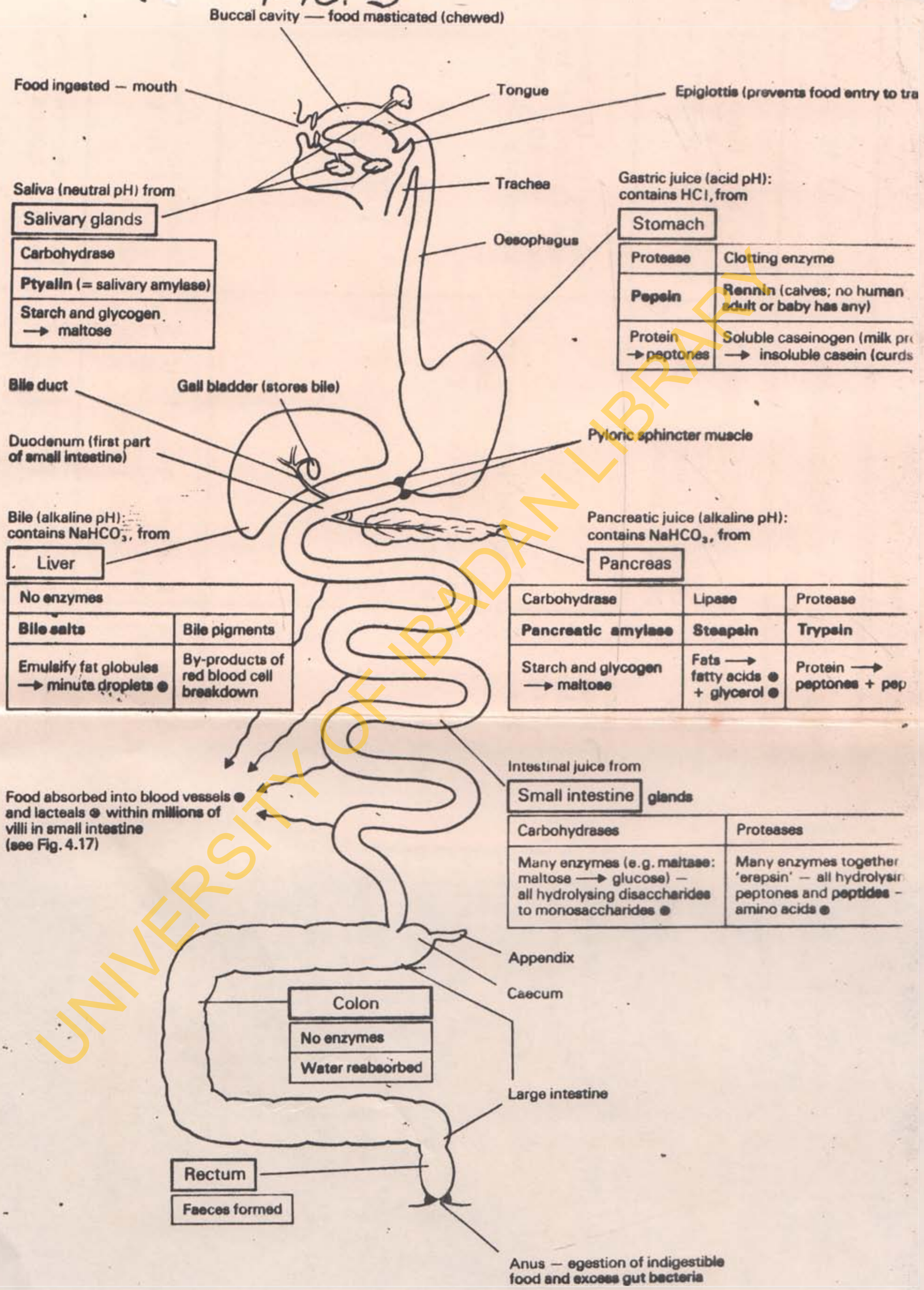
WEEK 2: LESSON 2: SHEET 11

WEEK 2 LESSON	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		10 Mins.	Teeth and jaw: Carnivores (Dog skull) See fig. 1A to be drawn on potable board or cardboard.	1. Upper lower jaw and teeth of a dog.	Labelled diagram: 10 mins: Teeth and jaw carnivores.	Observe and identify the various layers of a carnivores tooth.
		1 Min.	Description of herbivore teeth and jaw: They also include various modifications. But one can recognise: 1. A horny pad: To pull grass (replaces Upper incisors).	2. Portable board.	Local specimen: 1 min: Upper Jaw of the goat.	Identify and state the function of the horny pad.
		1 Min.	2. Diastama (replaces the canine		Local specimen: 1 min: Lower jaw of the goat,	Identify the diastema.
		2 Mins.	3. Premolars and molars: Ridged, file-like. They are continuously growing grinding teeth.		Local specimen: 2 mins: Upper and lower jaws of the goat.	Describe the nature and function of premolars and molars.
		1 Min.	4. Huge masseter muscles: For rocking the jaws sideways.		Inquiry method: 1 min: Relate the structure of masseter muscles to the function.	State the function of the masseter muscles.

WEEK 2: LESSON 2: SHEET 12

WEEK 2 LESSON	LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?—COMM. STRATEGY	STUDENTS ACTIVITIES
		2 Mins.	5. Back joint: Unlike in carnivores, it is very loose to allow for sideways movement needed for grinding action.		Inquiry method: 2 mins: Relate the position and structure of the back joint to their function.	State the nature of and function of the back joint.
		2 Mins.	6. Temporal muscles: Also unlike in carnivores, they are small since they are needed only for raising the lower jaw.		Inquiry method: 2 mins: Relate the structure of the temporal muscles to their function.	Identify the nature of the temporal muscles.
			TOTAL TIME: 74 Minutes		SUMMARY: 1. Labelled diagrams and pictures: 30 Mins. 2. Leading questions: 6 mins. 3. Probing questions: 7 mins. 4. Contextual questions: 8 mins. 5. Defined terms: 11 mins. 6. Local specimen: 5 mins. 7. Inquiry method: 7 mins.	

FIG. 3



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WEEK 3: LESSON I (80 MINUTES) SHEET I

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
1. MAMMALIAN ALIMENTARY CANAL. 2. Treatment of food from mouth to anus.	20 Mins.	See fig. 4: To be previously drawn on the blackboard.	1. Portable black-board. 2. Chart showing the human alimentary canal.	Labelled diagram: 20 mins: Alimentary canal of man drawn on the board.	Draw and label the different parts of the human alimentary canal.
	15 Mins.	Description of parts of the alimentary canal. 1. Buccal cavity 2. Salivary glands 3. Oesophagus 4. Stomach 5. Gall bladder 6. Liver 7. Pancreas 8. Small intestine 9. Colon 10. Rectum. The students are to identify these areas on the diagram.		Labelled picture 15 mins: Chart of the human alimentary canal.	Follow up the teachers description on the chart of the human alimentary canal.
	1 Min.	Treatment of food during digestion: 1. Mouth: Food is ingested.	1. Diagram of the human canal. 2. Chart of the human alimentary canal.	Leading question: 1 min: What process goes on in the mouth?	Enumerate the digestive process in the mouth.
	1 Min.	2. Buccal cavity: Food is masticated (chewed)		Leading question: 1 min: What happens in the buccal cavity?	Enumerate the process in the buccal cavity.

WEEK 3: LESSON 1: SHEET 2

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	1 Min.	3. Epiglottis: Prevent food entry into trachea.		Leading question 1 min: What is the role of the epiglottis?	State the functions of the saliavary gland.
	5 Mins.	4. Salivary glands: Produce saliva - with neutral P.H. Here carbohydrate digestion b--ins by action of ptyalin (salivary) amylase. Starch and glycogen is converted to maltose.		Contextual question: 5 mins: How would you relate the position and chemic-al constituents of the salivary glands to digestion?	Describe the nature and functions of the salivary glands.
	1 Min.	5. Oesophagus: Food passage.		Leading question: 1 min: What is the role of the oesophagus.	Identify the oeso-phagus.
	5 Mins.	6. Stomach: Contains the gastric juice and hydrocholoric acid. C. contains clotting enzyme. Contains Pep-sin - enzyme which changes protein to peptones. There is also Renin. There is also the convertion of soluble caseinogen (milk protein) to insoluble casein (curds).		Inquiry method: 5 mins: Stomach is the large part of the alimentary canal. Relate the position to the function.	Describe the digestive in the stomach.

WEEK 3: LESSON 1: SHEET 3

LESSON TOPIC	TIME .	7. WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	1 Min.	7. Pyloric Sphlinter muscle.		Defined term: 1 Min. Pylcric splinter muscle.	Identify the pyloric droplets muscle.
	2 Mins.	8. Gall bladder: Stores bile. Bile is alkaline contains sodium bicarbonate.		Leading question: 2 mins: What is the role of the gall bladder.	State the functions of the gall bladder.
	1 Min.	9. Bile duct		Defined term: 1 Min: Bile duct.	Identify the bile duct.
	2 Mins.	10. Duodenum: First part of smallintestine.		Probing question: 2 mins: Describe the position of the deodenun.	Identify the duodemum.
	10 Mins.	11. Liver. Produces bile: The bile salts emusify fact globules into minute sphlinter Bile pigments are by-products of red-blood cells breakdown.		Probing questions: 2 mins: What is the nature, secretion and function of the liver.	Describe the functions and secretion of the liver.

WEEK 3: LESSON 1: SHEET 4

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	10 Mins.	12. Pancreas Contains the pancreatic juice. It is alkaline containing sodium bicarbonate. Digestion of carbohydrate protein and fat continues. a. Carbohydrates are acted on by the pancreatic amylase. Converts amylase and glycogen to maltose. b. For fat, steapsin changes fat into fatty acids and glycerol. c. For protein: Trypsin changes protein to peptones and peptides.		Defined terms: 2 mins: Pancreatic juice, starch. trypsin and steapsin. Local specimen: 6 mins: Starch, mutton fat, milk. Probing question: 2 mins: What is the secretion and chemical nature of the pancreatic juice.	Identify the position of the pancreas
	10 Mins.	13. Small Intestine. It produces the intestinal juice and has a number of glands. Food is absorbed into blood vessel and lacteals within millions of villi in the small intestine. Digestion of carbohydrate and protein continues. a. Carbohydrate: Acted upon by many enzymes e.g. maltase. Arts and changes maltose to glucose - all hydrolysing dissacharides to monosaccharides.		Defined term: 2 mins: maltose, erepsin. Inquiry method: 6 mins: Quite a number of gland secretions and intestinal juice are present in the small intestine. Identify the juices, enzymes and their respective functions	Identify the position of the small intestine in the chart of the human alimentary canal State the end-product of the digestion of carbohydrates and protein.

WEEK 3: LESSON 1: SHEET 5

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH-COMM. STRATEGY	STUDENTS ACTIVITIES
		b. Protein: Acted on by many enzymes which are together called erepsin. Convertsall hydrolysing peptones and peptides to amino acids.		Contextual questions: 2 mins: State the small intestine in digestion and absorption.	
	2 Mins.	14. Appendix		Defined term: 2 Mins: Appendix	Identify the appendix
	2.Mins.	15. Caecum.		Defined term: 2 Mins: Caecum	Identify the caecum.
	2 Mins.	16. Large intestine: The vertical column is called the colon. Has no enzymes. But water absorption takes place.		Contextual question: 2 mins: What diges- tive process occurs in large intestine?	Describe the nature and function of the large intestine.
	2 Mins.	17. Pectum: Faeces is formed.		Contextual question: 2 mins: What is the function of the rectum?	State the processes at the rectum.

WEEK 3: LESSON 4 SHEET 6

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		18. Anus: Egestion of indigestible food and excess gut bacteria.		Contextual question: 2 mins: State the role of the Anus.	Describe the function of the anus.
		TOTAL TIME: 80 minutes		SUMMARY 1. Leading questions: 6 mins. 2. Probing questions: 6 mins. 3. Contextual questions: 13 mins. 4. Defined terms: 10 mins. 5. Local specimen: 6 mins. 6. Inquiry method: 11 mins.	

WEEK 3: LESSON 2: SHEET 7 (80 MINUTES)

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIAL	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
PRACTICAL EXPERIENCE	5 Mins.	FOOD TEST You are provided with two boiling tubes A and B with solutions. 1. Take the solution in tube A. Pour a small quantity into a clean test tube.	1. Glucose solution. 2. Starch solution. 3. Four boiling bubes per student. 4. Bursen burner.	CHALLENGING PRACTICAL EXPERIENCES 25 Mins: This is individual student practical exercises. They are to provide students with unique opportunities to study abstract concepts and generalisations through the medium of real materials.	Carryout specified instruction, observe and record findings and make deductions from findings.
	5 Mins.	2. Then add few drops of Benedict solution.			
	5 Mins,	3. Then boil the constituents for some minutes.			
	5 Mins.	4. Observe the solution and the bottom of the tub.			
	5 Mins.	5. Record your observation and inferences on the food substance in A. NOTE: CONCLUSION: A = Glucose, B. = Starch.			

WEEK 3: LESSON 2: SHEET 8

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIAL	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	INVESTIGATING THE EFFECT OF TEMPERATURE ON DIGES= TION OF STARCH BY SALIVARY AMYLASE (PTYALIN) You are provided with the following: a. six boiling tubes. b. starch solution c. saliva (diluted) - use your own. Then carry on the following instructions. i.Add 5 cm^3 of the starch solution to 5 boiling tubes.	1. Starch solution. 2. 12 boiling tubes per group 3. Saliva solution. 4. White tile 5. Bunsen burner. 6. Ice bath 7. Warm water. 8. Boiling water 9. Iodine solution. 10. Clock.	CHALLENGING PRACTICAL EXERCISES 55 Mins: This exercise is to be performed by groups of four students. It involves the students with opportunities to study abstract concepts and generalisation using concrete real materials.	a. Carry out instructions. b. Observe and record findings. c. State inferences from observed phenomenon. d. Give reasons for observed phonomenon.
	2 Mins.	1. To another 4 boiling tubes add 1 cm^3 of saliva diluted with water.			
	2 Mins.	2. Pair up the tubes in i) and B) so that you have five pairs (a tube with starch solution and another with saliva).			

WEEK 3: LESSON 2: SHEET 9

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENT ACTIVITIES
	3 Mins.	3. Put a pair of each into these different conditions. a. Ice bath b. Water at room temperature. c. Warm water (about 35.°C) d. Boiling water e. This is the control: To see if starch solution without enzymes will change. Here only one boiling tube (the one with only starch solution) should be put.			
	5 Mins.	5. Leave the starch solution and the saliva for 3 minutes in a water bath.			
	8 Mins.	6. Pour the saliva into the tube with starch solution next to it, mixing it as you pour. You are to do this for the tubes in A - D of (4).			
		7. Using a dropper test one drop from each boiling tube with iodine. First put a drop of iodine and then from each of the boiling tubes A-D put in a solution to each on the iodine drop.			

WEEK 3: SHEET 10 LESSON 2

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW-TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	5 Mins.	8. Note the time when each drop no longer turns the iodine blue-black (that is when the starch is digested).			
	5 Mins.	9. Record your observation and inferences			
	6 Mins.	10. Now put the boiling tubes A-D into warm water and test after 5 mins.			
	2 Mins.	11. Now observe and note the colour of A and D.			
	2 Mins.	12. Looking at E and C how can you describe the digestion process.			
	2 Mins.	13. Using A, what can you conclude			
	2 Mins.	14. Using D what can you say?			

WEEK 3: LESSON 2: SHEET 11

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
		NOTE: 1. Colour of A is dark brown. 2. Colour of D is blue-black 3. Digestion at A,E and C are faster at warm temperature. 4. With A at low temperature, enzyme is inactive but not destroyed.			
		TOTAL TIME: 80 minutes		SUMMARY Challenging Practical Exercises 80 minutes.	

WEEK 4: LESSON 1 (80 MINS.) SHEET 1

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH-COMM. STRATEGY	STUDENTS ACTIVITIES
ABSORPTION OF FOOD AT VILLI	10 Mins.	See Fig. 31 B: To be drawn on the board.	1. Diagram of the villi on portable board.	Labelled diagram: 10 mins: Enlarge longitudinal section of a villi	Observe and identify various parts of the villi.
	2 Mins.	Description of absorption at villi. The structure of the villi is related to the function of absorption that it performs.	2. Slide of the section of small instestine. 3. Microscope.	Probing questions: 2 mins: How would you describe the structure of villi.	State the functions of the small intestine and the villi.
	2 Mins.	1. Epithelium: It is the thin outer layer of the villi.		Leading question: 2 mins: What is the nature of the epithelium.	Describe the nature of the epithelium.
	5 Mins.	2. Capillaries: They carry the water soluble food substances. These are monosaccharides, amino aids, vitamins C, salts and water.		Defined term: 5 Mins: Capillaries.	State the functions of the capillaries.
	5 Mins.	3. Lacteal: It carries fatty substances, these are fatty acids and glycerol fat dropleis, vitamins A.D.E and K.		Defined term: 2 Mins: Lacteal. Leading question: 2 mins. What type of materials are carried in the lacteal?	Enumerate the role of the lacteal.

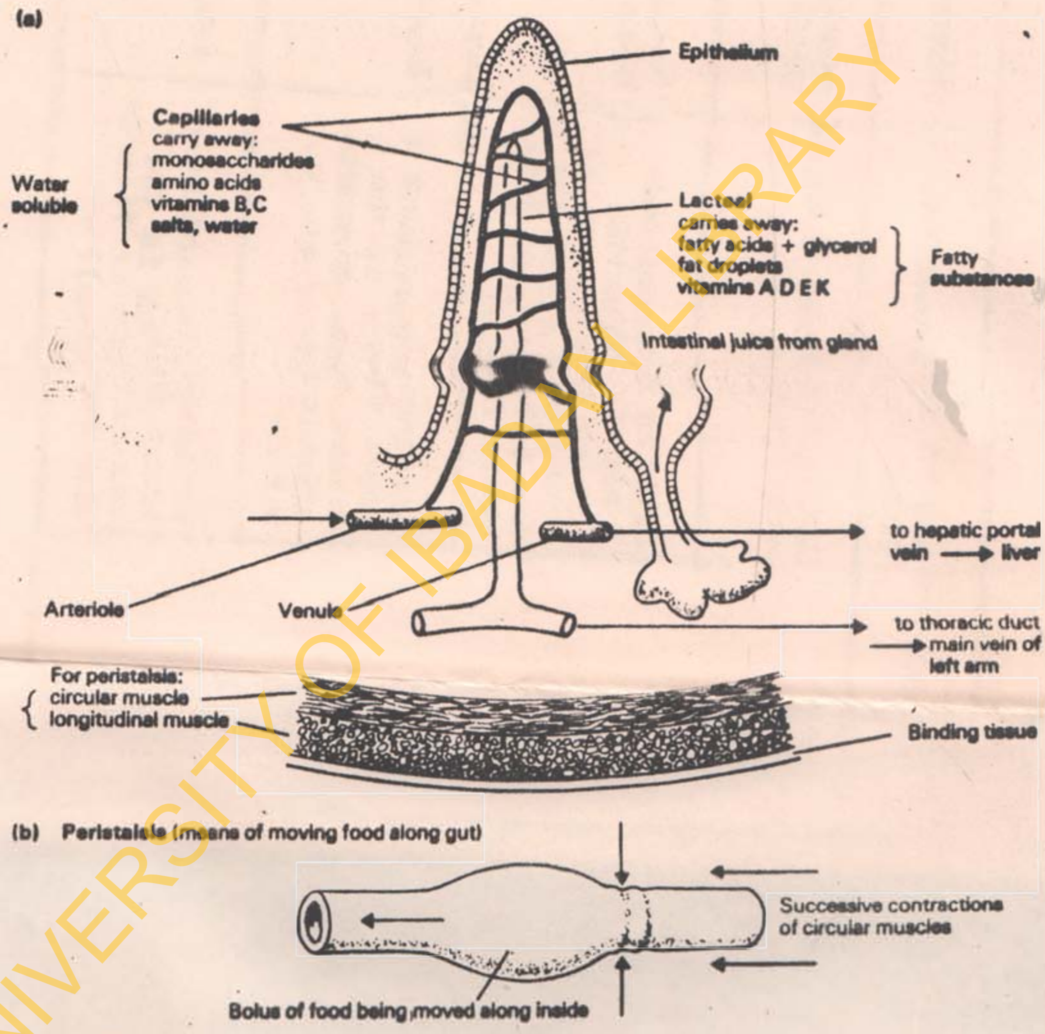

FIG: 4: (a) Enlarged longitudinal section of a villus (millions lining the small intestine) (b) Peristalsis

WEEK 4: LESSON 1: SHEET 2

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH-COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	4. Arteriole: From where blood is supplied to the villi.		Defined term: 2 Mins. Arteriole	Identify the arteriole.
	2 Mins;	5. Intestinal juice is also supplied to the villi from the surrounding glands.		Probing questions: 2 mins: With the nature of the villi where do you think the intestinal juice comes from?	Describe the intestinal juice.
	5 Mins.	6. Venule: It carries blood from the villi to the liver through the hepati portal vein.		Leading question: 5 mins: What is the nature and characteristics of the v venule?	Identify the venule.
	5 Mins.	7. The lacteal also goes to the main vein of the left arm through the thoracic duct.		Probing question: 5 mins: What is the direction of flow of the lacteal?	Identify the lacteal.

8 Mins.

WEEK 4: LESSON 1 : SHEET 3

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	8 Mins.	8, For peristalsis movement, the villi has three layers of muscles surrounding the exterior. These are: 1. Binding tissue: Outer most layer. ii. Longitudinal muscles iii. Inner most circular muscle.		Probing question: 3 Mins: What is the nature of the Villi and how is this related to peristalsis movement? Contextual question: 5 mins: What are the types and layers of muscle in the villi?	Enumerate the factors necessary for peristalsis movement.
	5 Mins.	Peristalsis movement: See fig. 2b. Can be drawn on the board.		Labelled diagram: 5 mins: Peristalsis movement.	Observe and discuss peristalsis movement as in the diagram.

WEEK 4: SHEET 4

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	12 Mins.	Description of peristalsis (With the aid of Fig 3b): This is one means of movingfood along the gut. Since the small intestine has by means of their circular and longitudinal muscles to move the food through the gut. As the food moves forward there is a zone of contraction immediately after tbe bolus of food resulting from sucessive contractions of the circular muscles. By this series of contractions, the food is moved forward.		Inquiry Method: 12 mins: When a deflated bicycle tube is about to be inflated, as air is gradually introduced, the movement of the air can gradually be seen as if is being inflated. If you imagine the air in the tube to be food and the bicycle tube to be the small intestine, the peristalsis movement can be appreciated. With the structure of the small intestine, how do you think food would be moved up to the large intestine.	Using fig. 3b, observe and describe the nature of peristalsis movement.
	2 Mins.	Herbivores and Carnivores gut: Carnivores: Short gut - this is because their food is largely protein which is easy to digest.	1. Slide on the section of the herbvores and carnivores gut. 2. Microscope.	Local specimen: 2 mins: Dissected dog to show the gut - a preserve a specimen	Describe the gut of carnivore. (dog).

WEEK 4: SHEET 5

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH-COMM. STRATEGY	STUDENTS ACTIVITIES
	8 Mins.	Herbivores: The gut is long. Since no animals has a cellulose digesting enzymes, they are aided by bacteria which have cellulase. The bacteria have in synbiosis in rumen of ruminants e.g. as in cow and sheep or caecum as in horses and rabbits. Rabbits eat their green nutritious faeces from first passage through the gut ("reflection"), absorbing more food during second passage. Horses do not reflect.		Local specimen: 2 mins: Dissected dog to show the gut - a preserved specimen. Contextual question: 4 mins: What is the nature of the gut in herbivores and how does this affect digestion and reflection in rabbits and sheep?	Enumerate the gut and nature of an herbivore (rabbit).
		TOTAL TIME: 80 MINUTES.		SUMMARY: 1. Leading questions: 9 mins. 2. Probing questions: 12 mins. 3. Contextual questions: 9 mins. 4. Defined terms: 13 mins. 5. Local specimen: 10 mins. 6. Inquiry method: 12 mins. 7. Labelled diagrams: 15 mins.	

WEEK 4: LESSON 2: (80 MINUTES) SHEET 6

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	5 Mins.	Food is usually stored in three different ways. 1. Monosacharides: e.g. Glucogen in the liver and muscles. The excess if converted to fats and stored under the skin.	1. Chart of the human alimentary canal. 2. Diagram of the human alimentary canal.	Local specimen: 3 mins: Glucose, starch, liver. Leading question: 2 mins: What food substances are stored in the body?	State the natural form of glucose and the stored form.
	5 Mins.	2. Amino substances: They are stored in the liver- in addition to vitamins A, D - and under the skin:		Leading question: 5 mins: Where are fatty substances stored in the body?	State the form in which fatty substances are stored.
	10 Mins.	3. Ammonia / acids: They are not stored. They are used immediately. The excess is de-aminated in the liver to give two parts; i. Nitrogen containing part - ammonia which becomes urea - exereted by the kidney. ii. The remainder can be respired - used as fuel.		Probing question: 10 mins: Amino acids are known not to be stored in the body. How does the body gets rid of them and in what form?	Enumerate how amino acids are stored and eliminated.

WEEK 4: LESSON 2: SHEET 7

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	10 Mins.	Liver: Structure: It is a large organ, concerned with homoestatis by metabolising food and poisons and removing unwanted cells. They store foods and blood. Receives blood from two sources, the hepatic artery through the aorta and the hepatic portal vein. It's blood supply passes back through the hepatic vein to the venaecava. It also discharges bile.		Defined term: 3 mins: Liver. Contextual question: 7 mins: How can you relate the structure of the liver to it's function of digestion and storage? How does it get it's blood supply?	Describe the structure and nature of the liver.
	2 Mins.	Functions of the liver: 1. Stores glucose as glycogen, hydrolysing it back to glucose when needed.		Leading question: 2 mins: How is glucose stored in the body and how is it utilized.	Enumerate the functions of the liver.

WEEK 4: LESSON 2: SHEET 8

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	2 . Stores vitamins A and B_{12}		Probing question: 2 mins: Where do you think vitamins A, D and B_{12} is kept in the body?	Functions of the liver cont.
	5 Mins.	3. Stores iron from worn out red blood cells, which it breaks down, excreting bile pigments in the process.		Contextual question: 5 mins: How is iron recovered from red blood cells and relate this to the excretion of bile pigments?	Functions of the liver cont.
	5 Mins.	4. De-aminates excess protein produce urea from the process into the blood for excretion by the kidneys.		Inquiry method: 5 mins: Urea has a purgent smell, how is it formed and which food substance do you think is the primary source?	Functions of the liver cont.
	2 Mins.	5. Makes blood protein e.g. fibrinogen for clotting.		Defined term: 2 mins: Fibrinogen.	Functions of the liver cont.

WEEK 4: LESSON 2: SHEET 9

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	6. Makes bile saltsffor emulsifying fats in intestine.		Leading question: 2 mins: What constituent of the secretions of the liver aids fat digestion?	functions of the liver cont.
	2 Mins.	7. Makes poison harmless e.g. ethanol drink or poisons from gut bacteria		Local specimen: 2 mins: Ethanol drink.	Functions of the liver cont.
	2 Mins.	8. Filters out pathogens e.g. bacteria protozoa in the blood, using large phagocytic cells.		Probing questions: 2 mins: How are pathogens got out of the body.	Functions of the liver cont.
	2 Mins.	9. Produces heat from metabolism which assist in temperature regulation.		Leading question: 2 mins: How are temperature regulation achieved?	Functions of the liver cont.
	5 Mins.	DIET: A balanced diet is one th[illegible] that maintains health. It differs according to age; occupation, climate and sex.		Local specimen: 2 mins: Beans, rice, maize, meat, castor oil, fish, meat, vegetables. Defined term: 2 mins: Balanced diet.	State the different (common types) of Nigerian food substances.

WEEK 4: LESSON 2: SHEET 10

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	3 Mins.	CONSTITUENTS OF A DIET: (a) Energy - according to requirements - Carbo-hydrates and fats.		Inquiry method: 3 mins: People of different ages, sex and climate, do different jobs, how can one relate their occupation to the needs?	Enumerate the merits of a balanced diet.
	3 Mins.	(b) Materials for growth and repairs - provided by proteins.		Local specimen: 3 mins: Sources of protein - beans, meat.	State the role of proteins in the body
	3 Mins.	(c) Co-factors for enzymes to work - provided by vitamins.		Defined term: 3 mins: co-factors	State the role of co-factors in the human body.
	3 Mins.	(d) Salts - to replace those lost in sweat.		Contextual questions: 2 mins: Sweat is salty, how and why does the body need salts?	Identify the role of salts in the body.
	2.Mins.	(e) Water		Local specimen: 2 mins: Water.	Identify the role of water in human diet.

WEEK 4: LESSON 2: SHEET 11

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
	2 Mins.	(f) Roughage - indicestible bulk to help peristalsis.		Defined term: 2 mins: Roughage.	State the functions of roughage.
	5 Mins.	Note: First class protins contain the eight amino acids that man can not make on his own. Animal protein is rich in them plant protein usually poor. Without them, kwashiorkor results (wasting of limbs, pot-belly full of fluid occurs when one feeds mainly on maize - with only second class [illegible]. protein. Beans are richer in first class protein.		Inquiry method: 5 mins: Kwashiorkor is a common deficiency amongst low protein feeding Africans. If you see a mother with a child suffering from kwashiorkor, what type of food nutrients do you or would you suggest for the child.	Enumerate the nature, function and deficiency of first class proteins.
		TOTAL TIME: 79 MINUTES. END OF TREATMENT.		SUMMARY: 1. Leading questions: 13 mins. 2. Contextual questions: 14 mins. 3. Local specimen: 12 mins. 4. Probing questions: 14 mins. 5. Defined terms: 13 mins. 6. Inquiry method: 13 mins.	

WEEK 4: LESSON 2: SHEET 12

LESSON TOPIC	TIME	WHAT TO TEACH?	MATERIALS	HOW TO TEACH?-COMM. STRATEGY	STUDENTS ACTIVITIES
				SUMMARY OF TIME ALL-OCATION TO COMMUNI-CATIONAL STRATEGY 1. Challenging Practical Exerc-ises: 80 mins. 2. Labelled diagrams and pictures: 80 mins. 3. Inquiry method: 72 mins. 4. Local specimen: 79 mins. 5. Defined terms: 95 mins. 6. Contextual questions: 90 mins. 7. Probing Questions: 73 mins. 8. Leading questions: 71 mins. TOTAL: 640 minutes	