A TASK ANALYSIS OF THE SCIENCE TEACHERS' ASSOCIATION OF NIGERIA (S.T.A.N.) BIOLOGY TEXTBOOK

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D E C L A R A T I O N

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D E D I C A T I O N

Dedicated to Gordon for his support and encouragement, and to little Binaebi who saw it all in the making.

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HELEN I. BOZIMO (MRS)

ABSTIUCT

This 1B a task analytical study of the new Biology prograiaLie developed "by the Science Teachers' Association of Nigeria (S.T.A.N.)

The study examined the laboratory activity/practical work organization and analysed the structure and skill levels of the tasks students are expected to bo engaged in during the practical work phases of the programme.

The instrument used for the analyses was the Laboratory Structure and Task Analysis Inventory (LAI) developed by Tamir & Lunetta (1973).

The results chow that the practical activities are more highly structured (i.e. giving specific instructions to students on how to carry out the experiments) than open-ended. The programme encourages students to adopt an inductive approach (i.e. generalize from data gathered) in solving problems. The practical activities are all designed to follow the text, a few integrated within the text, and none to precede the text. In all the practical activities, students are expected to work individually, independent of others. The practical activities expect students to perform a variety of observational, measurement, apparatus manipulation and reporting procedures. These all qualify as lower order skills. Students are rarely asked to carry

out higher order activities like predicting experimental results, designing observation, measurement, and experimental procedures. There are no opportunities for students to apply experimental techniques to new problems or variables.

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CHAPTER ONE

1.0 THE PROBLEM

1.1 I N T R O D U C T I O N

The period between the late 1950's and 1970 was characterized by the emergence of new curricular programmes in science which changed the emphasis in science teaching. Numerous national projects, starting with the Physical Science Study Committee (PSSC) in the U.S.A., have led to the development of new curriculum materials stressing "inquiry" as an approach to science instruction. Among other factors, this change in emphasis was due partly to widespread dissatisfaction with the curricula that were then in use in the schools and partly to a new perception and definition of the methods and goals of science and science teaching in schools. For a long time, the standard definition of science has been "a body of systematized knowledge resulting from observation study, and experimentation" (Victor & Lerner, 1971). Many scientists have, however objected strongly to this definition, and have insisted that science is "a process of inquiry, resulting in a body of systematized knowledge". Inquiry, in this context is defined as "a search for knowledge or truth" (Sund & Trowbridge, 1967). The inquiry or discovery approach to science instruction does not stress the accumulation of authoritative information. Rather, it stresses student-centred class instruction and is more concerned with students'

discovering how scientists come to know what they know. The emphasis is on the process rather than the product.

Schwab (1962) depicts the traditional science course as a literal treatment of science and an unmitigated rhetoric of conclusions. According to him, "it has tended to treat only the outcomes, the conclusions of inquiry divorced from the data which support them and from the conceptual frames which define - and limit-their validity. The result has been to convey a false image of science as knowledge that is literally true, permanent, even complete".

In contrast, teaching science as inquiry, emphasizes the investigative processes of science so that students learn science as a process and understand the empirical basis of scientific evidence. The purpose of the inquiry approach is to involve the students in how a scientist really operates in discovering new knowledge. According to Suchman (1960):

"Inquiry training is designed to supplement the ordinary science classroom activities. It gives the child a plan of operation that will help him to discover causal factors of physical change through his own initiative and control and not to depend on the explanations and interpretations of teachers or other knowledgeable adults". It is for this reason that the inquiry approach has sometimes been called the discovery approach.

It is against this background that the nature of elementary and secondary school science has changed over the past several decades. Thus, theories of instruction and design of curriculum have gone through a variety of modifications. Throughout this period, however, Macbeth (1974) maintains "there has remained nearly unanimous agreement that learning in young children is likely to be more efficacious if the child is involved in first-hand direct manipulative experiences".

This concern for active pupil participation in the learning experience did not just arise with the emergence of the new curriculum programmes of the sixties. This concern was advocated in earlier years by writers such as Maria Montessori (1912) and John Dewey (1916). The theoretical findings are also supportive of this notion. Developmental psychologists, such as Jean Piaget (1964), Jerome Bruner (1961) and Robert Gagne (1965) suggest that active pupil participation and direct manipulation of concrete objects are important in the development of learning in young children. Bruner (1961) for example, suggests that knowledge is acquired through the act of discovery. Discovery here is "not restricted to finding out something that before was unknown to mankind but includes all forms of obtaining knowledge for oneself by the use of one's own mind". In more recent years, this concern has been expressed by the auhors of the experimental science

curriculum projects (e.g. Hawkins 1965, Karplus 1963, Livermore 1964). As Hurd (1964) stated: "To escape the threat of obsolence, education in the sciences must be based upon the kind of information that has survival value and upon strategies of inquiry that facilitate the adaptation of knowledge to new demands"

Generally, curriculum changes arise as a result of the awareness on the part of educators and society as a whole, that the existing curriculum is no longer serving the needs of the students and society. In the United States of America, the recent series of curriculum reforms began in 1952 with the establishment of the University of Illinois Committee on School Mathematics (UICM). However, radical revolutionary changes in curriculum were actually triggered off by the successful launching of the Russian space-craft, Sputnik, in 1957. In an attempt to counter the apparent Soviet supremacy in Science and technology, many countries, especially the U.S.A. made frantic efforts to improve learning of science and mathematics in their schools. The National Science Foundation (NSF) has been in the fore-front of these curriculum reforms in the U.S.A. Early in the history of the NSF, the Division of Scientific Personnel and Education was established to develop means of advancing education in the sciences. Following the precedence set by the United States of America, Britain also began to set up curriculum development projects on a national scale in the

early 1960's. The Nuffield foundation took the lead in these endeavours, followed later by the schools council.

In 1956, the National Science Foundation established the Physical Science Study Committee (PSSC) to develop a new curriculum in high school physics. Curriculum reformers in the Biological Sciences and in Chemistry swiftly followed the Mathematicians and Physicists, and new programmes were evolved and tried out both at the primary and secondary levels. Some of the curriculum projects that emerged in this vein are the:

Biological Science Curriculum Study (BSCS).
Chemical Bond Approach Project (CBAP).
AAAS Science - A Process Approach (SAPA).
Elementary Science Study (ESS).

In Britain the more important early projects included the School Mathematics Project and the Nuffield Science Teaching Project.

Certain elements common in the objectives and orientation of the new programmes need mentioning. For instance greater concern is given to inquiry-discovery, individualisation, computer-aided instruction, skill learning and the specification of behavioural objectives (Oyedum, 1980). Special stress has been laid on the laboratory part of the course; the objective has been to replace routine cookbook procedures with an approach in which the students will develop a genuine feeling for the nature of scientific inquiry and discovery. In some cases, parts of a course are taught largely through laboratory and field experience.

Also notable were the use of independent study, demonstrations, etc.

In line with world trends, science curriculum reforms found their way into Nigeria through the African Primary Science Programme (APSP). The APSP started around 1965 with assistance from USAID and the Ford Foundation. The overall purpose of the project was to introduce modern methods and materials for teaching science to primary schools of English-speaking tropical Africa. The project which began as an African continuation of the APSP is the Science Education Programme in Africa (SEPA). At the secondary level, the first science curriculum project was the "Aiyetoro General Science or Basic Science Syllabus". The project, known as Basic Science for Nigerian Secondary Schools (BSNSS) reflected the first attempt to shift from the didactic method of science teaching to a laboratory oriented course in Nigeria. Other programmes with similar orientation were developed and tried out, for example:

Yoruba Six-year Primary Project (YSPP).
Mid-Western State (now Bendel) Primary Science Project (MPSP).

In 1971, the Nigerian Educational Research Council (NERC) organized a National Workshop on the primary school curriculum. As a basis for building new curricula, the science panel at this workshop adopted a modified version of the Process classification Scheme of the American Association for the Advancement of Science (AAAS).

The NERC recommended that this approach should be adopted for primary schools throughout the country (NERC, 1971). The NERC guidelines have provided the framework for the Primary Education Improvement Programme (PEIP) science materials.

In response to WAEC's request in 1968, the Science Teachers Association of Nigeria (STAN) developed syllabuses for Biology, Chemistry and Physics for the upper classes of the secondary school. The Comparative Education Study and Adaptation Centre (CESAC), University of Lagos adopted the syllabus for a Project - The Nigerian Secondary Schools Science Project (NSSSP). This project which has Biology, Chemistry and Physics versions, adopted a conceptual scheme approach.

The STAN on its own part felt there was need to have a balanced nationally uniform science background in the junior forms if their efforts were to be meaningful. They therefore decided to draw up a basic science course for the first two years of the secondary school, and this is what is now known as the Nigerian Integrated Science Project (NISP).

As at the moment, the major curriculum development agencies or bodies in the country are the CESAC, NERC and STAN. The NERC was actually created as a unit within the Federal Ministry of Education to coordinate and to solely provide leadership in matters of curriculum policy and

educational research. In this capacity, it summoned the first National Curriculum Conference in 1969 and organized the various curriculum workshops that followed. It is the plan of the NERC to develop texts in due course on these programmes. Programmes initiated by these three bodies have national coverage. The Nigerian programmes are tailored along the same lines as their predecessors in the U.S.A. and Britain. For example, they are inquiry - discovery oriented, emphasize the acquisition of scientific skills and the use of independent study. They stress the use of practical work and the laboratory has taken on a new importance. The new programmes emphasize the active involvement of the students by engaging them in task-related activities.

To ensure continuity with work done at the Junior Secondary School, relevant syllabuses and textbooks in the separate scientific disciplines of Biology, Physics and Chemistry for the Senior Secondary School (S.S,S.) have been written by STAN. The writers of the STAN Biology textbook have built in suggested practical work for students at the end of each chapter of the book. This text is assumed to be a continuation and extension of the NISP to which the students have been exposed during the first three years of the Junior Secondary School (J.S.S.). It is to be expected, therefore, that, in order to maintain continuity with work done at the Junior Secondary School (J.S.S.) the suggested practical activities will reflect the objectives and philosophy of science teaching stated in the

NISP. Furthermore, by engaging in the activities listed in the new Biology course, it is expected that today's young Nigerian biologist will be able not only to describe phenomena, but also to undertake firsthand investigations as mature scientists do.

In the light of this, there is a need to critically examine the laboratory activity/practical work organisation and give a detailed description of the skill levels of the tasks in the practical exercises of the biology text. According to Lunetta and Tamir (1979) "it is not enough that students be busy. It is imperative that laboratory activities be selected to enhance our teaching goals, considering the amount of funds and time expended on new curriculum programmes". The tasks and the skill levels involved, they say, are essential in science laboratory work if we want to develop in students the so-called "higher" cognitive processes on which much of science is based - like hypothesizing, predicting, and so on. This is so because the goals of science teaching have moved away from involving students in activities that merely illustrate, demonstrate, or verify known concepts and laws. Other goals that are considered to be important include the development of attitudes and skills consistent with the work of scientists, and the understanding of scientific relationships, concepts and

models. Lunetta and Tamir (1979) have therefore culled from the literature different skills and behaviours which are related to the processes of scientific inquiry and problem solving. Those performance activities in which students are involved in doing the experiment, manipulating equipment, as well as observing and reporting data, they have designated low-level skills. Higher level skills, on the other hand, involve the analysis and application phases. These may include behaviours involved in processing data, explaining relationships, formulating questions for further investigation, making predictions for new situations or applying inquiry techniques to new problems, etc.

It is therefore very vital at this moment in time when the new STAN Biology book is being introduced into schools, to find out if infact appropriate tasks commensurate or in consonance with the theoretical presentation that precedes each section on practical work have been provided and what level of skills they belong to. Task analysis and student interaction in practical or laboratory work are interrelated. It is assumed that the cooperative interaction role will enhance achievement of the required skills. In analysing practical work in school science, it has also become very necessary to investigate the role of interactions among students and between students and materials in order to ascertain which of the interaction models would best suit science. Many writers have suggested that groupwork or

group activities, as opposed to the traditional learning method of individual activities are a better way of learning e.g. Kayo and Rogers (1968), Johnson (1972). Sociologists like Banks (1968), Parson and White (1960), and White & Lippit (1960), were also of this view. In summary, the general consensus from all the available studies on the interaction of students in science practical is that the cooperative interaction pattern is better for promoting achievement in biology than both the competitive and the individualistic interaction pattern (Okebukola, 1984). Since this is very basic and important to school science as contemporary studies have shown, it is useful to investigate the kinds of student interactions proposed and dominant in the new biology textbook (see Humphreys, Johnson & Johnson 1982; Johnson, 1967; and Tjosvold, Marino & Johnson, 1977).

This study is therefore aimed at analysing the tasks students are expected to be engaged in during the practical work phases of the STAN Biology programme and to examine the laboratory activity/practical work organisation. As mentioned earlier the STAN Biology programme is inquiry-based. This implies that the programme will provide students with extended opportunities to investigate and inquire, consistent with the goals of communicating the method and spirit of scientific inquiry. It is also assumed that the new science curricula will teach students to solve problems and to think using the laboratory as the primary vehicle. It is therefore expected that the laboratory activities or suggestions for practical work will be written to provide higher levels of initiative

and conceptualization for individual students.

To ascertain whether the programmes are achieving these objectives for which they were designed will require an analysis of what kinds of learning are taking place and what kinds of instruction actually occur during the practical work phases. This study is an effort to describe the structure and skill levels of the tasks in the suggested practical activities. This will assess the extent to which the activities students engage in, in the biology classes are pointedly enriching toward the acquisition of science process skills.

1.2 STATEMENT OF THE PROBLEM.

This study has attempted to analyse the tasks students are expected to be engaged in during the practical work phases of the new S.T.A.N. Biology programme.

It specifically examined laboratory activity/practical work organisation and described the structure and skill levels of the tasks in the practical exercises of the Biology text.

In examining laboratory activity organisation, the study sought to answer the following questions:

(1) Are the laboratory or suggested practical experiences highly structured or are they open-ended?

(2) Do the laboratory or practical experiences precede or follow the text discussion of the concepts?

(3) What kinds of student interaction are proposed - are they asked for example to pool their results?

In analysing laboratory tasks, the study tried to find out:

(4) What students behaviours are emphasized?

(5) Do these behaviours reflect goals and objectives of the new biology curriculum and other science educators?

In attempting to answer the above questions the following hypotheses were formulated for testing:

HC_1: There is no significant difference in the proportion of laboratory or practical experiences that are highly structured and those that are open-ended.

HO_2: The proportion of laboratory experiences that are integrated with the text and those that follow text discussion of the concept is the same.

HO_3: The proportion of individual and group practical activities are the same.

HO_4: There is no significant difference in the proportion of laboratory tasks demanding high level skills and low level skills.

HO_5: The behaviour demanded of students have no relationship with the objectives enunciated by the STAN Biology curriculum.

1.3 BASIC ASSUMPTIONS.

The basic assumptions on which this study was based are that:

(1) The STAN biology programme is inquiry-based.

(2) The suggested practical exercises are necessarily laboratory activities.

(3) The inquiry-based science curriculum projects require the students to engage in certain task-related activities.

(4) An inquiry-based programme is successful if:

  (a) it is found to expect students to engage in first-hand investigations.

  (b) suggestions are open-ended.

  (c) it emphasizes higher level skills.

(5) The practical activities contained in STAN biology could be evaluated through a study of task analysis.

1.4 DEFINITION OF TERMS.

The meaning of some abbreviations and terms which are used in this study are defined in this section.

N.E.R.C.	-	Nigerian Educational Research Council.
S.T.A.N.	-	Science Teachers Association of Nigeria.
C.E.S.A.C.	-	Comparative Education Study and Adaptation Centre.
W.A.E.C.	-	West African Examination Council.
P.E.I.P.	-	Primary Education Improvement Programme.
N.I.S.P.	-	Nigerian Integrated Science Project.
U.N.E.S.C.O.	-	United Nations Educational Scientific and Cultural Organisation.
U.N.I.C.E.F.	-	United Nations Children's Emergency Fund.
A.A.A.S.	-	American Association for the Advancement of Science.
U.S.A.I.D.	-	United States Agency for International Development.
S.E.P.A.	-	Science Education Project for Africa.
A.P.S.P.	-	African Primary Science Project
M.P.S.P.	-	Midwest Primary Science Project
N.S.S.S.P.	-	Nigerian Secondary Schools Science Project.

B.S.N.S.S.	-	Basic Science for Nigerian Secondary Schools.
Y.S.P.P.	-	Yoruba Six-year Primary Project.
N.S.F.	-	National Science Foundation.
P.S.S.C.	-	Physical Science Study Committee.
U.I.C.M.	-	University of Illinois Committee on School Mathematics.
A.I.B.S.	-	American Institute of Biological Sciences.
B.S.C.S.	-	Biological Science Curriculum Study.
C.B.A.	-	Chemical Bond Approach
CHEM Study	-	Chemical Education Material Study
Junior Secondary School	-	Forms I, II and III of a Nigerian Secondary School in the new 6-3-3-4 system.
Senior Secondary School	-	Forms IV, V and VI of a Nigerian Secondary School in the new 6-3-3-4 system.
Process Skills	-	Mental or intellectual skills the scientist uses in solving problems in his scientific enterprise.

6-3-3-4 - The new system of education in Nigeria under the new National Policy consisting of 6 years primary schooling, 3 years Junior Secondary education, 3 years Senior Secondary education and 4 years Higher education.

Task - Specific piece or amount of work assigned by another and often required or expected to be finished within a certain time.

Activity - An educational procedure designed to stimulate learning by firsthand experience or observation, experiment, inquiry, etc.

1.5 SIGNIFICANCE OF THE STUDY

It has been said that scientific knowledge is increasing at an exponential rate. In the past ten years, it is believed, the total quantity of knowledge in any given science field has more than doubled and the prospects for the future are even more profound (Sund & Trowbridge, 1967). There has also been lots of scientific and technological advances in recent times. To get into the mainstream of the world technological culture, a developing country like Nigeria needs an education in the sciences that is up-to-date

and relevant to contemporary life. This will also go a long way to help solve our problem of scientific and technological manpower needs by producing the required technologists (Abdullahi, 1982).

That apart, it is imperative that young people should be educated for the world in which they will be living and the purposes for teaching science need to be defined in these terms. The layman is surrounded by scientific developments and is faced with a wealth of scientific information. It is therefore the responsibility of the schools to produce an intelligent and scientifically literate citizenry. The ability of our citizens to understand national and international problems is dependent in part on their scientific literacy (Sund & Trowbridge, 1967). A literate individual must have some understanding and appreciation of science in order to make valid judgements as a citizen.

Our traditional religious beliefs run counter to western ones and some of the teachings of western education. Some of the conflicts arising as a result of this dual culture in which our children find themselves could be resolved by an understanding of the scientific principles governing certain phenomena. A lot of superstitious beliefs could be explained this way. Also, there is the need for establishing specific competencies in students which will make them better equipped to solve life's problems. There

was thus a call for schools to provide the right type of science education for our children that emphasizes the acquisition of certain intellectual skills like observation, manipulation of objects, etc. to enable them live a meaningful life in this age of rapid technological change (Abubakar, 1967; Cookey, 1970; Fafunwa, 1972).

Response to this call has been in the form of new programmes. Even before this call, there have been moves by science educators to fulfil these demands e.g. in the introduction of the NISP. The new STAN biology programme like the NISP and others before it, is intended to make the learning of science an investigative activity.

To ascertain whether a curriculum programme is achieving the objectives for which it was designed, there has to be a thorough evaluation of the materials in terms of these objectives. One objective cited almost without exception in the new science programmes mentioned in section 1.1 above, is bringing students to some understanding of the nature of scientific inquiry. This implies active pupil participation and emphasizes the centrality of teaching and learning in the laboratory. The major uniqueness of the laboratory lies in providing students with opportunities to engage themselves in the process of investigation and inquiry. To know whether this objective is being achieved, it might be worthwhile to determine the extent to which the doctrine

is incorporated in the actual structure of the textual materials. This study is one such attempt. This will enable the researcher ascertain the relationship between the actual materials and the stated goals of the curriculum developers and others. Such an investigation may help to identify the strengths and weaknesses of the project, especially as they relate to the acquisition of important skills by students.

This STAN biology book is a new book written by Nigerian science teachers for Nigerian students, bearing in mind our own peculiar culture and environmental conditions. They have therefore included a chapter on science and superstition. Special emphasis is placed on the importance of agriculture to the Nigerian society. Examples have been chosen in the book to illustrate the Nigerian and African environment rather than rely on European fauna and flora. This programme is still in its "trial" stage. So the kind of investigation carried out in this study will help point out some flaws, if any, that would have been noticed in a pilot-testing stage which this edition has skipped, and probably give pointers to areas that might need attention in subsequent revision exercises.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

INTRODUCTION.

In this chapter a review of the pertinent literature has been made to put the present study in its proper perspective. The origin of curriculum reforms was traced and a number of recently developed inquiry-based science curriculum programmes in and outside Nigeria was chosen for discussion. The purpose of evaluation and the different forms it may take were outlined. Some content analysis studies were looked at and more specifically, task analysis studies were discussed.

The manner of the review as set out in this chapter follows this order:

2.1 The Origin of Curriculum Reforms.

2.2 The Nature of Science and Objectives of Science Teaching.

2.3 Some Inquiry-based Science Programmes

2.4 Evaluation Studies.

2.5 Content Analysis Studies

2.6 Task Analysis Studies

2.1 THE ORIGIN OF CURRICULUM REFORMS.

In the late-fifties and early sixties a massive reform movement was generated to improve science teaching in American schools. This movement was part of a larger reaction among leading American educators against life-adjustment education and in favour of more discipline-centred instruction (Hurd, 1969). An awareness on the part of educators and society of the inadequacies of the traditional science courses to meet the contemporary needs of a rapidly changing society, and a redefinition of the nature of science among other factors brought about these reforms (Sund & Trowbridge, 1967). While some groups sought to rethink and modify existing courses, others spoke for more drastic action and for revolutionary changes. The latter groups proved to be more influential and as a result, new science courses were developed and tried out in schools. These courses not only contained new subject matter, but were written in terms of goals representing a new era in science teaching. They were designed to be taught differently and learned differently from science courses of the past (Hurd, 1969).

2.2 THE NATURE OF SCIENCE AND OBJECTIVES OF SCIENCE TEACHING.

It is an accepted fact that a teacher's concept of what science is influences not only what he teaches but how he teaches (Hurd, 1969). To fully appreciate the science curriculum reform movement and the trends in science teaching, it is relevant to have a clear notion of what is meant by science. The implication is that the educator's definition of science has influenced what he thinks should be taught and how it is taught. A clear definition of science is quite elusive. This is because science is a complex of intellectual activities and human purposes.

Science has been variously defined and viewed by various authors. It is now seen both as a body of knowledge and a process of inquiry or a way of investigating the world around us, i.e. both product and process (Sund & Trowbridge, 1967). For a long time, science was seen as essentially a body of systematically organized knowledge established as true, together with concepts and laws of nature assumed to be unchangeable, irrevocable and prescriptive, ignoring the processes (Hurd, 1969). Science is a human enterprise and our knowledge in real fact consists of limited observations and our supposed laws are summations of our experiences. As our experiences develop, new observations are added which consequently modify or even replace one-time laws or change

existing conceptions of what is true. It is therefore more appropriate now to see science both as a body of knowledge, and also a process of inquiry, resulting in a body of systematized knowledge. This redefinition of what science is, has subsequently gone to re-determine what the objectives of science teaching are.

According to Victor & Lerner (1971), the two major objectives of science education derived from the current view of science are to help the child develop:

(1) Knowledge of science concepts - the content of science, and

(2) facility in scientific skills and attitudes - the processes of science and scientific inquiry.

In trying to achieve these two objectives, science teachers have been encouraged to use the processes of science to achieve the learning of science content. However, all too often the major emphasis has been on content and process has been ignored. This has deprived the students of needed experiences with scientific inquiry and the processes of science. This formed the genesis of the widespread preoccupation with revising existing science programmes and developing new ones that are inquiry-based and more likely to ensure the acquisition of the science processes.

The history of modern science teaching in Nigerian schools is very recent. The missionaries who introduced western education in Nigeria could not start serious science teaching for various reasons. Thus, although "rudiments of science were injected into the school curriculum" before the full participation of the colonial government in the development of secondary education in the country, science teaching did not start as early as the first grammar school was opened in the country (Abdullahi, 1982). Kings school Lagos, the first government secondary school, established in 1909 was the first in the country to have a chemistry laboratory. This marked the beginning of proper science teaching in Nigeria and for many years King's School (now King's College) remained the only school which consistently offered science to the standard of the Cambridge University Senior Local Examination (Taiwo, 1975). Later, science courses began to feature prominently in the school curriculum of most secondary and primary schools.

In Nigeria, the National Policy on Education appears to project the modern aims of science education like inculcating in the child the spirit of inquiry and creative thinking, etc. In practice however, these aims appear to have been almost totally neglected. A lot of emphasis has been placed on the teaching of the facts and principles of science. Efforts at improving science teaching have had relatively little impact

on the performance of students in science and also on the improvement of the posture of science and technology in Nigeria. One of the reasons for this Nigerian Scientists claim, is the lack of understanding of the nature of science by science teachers and their pupils. To correct this situation, Nigerian science educators began to look at the problem and STAN came out with a new syllabus for integrated science for the junior forms and now for the separate science disciplines for the senior forms. These attempts have tried to present a course in science that is reflective of the nature of science (Abah, 1979).

However, for these programmes to be fully utilised, the teachers must have a proper idea of the nature of science. To know the existing level of understanding of the nature of science among science teachers, Abah (1979) conducted a survey. His study tried to provide information regarding the understanding of the nature of science among science and science education undergraduates in a Nigerian University (A.B.U.) and graduate science teachers in secondary schools and colleges in Kaduna and Zaria. On the other hand, STAN undertook a similar investigation on a nationwide scale (see S.T.A.N. Position Paper No. 1) to find out how the schooling and non-schooling communities in Nigeria perceive science.

Findings of these studies show that most of the subjects sampled in the STAN study hold the view that science is a body of accumulated facts i.e. most subscribe to the static view of science. The Abah (1979) study found a better understanding of the nature of science among the science education undergraduates and science teachers with professional training.

It is hoped that a better understanding of the nature of science by science educators will influence the type of science they teach and how they teach it. The present study will in part, try to find out if this change in the objectives of science teaching is reflected in the new STAN biology programme.

2.3 SOME INQUIRY - BASED SCIENCE PROGRAMMES

Curriculum projects representative of the inquiry-based science reform movement were initiated by the Physical Science Study Committee in the U.S.A. and subsequently by other projects like CHEM study, B.S.C.S., and the United Kingdom's Nuffield Project, to mention a few.

2.3.1 What is Inquiry-Based?

An objective common to all the "new" curriculum programmes in science is that of "bringing students to some understanding of the nature of scientific inquiry"

(see Section 2.4.2 - P.S.S.C., N.S.C.S., etc). By scientific inquiry we mean that disciplined form of satisfaction of human curiosity which involves scientists in "Ongoing, self-correcting and revisionary processes" which result in bodies of currently warranted fact and theory (Schwab, 1960).

The developers of the new science curriculum programmes believe that learning in young children is likely to be more effective if the child is involved in firsthand direct manipulative experiences (Macbeth, 1974). They have therefore emphasized "inquiry" as an instructional approach in their new programmes. They appear to be united in their conviction that the major function of the laboratory in this context is to convey the spirit of scientific inquiry by providing students with opportunities to investigate, to inquire, and to find things out by themselves (Tamir & Lunetta, 1981). This emphasis is in marked contrast to what used to be the practice, i.e. using the laboratory primarily as a place to illustrate, demonstrate and verify known concepts and laws. Schwab (1960) observed that "the laboratory is easily converted to inquiry...by having the laboratory lead rather than lag the classroom phase of science teaching".

Inquiry-based programmes are therefore, those programmes that are supposed to have shifted laboratory exercises from simply demonstrating or verifying known information to raising problems, developing inquiry skills, and providing opportunities for "discovery". Implicit in this is that laboratory inquiries will be set to precede the text, or integrated with it, thereby giving students opportunities

to discover many things through inquiry. Furthermore, instructions in laboratory manuals etc. will be kept to a minimum.

2.3.2 Some Programmes Outside Nigeria

A review/discussion of some science programmes developed in the U.S.A. and Britain is relevant to the discussion of the STAN biology programme because:

(1) Educational practices in these two countries have, since the introduction of western education, greatly influenced the system of education in Nigeria and the indication is that they are likely to continue to do so in the future (Oyedum, 1980).

(2) The STAN biology programme which is the focus of this study has a similar orientation to these programmes developed in the U.S.A. and Britain. In fact, a lot of the Nigerian programmes are adaptations of the foreign ones e.g. the PEIP science is similar to the AAAS Science-A Process Approach and the NISP is very similar to the Scottish Integrated Science Project.

(3) Most of the new curriculum programmes include as part of students' activities certain tasks to be carried out in the course of the learning of a science concept. Reviewing them, therefore would certainly bring into focus the objective of this study which concerns task analysis of the new STAN Biology book.

The few programmes reviewed in this study are:

(1) The Physical Science Study Committee
(PSSC Physics)

(2) The Biological Sciences Curriculum Study (BSCS).

(3) The Chemical Education Materials Study (CHEM Study).

(4) Harvard Project Physics (HPP)

(5) Chemical Systems (CHM Project)

(6) Nuffield Secondary Science Project.

(7) Science 5 - 13.

The effort to improve the teaching of physics was the first venture in the science curriculum reform movement. The Physical Science Study Committee (PSSC) was formed in 1956 as a group of University and Secondary-School physics teachers working to develop an improved physics course. The aim of the committee was to present a view of physics that would bring a student close to the nature of physical inquiry. It also sought to transmit the human character of the story of physics, not simply an up-to-date codification of the findings but as an unfinished and continuing activity. Materials for direct instructional use include a textbook, laboratory apparatus and a laboratory guidebook for students, motion picture films, and a set of 10 achievement tests. Supporting materials include a four-volume teacher's guide and resource book, and a series of paperback books that provide authoritative science

literature for students and adults - appearing as the "Science Study Series".

The design of the course is such that the student is expected to be an active participant. Such a student was not taught to know the ideas of physics and the illustration of their utility with problems and in laboratory exercises, but was expected to wrestle with the basic lines of inquiry, including his own laboratory investigation that leads to basic ideas. The students' laboratory guidebook kept specific instructions to a minimum, directing the students' attention to key points by raising questions. Films were used to demonstrate a range of experiments that were likely to be too difficult, too time-consuming or too costly for students to perform or for teachers to demonstrate (Finlay, 1962).

In the wake of the introduction of the PSSC, the American Institute of Biological Sciences (AIBS), with support from the NSF, established the BSCS in 1958 to initiate a biology programme. The principal aim of the programme was to restructure the discipline in such a way as to prepare students to cope with the biological problems faced by the simple fact of being a living organism.

In 1960, the first "experimental" edition of this course appeared. Finally, three versions of the programme were produced by three different groups of University specialists in different fields and high school biology teachers. They

were the Yellow, Blue, and Green versions. The Yellow version centred on the genetics and developmental aspects of biology, the Blue version on the biochemical and physiological aspects and the Green on ecological and evolutionary approaches to biology. Each BSCS programme includes materials selected for their applicability in the latter half of the 20th century and their ability to illuminate the principles and concepts that underlie biological science. In addition to the three texts, there are laboratory guides, teacher's guides, laboratory blocks and the teacher's handbook. The laboratory block is a plan of instruction that involves the entire class and provides real depth of investigatory experience (Glass, 1962).

In 1959 the American Chemical Society established a committee composed of distinguished chemists from high schools, universities, industry and government. In 1960, with a grant from the NSF, the group assembled to investigate what could be done to produce an effective high-school chemistry course. The Chemical Education Material Study (CHEM Study) grew out of this. The main objective of CHEM Study was to experiment with as many means as possible of making a high-school chemistry course highly effective.

The committee prepared a textbook and a laboratory manual in High School Chemistry. There was also a teacher's guide which matched the laboratory manual and textbook. Films and motion pictures of various kinds were also

introduced in the course, and these were meant to assist the teacher in the illustration of experiments and concepts that would be difficult to illustrate in any other way. In addition, there were some special equipment, wall charts and chapter and review tests. About three-quarters of the laboratory experiments are quantitative in nature, but the level of mathematical ability required to handle the results was not too demanding for students of the level. Equipment was kept simple in design and low in cost. There was strong emphasis on experimentation and the student was normally expected to do the experiment before he read about the material in the textbook or before the material was discussed in class. The student was allowed to discover many of the fundamental ideas and relations himself and discuss them in a laboratory context with his classmates, rather than read about them or merely hear them discussed as things that could be observed. Thus, the student was sent to the laboratory the first day of school, and worked there about seven of the first ten days of school. He was not given his textbook until the fourth day of school. This conveyed to the student that Chemistry was indeed an experimental science (Campbell, 1962).

Diversity is a highly valued concept in American education. In spite of the tremendous success of the PSSC, several science educators felt that more than one or two physics courses should be available for use by secondary schools. A point of view, namely, that there is no single

best way to organize a high school course in physics was responsible for the NSF exploring other approaches to the study of physical science in high schools. Moreover, the staid image of physics to a majority of students and a general discontent with existing courses strongly suggested a need for complementary physics courses. So in 1962, a series of discussions began at Harvard University about the need for a new approach. In 1964 the group began the development of a new physics course, the Harvard Project Physics (HPP).

The HPP course attempted to produce a "model" built upon the concept of a historical and cultural approach to Physics. It emphasized the close connection of physics to other sciences, illustrating the methodological and historical development of the sciences and the social and cultural consequences of the progress of science. Support for the programme came from the Carnegie Corporation, the Alfred P. Sloan Foundation, the U.S. Office of Education, and the National Science Foundation. The developers of the Project were of the opinion that all students should have physics to understand modern society. They therefore provided a physics course related to human endeavour within a cultural context.

The HPP has produced for each of its six basic units student guides (texts) laboratory and demonstration equipment, laboratory manuals, tests, books of readings,

films, loops, transparencies, programmed instruction booklets and teacher guides, with the course progressively moving away from the idea that a text must be a major source of information for the student. This they christened a multi-media approach to learning. Topics that might have been viewed as becoming inappropriate in a physics course are included as well as being cast in a mode that facilitates an inductive approach. An important characteristic of HPP is its emphasis on flexibility, both in content and approach. It is concerned with redefining the role of the teacher and including sufficient flexibility to cope with diversity of content and student needs. The range of curriculum and teaching criteria considered is unique among new science teaching programmes. They sought to go beyond the 1960 idological setting for curriculum improvement. (Hurd, 1969; Moore, 1968).

In 1957, at the request of the American Chemical Society, a group of College Chemists and High school chemistry teachers met to consider ways of correlating college and high school chemistry. The discussions of this group led to the idea of a high school chemistry course (the Chemical Bond Approach) that would stress basic principles, with chemical bonding as a central theme. The course was written with the primary purpose of preparing students for the further study of chemistry in college. Through pilot work and a writing conference in 1959, the

Chemical Bond Approach (CBA) produced the first version of a textbook and a laboratory programme. It was hoped that the course would develop critical thinking, scientifically literate citizenry, and stimulate an interest in Chemistry. It therefore had a strong humanistic orientation.

Instructional materials for the CBA course consist of a textbook-Chemical Systems, and a laboratory manual-Investigating Chemical Systems for the student and a guide to each of these for the teacher. CBA does not have a film programme of its own but makes use of films selected from the PSSC and CHEM study series.

In the laboratory programme there is an underlying emphasis upon "thinking about" experiments in terms of the problem to be investigated. Laboratory and class work are seen as interrelated parts of scientific inquiry and are not sharply distinguished. The emphasis is upon how humans arrive at understanding and how they develop insight. Students are therefore not asked to do experiments which merely demonstrate what they already know, nor are they expected to get the "right" answers. The student is expected to devise his own procedure for working on a problem and the teacher's task is to help and encourage the student to be an investigator of chemical systems rather than simply a spectator (Chemical Systems, 1964; Hurd, 1969).

Following the lead set by the U.S.A., Britain came up

with some national programmes. Notable among the British Programmes is the Nuffield Secondary Science Project. This project was set up in 1965 with some assistance from the Schools Council. It has developed materials for an integrated science course for pupils aged 13 - 16 who are not likely to take 'O' level examinations in science.

The teaching materials are related to eight themes and include books for teachers on each theme, an Apparatus Guide, a general Teachers' Guide and a further book to aid teachers preparing Mode III examinations. There are thirty-four film loops, mainly in colour, plus slide sets and packs of black and white pictures. Two background books, Britain's Fuels and Rocks, Minerals and Fossils, have been prepared; this series is being extended with other books written by members of the project team. The first published materials appeared in 1971. Considerable emphasis was given to the involvement of the pupils through their own experimental investigations of problems which are real to them. These boys and girls are not expected to become scientists but could to a limited extent be given some feeling through their own direct experience of a few of the ways in which scientists work. It is hoped too that they would develop an attitude to science which shows some understanding of what science is and how their own lives can be affected by the use and misuse of scientific ideas.

To consolidate and extend the work on primary science teachin, initiated by the Nuffield Junior Science project, Science 5 - 13 was established. The project was set up in 1967 for five years and later extended to 1973 to permit further work on diffusion. It is jointly sponsored by the Schools Council, the Nuffield Foundation and the Scottish Education Department. Its aim has been to assist teachers in helping children, through discovery methods, to gain experience and understanding of their environment and to develop their powers of thinkin effectively about it. This has been done through the identification and development of topics or areas and themes of science related to a framework of objectives appropriate to pupils' stages of educational development. The project team have produced a series of units for teachers on the subject areas. Each unit consists of one or more illustrated books and ives advice, starting points and background information. The basic project thinking has been set out in a separate book, "With Objectives in Mind"; another publication, "Early Experiences" is designed specifically for those teaching in the infant school; it is also used for older retarded children. A source book, "Using the Environment", has also been prepared, and also the project's familiarization unit, intended to help teachers assess the value of the project to themselves.

2.3.3 Programmes in Nigeria.

In this age of scientific and technological explosion, the need for science curriculum reform is imperative in a developing country like Nigeria, if she has to get into the mainstream of the world technological culture. This aside, the need for reform is even more urgent in a country like ours because of our alien educational legacy. The dysfunctionality of the inherited educational programmes stimulates an urgent need for curriculum reform. So science curriculum reforms which began in the U.S.A. and moved to Europe and so on, found their way into Nigeria through the African Primary Science Programme (APSP).

A review of some Nigerian programmes is relevant to the present study because:

(1) these programmes, like the STAN Biology, were developed in Nigeria for Nigerian children whose cultural environment is different from that in other parts of the world.

(2) They all represent a shift from the traditional mode of science teaching to an inquiry-discovery approach.

(3) They require the children to engage in certain task-related activities.

(4) They were developed in Nigeria for groups of primary and junior secondary school children who

will eventually move on to the senior secondary school to study the STAN Biology materials.

The few programmes reviewed in this section are:

(1) The African Primary Science Programme (APSP)

(2) Basic Science for Nigerian Secondary Schools (BSNSS).

(3) Yoruba Six-year Primary Project (YSPP).

(4) Mid-Western (Bendel) State Primary Science Project (MSSP).

(5) Primary Education Improvement Programme (PEIP) Science.

(6) Nigerian Secondary Schools Science Project (NSSSP).

(7) Nigerian Integrated Science Project (NISP).

(8) STAN Biology Programme.

The African Primary Science Programme (APSP) was one of the three major projects in Africa sponsored by the Educational Services Incorporated (ESI), later Education Development Centre (EDC), Newton, Massachusetts, U.S.A. in the 1960s. The programme also received assistance from USAID and the Ford Foundation. The over-all purpose of the programme was to introduce modern methods and materials for teaching science to primary schools of English-speaking tropical Africa. Nigeria was one of the 14 English-speaking African countries that adapted the programme and the trial courses.

Materials for the course consisting of over 40 units were mainly Teachers' Guides. There were however, a few pupils' books and a science library series for background reading.

The emphasis of the APSP was the child and, by implication, a predominantly "open" classroom where the child's participation in what was to be learned was high (Yoloye, 1971). Although there were no clearly stated programme objectives, the APSP aimed at the development of the following characteristics in children:

(1) First-hand familiarity with a variety of biological, physical and man-made phenomena in the world around them.

(2) Interest in further exploration of the world around them on their own initiative.

(3) Ability to find out for themselves - to see problems and to be able to set about resolving them for themselves, and so on.

The project which began as an African continuation of the APSP is the Science Education Programme for Africa (SEPA).

With the establishment of Comprehensive High School, Aiyetoro in the sixties, a general science project, Basic Science for Nigerian Secondary Schools (BSNSS) was produced. The materials were developed for the Junior Forms of the

secondary schools and were printed in two volumes, in the form of Teacher's Guides for Form I and Form II. These books were prepared by members of the Science Department of the Comprehensive High School between 1962 and 1966, in collaboration with distinguished Nigerian and foreign educators. Over-all support was provided by the United States Agency for International Development and the Harvard Graduate School of Education.

The programme is a two-year, laboratory oriented, child-centred activity course, designed to make the pupils think rather than accept blindly what the teacher says. It aims at directly involving the pupils in activities and discussion questions so as to develop in them scientific attitude, manual competence and intellectual skills. This represented a major departure from the traditional method of teaching science in Nigerian Secondary Schools in which the emphasis had been on rote learning and stuffing the pupils' brains with a lot of facts (Somade, 1973).

The Philosophy of the programme is "Doing Science the way the scientists do it" - observing carefully, reporting honestly what is observed and being patient. To underscore this, the programme is broken up into pupils' activities, that is, the pupils would actually be "doing" science, not learning about science. Each activity is followed immediately by suggested observations of anticipated pupils behaviour, thus providing a basis for evaluating the effectiveness of

the activity. A two-year pilot trial feedback conference was held and the two volumes of Teacher's Guides combined into a single volume. Although the programme did not take off beyond trial phase, it was generally acknowledged that BSNSS was the first integrated science course to be used in Nigerian Secondary Schools. The NISP has a philosophy similar to this.

A programme which began as an off-shoot of the APSP is the Yoruba Six-year Primary Project. This project which was conceived by Prof. Babs Fafunwa, was launched in January 1970. It was sponsored by the Institute of Education, University of Ife, with aid from the Ford foundation and Carnegie corporations. In realization of the importance of the mother-tongue as the medium of education, the programme was developed with Yoruba as the medium of instruction throughout the six-year primary course, with English as a second language taught from primary one to primary six. It decided to educate the children in five broad curriculum areas:

(1) Science

(2) Mathematics

(3) Social and Cultural Studies

(4) Yoruba as language and literature

(5) English as a second language

Books were made available to Primary One to Six as pupils texts and Teachers' Manual. Materials for the science course began with familiar objects, utensils, chemicals, etc used in

the kitchen, home and surroundings. This orientation is similar to that of the STAN biology which has been written with our own peculiar culture and environmental conditions in mind. Examples in the STAN biology have been chosen to illustrate the Nigerian and African environment.

The Ife project was a six-year experiment, and the proponents are convinced that African children and Africa for that matter will be better off if her children are educated in their mother tongue during the first twelve years of life" (Fafunwa, 1983).

A science curriculum project on a state-wide scale was the Mid-West (Bendel) State Primary Science project. For children to be part of the developmental changes going on around them, it was felt that they should learn more science and better science. To achieve this, the Mid-western state of Nigeria (now Bendel), decided in 1966 to include science in its Primary School curriculum. Work on the Primary Science Project started in 1966 - 67 with the co-operation of Peace Corps volunteers, UNICEF and UNESCO but could not be continued due to the national crisis. Thus actual work to develop science curriculum for primary schools started in 1968 - 69.

The development of a science syllabus and teaching materials started in the later part of 1968 under the overall guidance of a full-time Staff Inspector (Science) appointed by the Ministry. The panel assigned this job was assisted by

a UNESCO Science Adviser. The objectives of the programme were to develop in children:

(a) a habit of keen observation

(b) an attitude of inquiry

(c) the habit of exploring, experimenting and recording data

(d) basic concepts of cause and effect

(e) an appreciation of the usefulness of cooperative group work. (See Science is Discovering, 1972 pg. 1 and 2).

In essence, the science curriculum is expected to help accelerate the development of certain basic scientific concepts among the children and the attainment of the processes of science. This is similar to the STAN programmes which emphasize attainment of certain intellectual "skills". The writers of the MPSP advocated that activities should be structured to lead to discoveries, and as such, their books were titled "Science is Discovering".

The books were tested in 100 experimental schools under a pilot project and were later revised on the basis of the feedback. A Science Curriculum Development Centre was established in November, 1971 at Abraka, and with it a Permanent In-Service Training Centre. A science kit to go with the books was developed at the Science Curriculum Development Centre. Science was made compulsory in all

Grade II teachers training colleges to produce teachers for the programme.

A major curriculum innovation with wide coverage is the Primary Education Improvement Programme (PEIP). This project which started in 1970 was co-ordinated by the Institute of Education, A.B.U., Zaria. It was sponsored by UNESCO/UNICEF and implemented in primary schools in the northern states. The Primary Science Programme is part of this project to improve the quality of Primary education in the then six northern states of Nigeria (See Kolawole, 1980).

In 1971, the writers of the PEIP materials in science decided to adopt a "process approach" to the teaching of science in primary schools. This decision followed the NERC recommendations of process approach teaching (NERC, 1971). The PEIP science concentrated on involving the children and the teachers in activities which provided opportunities to practise process-type skills such as observation, classification, measuring, etc. They wrote out pupils' texts and Teachers Guide. Accompanying Primary Science One was a science kit of simple equipment which was supplied by UNESCO/ UNICEF (See Primary Science One 1972). Emphasis on equipment has deliberately been on local, easily available materials like buttons, empty tins and jars, matchboxes, etc. The materials were tried out in 66 pilot schools and teachers and the mobile teacher trainers provided the Institute with feedback. Consequently, some of the materials were re-written.

The pilot phase lasted from 1971 - 1974 and the expansion phase from 1974 - 1978.

In response to WAEC's request in 1968 that STAN should develop syllabuses for Biology, Chemistry and Physics suitable for the upper classes of the secondary schools STAN set up Curriculum Development Committees to study the materials available world-wide and to come up with recommended syllabuses for the country.

In 1968, the Comparative Education Study and Adaptation Centre (CESAC) was established at the University of Lagos, with a grant from the Ford Foundation. Its function is to introduce change and innovation into the educational system through curriculum development and renewal. Since its inception, the centre has concentrated on curriculum development for secondary schools. They have adopted the STAN syllabus for a Project - the Nigerian Secondary Schools Science Project (NSSSP).

The project, which started in 1970 has Biology, Chemistry and Physics versions. For each version there are "Students Text" and "Teacher's Guide". The students text serves as a laboratory book and provides discussion of the science that the experiments reveal. Often the student is led through this discussion by suitable questions designed around the experiments. By providing many student activities, the books serve a major purpose of a science course, namely experimentation

through personal involvement of the learners. It is hoped that the increased student participation will result in a significant change of attitude and feeling towards science, and will promote curiosity and the acquisition of technical skills (see Nigerian Secondary Schools Science Project, 1970).

The writers of the projects have tried in their work to stimulate the child to study as much science as possible in his locality, at home, in the farm and in the playing fields. Examples have therefore been drawn largely from the Nigerian environment. They have suggested the use of inexpensive, easily available improvised apparatus for most of the experiments. It is hoped that the child will from this relate the science learnt in school to his/her everyday life. This project has used the same syllabus (drawn up by STAN for the upper classes of the secondary schools) as the STAN biology programme. The NSSSP Biology should therefore have a lot in common with the STAN biology programme. The STAN biology also emphasizes the use of the Nigerian environment, and so on.

The NSSSP went through several critique conferences and field testing in order to obtain feedback and assessment of the materials. Appropriate in-service courses on the project had taken place in order to acquaint the teachers with the objectives of the project.

The STAN Curriculum Development Committees, in their attempt to review the WAEC syllabuses for the upper classes of the Secondary schools as requested by WAEC in 1968, felt

there was need to have a balanced nationally uniform science background in the junior forms if their efforts were to be meaningful. They therefore decided to draw up a basic science course for the first two years of the secondary school. Work on the separate science disciplines of Physics, Chemistry and Biology" was followed by joint sessions of representatives from the three committees to make an attempt at integration of those disciplines" (Oyewole, 1971). This is what resulted in the Nigerian Integrated Science Project (NISP).

By 1972, the NISP materials, consisting of Pupils' Textbooks and Teacher's Guides were published and introduced into the schools without pilot-testing. Like the PEIP, the NISP followed the NERC guidelines of Process Approach teaching. The essence of the programme, according to the writers is to teach students what science is and how a scientist works. This implies developing in the students a series of "skills" the scientist requires to carry out his work - like observing, reporting accurately what is observed, organizing information acquired, etc.

With the introduction of the new 6-3-3-4 system in the Nigerian National Policy on Education, there was urgent need to revise the materials to cater for the three years of the Junior Secondary School (J.S.S.). A core-curriculum for Integrated Science at the Junior Secondary School developed by the Federal Ministry of Education with the assistance of a group of Nigerian Science Educators has formed the basis of

this revision. To ensure continuity with work done at the Junior Secondary School, teams of experienced teachers and educationalists drawn from the members of STAN have written relevant syllabuses and textbooks in the separate scientific disciplines of Biology, Physics and Chemistry for the Senior Secondary school.

The writers of the STAN biology text have tried to produce a course which is modern and relevant to the Nigerian student. To achieve this, they have included some new topics which will not be found in traditional biology textbooks. In accordance with our Green Revolution Scheme and now "Back to the land", special emphasis is placed on the importance of agriculture to the Nigerian society. To bring the study of biology nearer home and to be meaningful, examples have been chosen in the book to illustrate the Nigerian and African environment rather than rely on European examples which the students are not familiar with. Also, a chapter on science and superstition examines local superstitions and provides scientific explanations. To enhance a smooth transition from the junior secondary to the senior secondary science, there is some overlap of content with the STAN integrated science course (Nwana, 1983).

The aim of the STAN biology text is to present biology not as a body of scientific facts related to living things, but as a continuing activity in which man tries to find solutions to his never-ending problems. The book therefore

includes experimental results and describes the procedures adopted by research biologists in arriving at their findings. It is hoped that by the end of the course, the students will not only have a substantial understanding of biology, but would have developed a genuine appreciation of the inter-related nature of living things as well as a readiness to solve problems through application of the intellect. (See STAN Biology, 1983).

2.4 EVALUATION STUDIES

Innovations have taken large sums of public and private funds. Local, Federal and International bodies that are financing these efforts have become increasingly interested in the evidence concerning the returns on their investments (Lindvall & Cox, 1970). In addition, with the rapid changes in curriculum materials there has come a need for thorough evaluation to determine whether a programme is achieving the objectives for which it was designed. Therefore, evaluation increasingly became an integral part of any curriculum development process. Unfortunately, however, as Herron (1971) noted, independent evaluative efforts have lagged behind widespread adoption of the materials. For example, a detailed evaluation of the NISP was carried out by Jegede (1982) only after a decade of introduction of the materials in the schools. The task analysis of the STAN biology has been undertaken partly for these reasons. A lot of time, energy and resources

have been put in to produce this new programme. This study attempts to find out if the materials match the stated goals of the programme writers.

2.4.1 Forms of Curriculum Evaluation

Curriculum evaluation can take two main forms according to Scriven (1967). The first is the gathering of data while a programme is being developed. This is the kind of evaluation which guides and aids the development process and is termed formative evaluation. The task of formative evaluation is to provide the curriculum worker with a means of identifying what he is doing so that this can be compared with what he intended to do and to provide a basis for improvement. On the other hand, when an evaluational procedure is used to make some type of summary judgement or assessment on the overall worth or value of the finished product, it is termed summative evaluation.

The STAN biology programme did not go through a formative evaluation process. The type of evaluation reported in this study is largely summative in nature as it is not likely that any modification will be made to the text as a result of this evaluation. However, findings in this study will help guide the writers in subsequent revision exercises.

Hitherto, evaluation studies have limited themselves to the traditional evaluation method (called the "classical" or

"Agricultural-Botany" paradigm) which uses a hypothetico - deductive methodology derived from the experimental and mental-testing traditions in psychology (See Parlett, 1972). The most common form in this tradition is presented as an assessment of the effectiveness of an innovation by examining whether or not it has reached required standards on pre-specified criteria.

In recent times, new forms of evaluation have been developed. Evaluation studies have moved away from the traditional type to the method that relates to social anthropology, psychiatry and participant observation research in Sociology (Jackson, 1968). This constitutes a second and contrasting paradigm of evaluation called the social-anthropology paradigm. The term "illuminative evaluation" has been used (Parlett & Hamilton, 1976) to represent this new model of evaluation. Illuminative evaluation takes account of the wider contexts in which educational programmes function. Its primary concern is with description and interpretation rather than measurement and prediction. The aims of illuminative evaluation as outlined by its chief exponents Hamilton (1976), Parlett and Hamilton (1967) and Tawney (1976) are:

(a) to study how the innovatory programme operates;

(b) to study how it is influenced by the various school situations in which it is applied;

(c) find out what those directly concerned regard as its advantages and disadvantages;

(d) find out how students' intellectual tasks and academic experiences are most affected.

It aims to discover and document what it is like to be participating in the scheme, whether as teacher or pupil; and in addition, to discern and discuss the innovation's most significant features, recurring concomittants and critical processes. It seeks to address and illuminate a complex array of questions.

To illuminate and find out answers to some of these issues, writers of programmes have indicated the need for evaluation studies of the programmes they have developed. This need is even more urgent for programmes that did not go through a pilot-testing stage. For example, this was expressed by the writers of the NISE (See Osiyale, 1975). Moreover, as Bloom (1966) points out, "New curricula are not acts of faith - they represent new hypotheses which should be empirically tested before they become an accepted part of the educational programme.

In response to this call, a number of evaluation studies have been carried out in different parts of the world. Alexander (1974) carried out an evaluation of the Nuffield Secondary Science Project (See Section 2.3.2 Pg. 39-40).

This was neither a formative nor summative evaluation. The aims of this evaluation were to investigate three aspects of the effects of the use of the project materials:

(a) the concept of significance i.e. changes in the popularity of science

(b) the emphasis on pupil involvement i.e. changes in the degree of pupil participation and in teaching style, and

(c) the possibility of change in attitude to science on the part of pupils.

To find out the answers to these issues the evaluation strategy comprised:

(1) a questionnaire to ascertain whether there were any useful aspects which the teachers themselves could notice and which seemed likely to give evidence of the impact of the secondary science materials.

(2) The NFER Pupil Opinion Poll: Science No. 104 with pupils after one year of working with the science materials.

(3) Emphasis on pupil involvement was explored by the use of an observation schedule.

Among her findings, the evaluator concludes that, after one year of use of the Nuffield Secondary Science materials,

the teachers' interest in the secondary science materials had been maintained. The pupils' attitudes towards their teachers had improved and the teachers' style of teaching had been modified.

Harlen (1975) carried out an evaluation of Science 5 - 13. The role of the evaluation was to assist in the production of the units and other books. Its role can be described as essentially "formative" or "on-going", so from the very beginning the evaluation was an integral part of the project's development. This was intended to improve trial versions before final publication. The purpose of the evaluation was to find out "how well the materials help teachers to provide intended learning experiences and interact with the children according to the project's intentions". The evaluation materials consisted of Teachers' questionnaires and pupils' tests. Teachers taking part in the trial were asked to complete 3 forms:

Form A - mainly blank paper on which teachers were invited to write an account of relevant activities of the children during the trial period.

Form B - a questionnaire, mostly pre-coded, asking for information about the class and school, relevant biographical data about the teacher, and opinions of the book "With Objectives in Mind".

Form C,D,E, or F - questionnaires, mostly pre-coded but with provision for free responses as well, asking for information, opinions and suggestions about the unit. (One of these forms was completed according to which unit was being tried by the teacher).

Information about interactions in the classroom was recorded after informal observations during visits by team members.

Pupils' tests took the form of a film medium. The test items were written to detect the various kinds of behaviour described in the objectives. The film was "used to present a problem the solution of which calls, for instance, for ability to identify and manipulate variables, in a way which is clearer than a verbal description of the problem".

The results played a useful part in confirming that the general approach of the material was effective in promoting achievement of its stated objectives and the development of tests also had side benefits for the production of units. The results also indicated that it may be useful to produce materials for pre-school children to serve as a good

introduction of what the children would meet in the primary school.

Brown (1978) evaluated the PEIP science. The purpose of the study was to evaluate the attainment of the science objectives in terms of the children's ability to practise process skills. It also attempted to measure children's interest, active participation and understanding of the lessons, as well as the availability of materials and ease of preparing and teaching the lessons for the teachers.

Data was collected by means of teacher opinionnaires and a children's test to measure the attainment of process skills.

The results showed that teachers who completed the opinionnaires rated the programme as successful in terms of all the measured criteria. The study revealed that some teachers were not teaching science because of lack of science competency and a shortage of science materials. Results on the process test indicated that the children in PEIP schools performed better than their counterparts in non-PEIP schools after one year of primary school, but not after two years. It was also noted that girls in PEIP schools seemed to have profited more than the boys in terms of an improved ability to practise process skills.

Jegede (1981) carried out an evaluation study of the NISP. The study focused on the achievement of the Project

objectives as expressed by the teachers involved and determined by the performance in, and attitude towards Integrated science by the students. To gather data, a number of instruments were used viz: Integrated Science Teachers Questionnaires, the Nigerian Integrated Science Project Assessment Test (NISPAT), the Nigerian Integrated Science Project Attitude Scale Test (NISPAST), Readability Tests and Anecdotal Reports.

The results suggested that the Integrated Science teachers are not favourably disposed towards the project due to lack of appropriate training. It was also found that the cognitive objectives achieved are below expectations, but the majority of the students have developed positive attitudes towards science through the NISP. A significantly negative association between attitude to science and achievement in integrated science was however found. The results also showed that the majority of the students found the NISP books very difficult to understand and the readability indices of the books indicated that they are far too advanced for the students for whom they are meant.

The present study is in part an evaluation study to see if infact the new STAN Biology, particularly the tasks included for the students, is appropriate for the level it has been written.

2.5 CONTENT ANALYTICAL STUDIES

A powerful and yet economical approach to curriculum evaluation is content analysis. While analysis of the content of curriculum materials does not provide direct data on student growth, it does enable the researcher to ascertain the relationship between the actual materials and the stated goals of the curriculum developers and others (Tamir & Lunetta, 1981). Materials to be analysed in this kind of study could be textual materials, laboratory handbooks or guides or course handbooks. The task analysis study of the STAN biology text reported in this write-up is a content analytical study.

To use content analysis to find out the relationship between the actual materials and the stated goals, of the curriculum, several studies have been carried out. They have tried to determine the extent to which the objectives are incorporated in the actual structure of the textual materials. This is one of the objectives of the present study.

Herron (1971) examined textual materials of three of the new science courses - the CHEM study, PSSC Physics and BSCS Blue version. Laboratory exercises of the three courses were examined according to their content and their stated purpose. The purpose of this exercise was to determine the extent to which the course materials are inquiry-based.

Of the 41 regular laboratory exercises in the CHEM study, 24 or greater than 50% appeared to be of the illustrative - demonstrative type, 6 of the open-ended problem - solving variety and only 11, or roughly 25% are "discovery" exercises. Of the 52 PSSC laboratory activities classified on a 4-point scale of "openness", 39 or nearly 30% were judged to be at zero level i.e. activities in which problem area, methods of solution and "correct" interpretations are given. 11 were judged to be at the first level, 2 at the second level, and none at the third level. This meant there were no activities in which the problem as well as answer and method are left open i.e. real inquiry activities. Classification of the BSCS blue version on the 4-point scale showed 45 of the 62 laboratory activities are at the zero level. 13 are at level 1, 4 at level 2, and none at level 3.

2.6 TASK ANALYTICAL STUDIES

More specifically related to the study in this report are attempts at analysing the laboratory activities to determine the tasks and skill levels required of students in a programme. To do this, some have used direct observation method while others have used a task analysis technique. For example, Tamir (1977) carried out a study describing what is actually happening in the laboratories in terms of students engagement in inquiry. The purpose of the study was to find out by direct observation, what kind of experiences high

school biology laboratories offer at different grade levels, and to what extent the laboratory exercises are inquiry-oriented?

The findings showed that inspite of the growing awareness regarding the importance of the investigative laboratory, the laboratories observed in this study exemplified the traditional approach in which every measure is taken to ensure smooth and safe completion of the task by providing detailed instructions, by eliminating any difficulty, and by guarding the students against any "mistakes" that may lead them to obtain unpredicted results.

2.6.1 Task Analysis

The technique called Task Analysis is an outgrowth of Gagne's analysis of learning types. Gagne described learning hierarchies as patterns of learning tasks that lead up to a terminal skill: each subordinate task would be a pre-requisite for the task above it, and would mediate transfer for that task. He recognised the fact that instructional objectives at the concept, rule, and problem-solving levels depend upon the attainment of sub-behaviours and then the integration of these. He devised a method by which complex objectives can be analysed for instructional purposes, a method that consists of asking: "What must the student be able to do in order to meet the

terminal objective?" A task analysis helps the teacher identify the range of choices open for the sequencing of instruction. It does not however depict the sequence in which the student must use the pre-requisite skills in order to master the terminal objective. Gagne suggested that this hierarchy refers to intellectual skills i.e. intellectual skills are acquired hierarchically and specifically excluded verbalized knowledge from his hierarchy postulate.

2.6.2 What is a task?

The Webster's Third New International Dictionary defines a task as a specific piece or amount of work assigned by another and often required or expected to be finished within a certain time. In accomplishing the task one might engage in one or more activities.

Tasks are embedded in activities scheduled for students at the end or in the middle of the text of a chapter. In the case of the STAN biology the activities are found at the end of the chapter as mentioned in section 1.1 page 8. To determine whether the right type of activities are selected to enhance the teaching goals, evaluation studies have moved on to analyse the tasks and skill levels of the tasks by a technique of task analysis. The objectives of these studies are similar to that of Horton (1971) but with a different methodology.

Yoloye (1976, 1977) evaluated the African Primary Science Programme (APSP) in order to:

(1) Help to identify and describe in appropriate language, the curriculum developer's assumptions with respect to antecedents and intents with respect to transactions and outcomes.

(2) Design and use a variety of techniques and instruments to collect data with respect to the validity of these assumptions and the realization of the intents. The task of evaluation in this latter respect, however, went beyond merely checking whether intents were realized or not, to identifying unintended outcomes.

(3) Analyse the data collected and supply summary information to the curriculum developers, organizers, etc., to help in the process of decision-making.

The evaluation strategy comprised task analyses to determine the concepts which the units set out to teach, readability determination of the materials and summative evaluation of items regarding the outcome on children and teachers.

To know whether the objectives of the programme have been realized, units of the ABSP were analysed by Balogun (1971) and a lesson by Rowe (1968). This task analysis was to enable them identify the instructional objectives of the various components (sub-units) of the units, the concepts they seek to teach, the methods and teaching-learning strategies to be used in acquiring the concepts. In this particular context, Rowe proposed the following elements as the basis of the task analysis: concepts; experimental operations, observations; and logical operations; apart from the identification and specification of the instructional objective(s) for each topic/lesson. Further, Rowe provided not only an explanation of the above categories, but also how the task analysis might be done-using them (see Balogun, 1971, pg. iv - v).

This analysis, according to Balogun (1971) in his 'preface' (see pg i) was offered not as a finished product, but rather as a tentaive effort. As he rightly pointed out, somebody else might have done it differently, and that is what Tamir & Lunetta (1978) have done. The present study, although a Task Analysis, is also different from what Balogun and Rowe did. It has used the Laboratory Structure and Task Analysis Inventory developed by Tamir & Lunetta (1978).

Tamir & Lunetta (1978) attempted to follow and refine the kind of analysis of laboratory manuals performed by Herron.

They proposed what they considered to be a more refined scheme for analysing laboratory investigations and analysed the 3rd edition of the BSCS yellow version according to the proposed scheme. In trying to match laboratory activities with teaching goals, Lunetta & Tamir (1979) came up with a slightly different but similar instrument with which they carried out an analysis of two common laboratory investigations in Project Physics (Experiment 12) and BSCS Yellow version (Inquiry 9 - 1).

Other studies with similar objectives are those by Lunetta & Tamir (1980) in which they reviewed some of the goals for the laboratory in contemporary science teaching and reported a study that analyzed and compared laboratory activities in the 3rd edition of the PSSC Physics Laboratory Guide and Project Physics course Handbook.

Also Tamir & Lunetta (1981) reviewed and compared the results of content analysis studies of Laboratory Handbooks of selected high school science curricula. Very closely related to the study in this report is an attempt by Fuhrman, Lunetta and Novick (1982) to find out if Secondary School Laboratory Texts reflect the goals of the "new" science curricula. To do this they analysed laboratory handbooks of contemporary chemistry curricula in terms of the inquiry and problem-solving behaviours expected of students. The study in this

report has been concerned with the suggestions for practical work at the end of each chapter of the STAN biology text since there is no separate laboratory handbook. A very closely related study to the present one is that by Okebukola (1983). He carried out a comparative task analytical study of the old and revised versions of the Nigerian Integrated Science Project of STAN. The study described and compared the structure and skill levels of the tasks in the activities of the old and revised editions of the NISP. It particularly focused on assessing the extent to which the activities students engage in, in integrated science classes are pointedly enriching towards the acquisition of science process skills. The study here is concerned with the biology programme developed by STAN and it is assumed to be a continuation of work done in the NISP. An alalysis similar to the NISP one is relevant to find out if the same objectives and philosophy is carried through as stated by the writers of the two programmes.

While the objectives of the studies cited so far are similar, the different researchers have employed different methodologies.

While Herron (1971) examined textual materials and classified the laboratory activities on a four-point scale of "openness" other researchers thought of a more refined scheme. Tamir (1977) tried to find out by direct observation, what kinds

of experiences the laboratories offer in terms of providing students the opportunities to inquire about or discover things for themselves. While those did not provide any detailed checklist for a fairly objective analysis, Tamir and Lunetta (1978) came out with an attempt at such.

Tamir & Lunetta (1978) developed a 16-item instrument based on task analysis and a 4-item instrument that measures the degree of integration of the laboratory work with other components of the course. The 16 task categories include the inquiry skills and actual behaviours required to perform the prescribed laboratory work. With these instruments they analysed all of the 70 laboratory inquiries in the 3rd edition of the BSCS Yellow version. The proposed study is similar to this in that it is also an analysis of a biology text. Like the BSCS yellow version, the STAN biology is designed to integrate the laboratory work with the text: therefore both are included in the same textbook. The difference however, is that the present study proposes to use a later edition of the instrument with 24-items instead of sixteen. Tamir & Lunetta (1979) came up with 24 skills and behaviours culled from the literature, which are related to the processes of scientific inquiry and problem solving. With this instrument they carried out an analysis of the extent to which two commonly used laboratory investigations (Experiment 12 in Project Physics and Inquiry 9-1 in the BSCS Yellow version)

call for these students behaviours. They also analysed the two projects from the point of view of their organisation. The study at hand has used this final form of the Laboratory Structure and Task Analysis Inventory (LAI) to analyse the practical exercises in the STAN biology text.

Lunetta & Tamir (1980) reported a study that analysed and compared laboratory activities in Project Physics and PSSC Laboratory Guide. They identified 18 skills or behaviours from a variety of statements on the processes of scientific inquiry and problem-solving. A task analysis instrument was then prepared in terms of the actual behaviours required to perform the prescribed laboratory work. Other items were developed to identify the integration of the laboratory work with other components of the course. The methodology is the same with that of the present study except that here, an 18-item instrument is used. Tamir & Lunetta (1981) reported a study in which they reviewed and compared the results of content analysis studies of Laboratory handbooks of selected high school science curricula using the LAI. The science curricula reviewed are:

(1) BSCS Yellow version

(2) PSSC Physics

(3) Project Physics

(4) Modern Chemistry

(5) CHEM Study - Cotton et al (1973)
O'Connor et al (1973)
Parry et al (1975)

(6) Interdisciplinary Approaches to Chemistry.

The analysis involved all the laboratory exercises included in the handbooks of the curricula cited above. Task categories were divided into 6 sections of inquiry behaviours. In the present study they are divided into 4 sub-sections. The final form of the LAI which the present study has employed, has only been previously used with the five chemistry curricula. The physics and biology curricula were analyzed using earlier versions of the instrument.

A closely related study by Fuhrman, Lunetta & Novick (1982) analysed laboratory handbooks of contemporary chemistry curricula using the LAI. The chemistry curricula analysed are:

(1) CHEM study editions - Cotton et al
O'Connor et al
Parry et al.

(2) Modern Chemistry

(3) Interdisciplinary Approaches to Chemistry.

The laboratory exercises were examined to determine their organisation and the specific tasks required of students. In the analysis of organisation, they attempted to determine how the laboratory work was integrated with other parts of the chemistry course. Special analyses of 12 laboratory investigations in each of the 5 curricula involving common chemistry topics were also performed.

The present study intends to examine all the suggestions for practical work at the end of each chapter of the STAN biology text using the LAI and to examine the laboratory activity/ practical work organisation.

A study more closely related to the one in this report is the one by Okebukola (1983) on the NISP. The LAI was used for data gathering in both the NISP study and the present study.

In the first section of the instrument, examining laboratory activity organisation, sub-section D was deleted from the final version of LAI used in both studies because the behaviour measured by this category was judged to be inappropriate for local conditions. In the second section analysing laboratory tasks, all 24 categories were not used in the NISP study. Some were merged, leading to a final total of 20 categories. On the other hand, the present study has used all 24 categories as developed by Tamir & Lunetta (1978).

In the studies cited so far, results of the analyses have been expressed inpercentages. The total number of tallies for each behaviour category was divided by the total number of activities. This was then expressed as a percentage. The present study intends to find the percentages and go on to compare the proportions of the percentages.

2.6.3 Results of Task Analytical Studies

With regard to laboratory activity organisation, the results show that the BSCS yellow version is designed to integrate the laboratory work with the text. Laboratory inquiries are set to precede and are integrated with the text, thereby giving students opportunities to discover many things through inquiry (Tamir & Lunetta, 1978). This is however not the case with the NISP. According to Okebukola (1983) a good number of the activities follow the text in both versions. This is in spite of the fact that there are no separate laboratory handbooks. The curricula with separate laboratory handbooks not only reflect a low level of "integration" with the text but give little assurance that the laboratory activities will precede presentation of the concepts in the text (Tamir & Lunetta, 1981). On the whole the narrative suggests a division of tasks among groups of students facilitating pooling of results of the entire class, but little or no specific guidance is given regarding post-laboratory activities. Most of the activities in the NISP, it was found, require students to work individually, independent of others (Okebukola, 1983).

Results of the task analysis show that in most of the laboratory inquires students actually carry out observations, measurements and experiments, etc. However, analysis of the laboratory activities reveal that "In spite of the growing awareness of the importance of investigative inquiry for

science students, the laboratory handbooks generally exemplify a rather conventional approach in which the problems and the ways to perform the investigations are provided rather explicitly by the text (Lunetta & Tamir, 1980). The analysis implies that students commonly work as technicians, following explicit instructions and concentrating on the development of lower level skills (Lunetta & Tamir, 1979; Tamir & Lunetta, 1981). Detailed guidance is often given to eliminate difficulty and to guard against student "mistakes" that may lead students to obtain unanticipated results (Lunetta & Tamir, 1980). Similary, activities in both versions of the NISP are highly structured, providing detailed step by step instructions for students (Okebukola, 1983).

In general, the laboratory guides were found to be lacking in instructions and questions that might stimulate such inquiry activity as the formulation of hypotheses, the definition of problems, and the design of experiments. The consensus of the investigators is that the laboratory handbooks of contemporary curricula do not provide students with extended opportunities to investigate and to inquire, consistent with goals of communicating the method and spirit of scientific inquiry that have been espoused by science educators and by curriculum developers. (Tamir & Lunetta, 1981).

In summary, the analyses of laboratory handbooks and textual materials of the new curricula reviewed have identified similar deficiencies in the materials. They have therefore recommended that if these deficiencies are corrected, the full potential of the laboratory experiences will be realized with these programmes. In general they found that:

(1) Students do not identify and formulate problems or hypotheses.

(2) Students have relatively few opportunities to design ways and means for the conduct of investigations or work according to their own design.

(3) Students are not encouraged sufficiently to discuss limitations and assumptions underlying their experiments.

(4) Students are generally not encouraged to share their efforts in laboratory activities where that might be appropriate.

(5) Explicit provisions do not exist for post-laboratory discussions to ensure consolidation of findings and their meanings. Unless the laboratory instructions explicitly encourage such discussions for the processing of generalizations and alternative explanations, some of the potential

value of inquiry-oriented laboratory work may be lost (Tamir & Lunetta, 1978, Lunetta & Tamir, 1980).

The present study shall attempt to find out if all these stand true with the STAN Biology.

CHAPTER THREE

3.0 P R O C E D U R E

3.1 THE INSTRUMENT

The instrument used for the study was a modified form of the Laboratory structure and Task Analysis Inventory (LAI) (See Appendix 1 Page 155) developed by Tamir & Lunetta (1978). The LAI was found most appropriate for this study because the aim of the study was to analyse the tasks students are expected to be engaged in during the practical work phases of the new STAN Biology programme and the LAI was specifically designed to facilitate such an analysis (see Technical Report 14, 1978). The LAI yields a quantitative picture of the kinds of activities required of a student in performing laboratory investigations. The LAI reached its present form in work reported in Fuhrman (1978). The LAI has two primary sections. The first examines Laboratory Activity Organisation and consists of 14 categories in the following 4 sub-sections:

A. Structure(High-Low, Inductive, deductive)

B. Relation to text (precedes, follows, integrated).

C. Cooperation mode (common task-pool results, different tasks-pool results, post-lab discussion required).

D. Simulations ("dry" lab, simulated task, gathering data from secondary sources such as films, interactive simulation, e.g. with a computer).

Sub-section D above was deleted from the final form of LAI used because the behaviour measured by this category was considered inappropriate for the Nigerian situation and particularly for the objectives of the study. The second major section analyses Laboratory Tasks and consists of 24 categories in 4 sub-sections:

1. Planning and Design (formulates questions, predicts results, formulates hypotheses, designs observations, designs experiments).

2. Performance (carries out qualitative observations, carries out quantitative observations, manipulates apparatus, records results, performs calculations, selects experimental techniques, works according to self-design).

3. Analysis (transforms results into standard forms, determines qualitative relationships, determines quantitative relationships, determines accuracy of data, defines variables, limitations and assumptions, generalizes, explains relationships, formulates new questions).

4. Application (predicts on the basis of results, formulates hypotheses on the basis of results, applies experimental techniques to new problems).

3.2 PROJECT MATERIALS ANALYSED

The Science Teachers Association of Nigeria (S.T.A.N) Biology textbook was analysed using the LAI. The biology text has no laboratory handbook to go with it but has suggestions for practical work at the end of each chapter. The book has a total of twenty-two chapters, as follows:

Chapter

1 : Science and Life
2 : Classification of Living things
3 : Ecology
4 : Exchange and use of materials
5 : Nutrition
6 : Transportation
7 : Respiration and energy release
8 : Excretion
9 : Ecological inter-relationships
10 : Energy and material flow
11 : Movement and support in animals
12 : Regulation and coordination
13 : Reproduction
14 : Growth
15 : Heredity and variation
16 : Population
17 : Natural selection and evolution
18 : Health and disease
19 : Community health

Chapter

20 : Agriculture

21 : Population and conservation

22 : Science and superstition

The assumption underlying this analysis is that the suggestions for practical work are laboratory activities as mentioned in 1.3.

3.3 CODING AND ANALYSIS

The analysis involved all the suggestions for practical work included at the end of each chapter of the biology text mentioned above. Each suggestion was taken as one inquiry and coded using the LAI. For example Chapter 3 - Ecology has (a) i) ii) iii); (b) i) ii); (c) i) ii) iii) iv) v) and (d), making a total of 11 inquiries.

For the Laboratory Organisation categories (subsections A through C), one check was placed in each category according to the classification of activities. For the Laboratory Tasks Categories (subsections 1 - 4), a check was placed in the appropriate behavioural category if the instruction to the students called for it at least once. If a statement called for more than one activity, more than one check was made. For example in Chapter 3, inquiry b) i) requires the students to carry out quantitative observation or measurement, manipulate apparatus, record results, and perform numeric calculations.

Accordingly, a total of 4 checks were placed for that activity. To establish coding reliability, two independent coders who reached 80% agreement using the LAI adjudged the ticks to be correct. Each task, not each statement, in the "suggestions for practical work" was coded; a group of statements may be interpreted as one task. The total number of tallies in each chapter, and for the whole book, was divided by the total number of activities and expressed as a percentage.

The tasks expected to be carried out by students were broadly classified as:

1) those requiring low level skills and
2) those requiring higher order skills.

This classification is derived from Bloom's Taxonomy of Educational Objectives which classifies objectives in the cognitive Domain into six well-defined levels of learning which increase in difficulty and complexity.

3.4 WHAT ARE LOW LEVEL SKILLS?

According to Bloom (1956), knowledge of specifics which may involve recall of specific and isolable bits of information, identification or recognition of facts, theories, etc., represent the lowest level of learning. The requirement is the ability to bring to mind the appropriate information. The next level in this taxonomy is comprehension which is the ability to grasp the meaning of phenomena, translate them,

and to add more information or material about them. At this level there is some transformation of the original material or information. Examples of this type of learning are explaining situations, summarizing passages, interpreting numbers or maps and estimating future trends. Comprehension represents the lowest level of understanding.

3.5 HIGHER ORDER SKILLS

The ability to utilize learned material or information in new situations is considered a higher order skill relative to recall and understanding. This may involve the application of rules, formulae, etc. It may also involve using learned material to solve certain problems, or to explain certain events or phenomena. A higher order than application is analysis which is the ability to separate or breakdown the material into its component parts for better understanding or appreciation. Then comes synthesis which is the ability to put parts or components or materials together to form a new whole. At this level, innovation, inventions or creation arising from insight, ingenuity, etc. are made. Lastly, and highest in complexity is evaluation which is concerned with the ability to judge the value of materials. Judgement is not just personal opinion but one that is based on clearly defined criteria.

In line with this taxonomy, Fuhrman et al (1979) gave a gradation of the activities in their Task analysis into:

(1) Lower order activities, and

(2) Higher order activities.

The activities in this study were broken down into the component sub-sections of the task analysis instrument, and further graded into Lower order activities and Higher order activities following the Fuhrman et al (1978) gradation. (see Table 9 in Chap. 4).

3.6 DATA ANALYSIS PROCEDURE.

There are usually several statistical techniques available for analysing any given set of data. The decision as to which type of statistical treatment is most appropriate for the study was taken after considering the type of data collected and the kinds of questions that were asked of the data.

The decision was to sum up the tallies for each organizational category and express these in percentages or proportions of the total number of practical activities. Simple proportions were used for comparison because the data do not come from independent samples. Notional conclusions were then arrived at intuitively. To establish the significance of the differences between the proportions, the F-test for analysis of variance was computed. This assumes that the data give a normal distribution. This was the best that could be done with the available data.

For the task categories, the behaviours were clustered according to the 4 sub-sections of the instrument. The mean for each cluster was calculated and a comparison of the means was done. This was further subjected to an F-test for the analysis of variance to give an indication of the extent to which these means differe The aim of the analyses is to compare two sets of data to see if there is a difference. The t-test is usually appropriate for this purpose. However, the t-test is more appropriate to data concerning only 2 variables. Since the variables in the set of data to be analysed here are in some cases more than 2, the F-test for the Analysis of variance was considered more suitable.

The ANOVA is a procedure which makes it possible to compare the effects of the variables being studied, first independently of the effects of all other variables, and second in all possible combinations with one another. It will tell if a particular factor has an effect and if this apparent effect is real. In this case it will tell if the apparent differences between the variables are real.

The data in Table 2 were fed into the computer to give the ANOVA with respect to the approach of the text, relation to text and the cooperative mode adopted in the programme. The significance of the F-value was read off from a table of F-values. The same was done with data in Table 3 to compare the different skill levels in the programme. With respect to structure of the practical activities in the programme, the Binomial test was carried out to ascertain the significance of the difference between the number of activities that are highly structured and those that are "open-ended". For this calculation, the raw figures in Table 1 for structure were used. The Mann-Whitney U-test was used to find the difference between High level and Low level activities.

Furthermore, a chi-square analysis was carried out to test the differences between the Biology programme that is the focus of this study, and its predecessor, the NISP.

CHAPTER FOUR

4.0 RESULTS AND ANALYSIS OF DATA

4.1 INTRODUCTION

This chapter contains the results obtained from the research study. These include findings on the Laboratory activity/practical work organisation and analysis of the tasks students are expected to be engaged in when carrying out the practical work in the new STAN Biology text as revealed by entries in the two sections of LAI.

Each of the 113 practical exercises in the book may expect students to carry out several activities or behaviours (at least more than one). Since these activities fall within various subsections, it follows that the activities are neither mutually exclusive nor independent between subsections. It appears, however, that the functions are mutually exclusive, even though their being independent is not likely. For example, to carry out behaviour category 2.6, that is "Work according to own design", one is expected to have performed 1.4 "Design observation or measurement procedure" or 1.5 "Design experiment". The mutual exclusiveness of the functions cannot be clearly established. However, they may be assumed to be mutually exclusive purely to facilitate the analysis. Hence any comparison of subsections would be done in terms of functions or behaviours rather than activities.

The presentation of the results has been done to show the organization and intergration of the practical work in the programme and the skill level of tasks required of the students by the practical activities. Furthermore, a gradation of the skills required in carrying out the practical activities was done. Finally, a testing of the hypotheses was done.

TABLE 1

Organization and Integration of the Practical Activities in the STAN Biology Programme

ORGANIZATIONAL CATEGORIES	SUGGESTIONS FOR PRACTICAL WORK — CHAPTER — No. of Practical Activities																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total	%
	7	1	11	8	7	8	8	6	4	2	9	7	9	3	3	2	3	3	4	3	3	2	113	
A. STRUCTURE.																								
1. High-degree	6	-	5	6	4	8	7	4	3	-	6	7	7	3	2	1	-	-	2	-	3	-	74	65.5
2. Low-degree i.e. open	1	1	6	2	3	-	1	2	1	2	3	-	2	-	1	1	3	3	2	3	-	2	39	34.5
3. Inductive approach	4	-	8	8	7	8	8	6	4	2	8	7	8	3	2	2	2	3	3	3	3	2	101	89.4
4. Deductive approach	3	1	3	-	-	-	-	-	-	-	1	-	1	-	1	-	1	-	1	-	-	-	12	10.6
B. RELATION TO TEXT.																								
1. Precedes text	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0.0
2. Follows text	7	1	11	8	7	8	8	6	4	2	9	7	9	3	3	2	3	3	4	3	3	2	113	100
3. Integrated with text	1	1	5	2	2	3	3	1	-	-	4	1	5	1	2	-	-	-	1	-	-	-	32	28.3
C. COOPERATIVE MODE.																								
1. Students work on common task and pool results,	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	2	1.8
2. Students work in pairs	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	1.8
3. Students work individually	7	1	11	7	7	8	8	6	4	2	9	5	9	3	2	2	3	3	4	3	3	2	109	96.4
4. Post-lab discussion required	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0.0

Table 1 presents data related to the organization and integration of the laboratory/practical work within the course. It presents the relative numbers of practical activities given in each chapter as well as their organization. It shows that there are more highly structured activities (65.5%) than there are low-degree or open-ended ones (34.5%). The table also shows that all the practical activities follow the text (100%), while a few are integrated with the text (28.3%). For almost all the activities, students are expected to work individually (96.4%), with very little pooling of results or group work. Also, for a greater part of the time, students are made to adopt an inductive approach (89.4%) in carrying out proffered tasks.

TABLE 2

Organization and Integration of the Practical Activities in the STAN Biology Programme

Derived Table of Percentages.

ORGANIZATIONAL CATEGORIES.	SUGGESTIONS FOR PRACTICAL WORK																						Total
	C H A P T E R																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
A. STRUCTURE.	No. of Practical Activities																						
	7	1	11	8	7	8	8	6	4	2	9	7	9	3	3	2	3	3	4	3	3	2	
1. High-degree	85.7	-	45.5	75.0	57.1	100	87.5	66.7	75	-	66.7	100	77.8	100	66.7	50	-	-	50	-	100	-	54.7
2. Low-degree i.e. open	14.3	100	54.5	25.0	42.9	-	12.5	33.3	25	100	33.3	-	22.2	-	33.3	50	100	100	50	100	-	100	45.3
3. Inductive approach	57.1	-	72.7	100	100	100	100	100	100	100	88.9	100	88.9	100	66.7	100	66.7	100	75.0	100	100	100	
4. Deductive approach	42.9	100	29.2	-	-	-	-	-	-	-	11.1	-	11.1	-	33.3	-	33.3	-	25.0	-	-	-	
B. RELATION TO TEXT																							
1. Precedes text																							
2. Follows text	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
3. Integrated with text	14.3	100	45.5	25.0	28.5	37.5	37.5	16.7	-	-	44.4	14.3	55.6	33.3	66.7	-	-	-	25	-	-	-	
C. COOPERATIVE MODE																							
1. Students work on common task and pool results.	-	-	-	-	-	-	-	-	-	-	-	14.3	-	-	33.3	-	-	-	-	-	-	-	1.8
2. Students work in pairs	-	-	-	12.5	-	-	-	-	-	-	-	14.3	-	-	-	-	-	-	-	-	-	-	1.8
3. Students work individually	100	100	100	87.5	100	100	100	100	100	100	100	71.4	100	100	66.7	100	100	100	100	100	100	100	94.4
4. Post-lab discussion required																							

Table 2 presents derived percentages of the data related to the laboratory structure and organization. It shows the percentages of practical activities in each chapter of the book and the percentage of activities per chapter that occur in each organizational category. This affords an opportunity to compare the chapters and see how each calls for the different organizational categories.

TABLE 3

Results of Task Analysis of the Practical Activities in the SPAN Biology Programme

SECTION 2: LABORATORY OR PRACTICAL TASKS

2.0 PLANNING AND DESIGN	SUGGESTIONS FOR PRACTICAL WORK — CHAPTER																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
A. The Suggested Practical Work	No. of Practical Activities																						
i) Formulates a question or problem to be investigated	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
ii) Predicts experimental results	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
iii) Formulates hypothesis to be tested in this investigation	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
iv) Designs observation or measurements procedure	–	–	3	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	1	3	–	–	10
v) Designs experiment	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
PERFORMANCE																							10
The suggested practical work expects students to																							
i) Carry out qualitative observation	6	1	3	7	6	7	6	5	4	2	9	6	8	2	2	1	3	3	3	3	3	–	90
ii) Carry out quantitative observation or measurement	–	–	10	1	3	3	3	3	1	–	–	1	1	2	2	1	2	–	2	2	1	1	39
iii) Manipulate apparatus, develop technique	7	–	11	8	4	8	6	6	3	1	7	6	6	3	2	1	3	3	2	1	3	–	91
iv) Record results, describe observation	2	–	10	8	7	5	5	4	3	2	3	4	4	2	3	2	2	1	2	1	2	1	75
v) Perform numeric calculations	–	–	9	1	3	2	3	3	1	–	–	1	1	1	2	1	–	–	1	–	–	–	29
vi) Explain or make decisions about experimental technique	2	–	–	–	–	1	–	–	–	1	3	3	1	1	1	1	–	2	2	–	–	–	18
vii) Work according to own design	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
ANALYSIS																							342
i) Transform results into standard form (other than graphs)	3	–	–	1	–	2	–	2	–	–	3	1	5	2	–	–	–	–	–	–	–	–	19
ii) Graph data	–	–	–	–	–	–	–	–	–	–	–	1	1	1	1	1	–	–	–	–	–	–	5
iii) Determine qualitative relationships	1	1	2	6	1	4	4	1	1	2	4	3	–	–	1	1	3	–	2	–	–	–	37
iv) Determine quantitative relationships	–	–	1	–	–	1	–	1	–	–	–	–	–	–	1	1	–	–	1	–	–	–	6
v) Determine accuracy of experimental data	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
vi) Define or discuss limitations and/or assumptions that underline the experiments	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
vii) Formulate or propose a generalization or model	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
viii) Explain a relationship	–	–	1	–	3	3	1	–	1	2	4	3	1	–	–	2	2	2	1	–	–	–	26
ix) Formulate new question or define project based upon result of investigation	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
APPLICATION																							93
i) Predict based upon results of own investigation	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
ii) Apply principles to new situations	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
iii) Design experiments to test predictions	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 3 presents the results of the task analysis of the practical activities which students are expected to carry out. It shows that for a greater part of the time in the practical sessions, students are required to manipulate apparatus (91 out of a total of 446 tallies i.e. 20.4%), and carry out qualitative observation (90 out of 446 i.e. 20%). They quite often record results and describe observations i.e. in (75 out of 446 i.e. 16.8% of the activities). A look at the 4 sub-sections shows that students more often carry out activities in the performance zone (342 out of 446 i.e. 76.6%) and in 93 out of 446 times i.e. 21.0%, they carry out activities in the Analysis and Interpretation domain. They perform fewer activities requiring planning and design (10 out of 446 i.e. 2.2%), and rarely any in the Application level (just one activity). The table also shows the occurrence of these behaviours chapter by chapter.

TABLE 4

Results of Task Analysis of the Practical Activities in the SPSS Biology Programme

Derived Table of Percentages.

SECTION 2: LABORATORY OR PRACTICAL TASKS

2.0 PLANNING AND DESIGN	SUGGESTIONS FOR PRACTICAL WORK — CHAPTER																						
A. The Suggested Practical Work	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
	No. of Practical Activities																						
i) Formulates a question or problem to be investigated	7	1	11	8	7	8	8	6	4	2	9	7	9	3	3	2	1	1	1	1	1	1	111
ii) Predicts experimental results	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
iii) Formulates hypothesis to be tested in this investigation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
iv) Designs observation or measurements procedure	-	-	27.3	-	-	-	-	-	-	-	-	-	-	-	66.7	-	33.3	-	25.0	100	-	-	
v) Designs experiment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PERFORMANCE																							
The suggested practical work expects students to																							
i) Carry out qualitative observation	87.7	100	27.3	87.5	85.7	87.5	75.0	83.3	100	100	100	85.7	88.9	66.7	66.7	50.0	100	100	75.0	100	100	-	
ii) Carry out quantitative observation or measurement	-	-	90.9	12.5	42.9	37.5	37.5	50.0	25.0	-	-	14.2	11.1	66.7	66.7	50.0	66.7	-	50.0	66.7	33.3	50.0	
iii) Manipulate apparatus, develo technique.	100	-	100	100	57.1	100	75.0	100	75.0	50.0	77.8	85.7	66.7	100	66.7	50.0	100	100	50.0	33.3	100	-	
iv) Record results, describe observation	28.5	-	90.9	100	100	62.5	62.5	66.7	75.0	100	33.3	57.1	44.4	66.7	100	100	100	66.7	50.0	33.3	66.7	50.0	
v) Perform numeric calculations	-	-	81.8	12.5	42.9	25.0	37.5	50.0	25.0	-	-	14.2	11.1	33.3	66.7	50.0	-	-	25.0	-	-	-	
vi) Explain or make decisions about experimental technique	28.5	-	-	-	-	12.5	-	-	-	50.0	33.3	42.8	11.1	33.3	33.3	50.0	-	66.7	50.0	-	-	-	
vii) Work according to own design	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ANALYSIS.																							
i) Transform results into standard form (other than graphs)	42.8	-	-	12.5	-	25.0	-	33.3	-	-	33.3	14.2	55.6	66.7	-	-	-	-	-	-	-	-	
ii) Graph data	-	-	-	-	-	-	-	-	-	-	-	14.2	11.1	33.3	33.3	50.0	-	-	-	-	-	-	
iii) Determine qualitative relationships	14.2	100	18.2	75.0	14.3	50.0	50.0	16.7	25.0	100	44.4	42.8	-	-	33.3	50.0	100	-	50.0	-	-	-	
iv) Determine quantitative relationships	-	-	9.1	-	-	12.5	-	16.7	-	-	-	-	-	-	33.3	50.0	-	-	25.0	-	-	-	
v) Determine accuracy of experimental data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
vi) Define or discuss limitations and/or assumptions that underline the experiment.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
vii) Formulate or propose a generalisation or model.	-	-	9.1	-	42.9	37.5	12.5	-	25.0	100	44.4	42.8	11.1	-	-	100	66.7	66.7	25.0	-	-	-	
viii) Explain a relationship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ix) Formulate new questions or define problem based upon result of investigation.																							
APPLICATION.																							
i) Predict based upon result of this investigation.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ii) Formulate hypothesis based upon results of this investigation.	-	-	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
iii) Apply experimental technique to new problem or variable.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 4 presents derived percentages of the results of the task analysis of the practical activities. It gives a picture of the percentage occurrence of the different behaviours per chapter. This tells what kinds of behaviours are emphasized in each chapter.

TABLE 5

Laboratory Task Analysis Summary Percent of Total "Experiments" in which The Activity Occurs.

TASK CATEGORIES	No. of Activities	Percent
Planning & Design		
A. The suggested practical work		
i) Formulates a question or problem to be investigated	0	
ii) Predicts experimental results	0	
iii) Formulates hypothesis to be tested in this investigation.	0	
iv) Designs observation or measurements procedure	10	2.2
V) Designs experiment	0	
PERFORMANCE	10	2.2
B. The Suggested practical work expects students to		
i. carry out qualitative observation	90	20.2
ii. carry out quantitative observation or measurement.	39	8.7
iii. Manipulate apparatus, develop technique	91	20.4
iv) Record results, describe observation	75	16.8
v) Perform numeric calculations	29	6.5
vi) Explain or make decisions about experimental technique	18	4.0
vii) Work according to own design	0	0
ANALYSIS & INTERPRETATION	342	76.6
i) Transform results into standard form (other than graphs)	19	4.3
ii) Graphs data	5	1.1
iii) Determine qualitative relationships	37	8.3
iv) Determine quantitative relationships	6	1.3
v) Determine accuracy of experimental data	0	0
vi) Define or discuss limitations and/or assumptions that underline the experiment.	0	0
vii) Formulate or propose a generalization or model.	0	0
iii) Explain a relationship	26	5.8
ix) Formulate new questions or define problem based upon result of investigation.		
APPLICATION	93	21.0
i) Predict based upon result of this investigation	0	
ii) Formulate hypothesis based upon results of this investigation.	1	0.2
iii) Apply experimental technique to new problem or variable.	1	0.2
GRAND TOTAL	446	

Table 5 presents a Task Analysis Summary. It presents the percent of total "experiments" in which a particular behaviour occurs. The Table shows that for 76.6% of the activities, students carry out performance activities. Of this total, 20.4% requires manipulation of apparatus, and 28.9% requires them to carry out qualitative/quantitative observation. Of the remaining 23.4% of the activities, 21.0% of the activities require them to function in the Analysis and Interpretation level. For only 2.2% of the activities are they expected to carry out any task that will require them to engage in any form of planning and design. A negligible 0.2% requires them to perform in the Application level.

TABLE 6

Breakdown of Skills in the STAN Biology Programme

TASK CATEGORIES.	No. Of Activities
1.0 Planning & Design.	
i) Formulates a question or problem to be investigated	0
ii) Predicts experimental results	0
iii) Formulates hypothesis to be tested in this investigation.	0
iv) Designs observation or measurements procedure	10
v) Designs experiment	0
	10
2.0 Performance	
a) The Suggested practical work expects students to	
i) carry out qualitative observation	90
ii) carry out quantitative observation or measurement.	39
iii) Manipulate apparatus, develoop technique	91
iv) Record results, describe observation	75
v) Perform numeric calculations	29
vi) Explain or make decisions about experimental technique	18
vii) Work according to own design	0
	342
3.0 Analysis & Interpretation	
Observational	
i) Transform results into standard form (other than graphs)	19
ii) Graphs data	5
iii) Determine qualitative relationships	37
iv) Determine quantitative relationships	6
v) Determine accuracy of experimental data	0
	67
Interpretational	
vi) Define or discuss limitations and/or assumptions that underline the experiment.	0
vii) Formulate or propose a generalization or model	26
viii) Explain a relationship	0
ix) Formulate new questions or define problem based upon result of investigation	0
	26
4.0 Application.	
i) Predict based upon result of this investigation	0
ii) Formulate hypothesis based upon results of this investigation	1
iii) Apply experimental technique to new problem or variable.	0
	1

Table 6 shows a breakdown of the skills that the students are expected to develop while carrying out the practical work (see Technical Report pg.30). Of a total of 446 tallies, only 10 require students to perform activities in the planning and design zone. All 10 require them to design observation or measurement procedure, and none in the other behaviour categories. A total of 342 activities require students to carry out performance activities. In the Analysis and Interpretation subsection 93 activities are recorded. Of these, 67 could be classified as observational activities and 26 activities call for performance that requires interpreting. Only one activity calls for performance in the Application realm. This one activity requires students to formulate hypothesis based upon results of this particular investigation and nowhere are they expected to apply a learned technique to a new problem.

Table 8, 10, 11 and 12 are ANOVA summary tables with respect to the skill levels required, the Approach, Relation of Laboratory activities to text and the cooperative mode required of the activities in the STAN Biology programme. The first column gives the source of variation, the next the sum of squares, Degrees of freedom, mean squares, F-value and the significance level.

TABLE 7

Table Comparing the Means of Skills in the STAN Biology Programme

	Treatment Variable	Chapters	Means
1.	Planning & Design	22	1.545
2.	Performance	22	23
3.	Analysis & Interpretation	22	3.5
4.	Application	22	.09

Table 7 shows a comparison of the means of activities in the various skill levels. There is apparently not much difference between the means for level (1) Planning & Design, (3) Analysis & Interpretation, and (4) Application. The difference is between these three levels and (2) Performance level. This accounts for the significant difference found in the Anova summary table below.

TABLE 8

Anove Summary Table Comparing the Means of Skills.

Source of variation	Sum of squares	Df	Mean squares	F	Significance Level
Between groups	7606.13	3	2535.38	42.827*	0.001 0.0001
Within groups	4972.77	84	59.199		
TOTAL	12578.9	87			

*P < 0.01

Table 8 displays an ANOVA summary comparing the means of the skills. There is apparently no significant difference in the means of activities in levels (1) Planning and Design, (3) Analysis and Interpretation, and (4) Application. There is however a remarkable difference in the means of activities in these three levels and (2) the Performance level.

The analysis of variance gives an F-value of 42.827 ($P < 0.01$). This value is significant at the 0.1% level.

TABLE 9

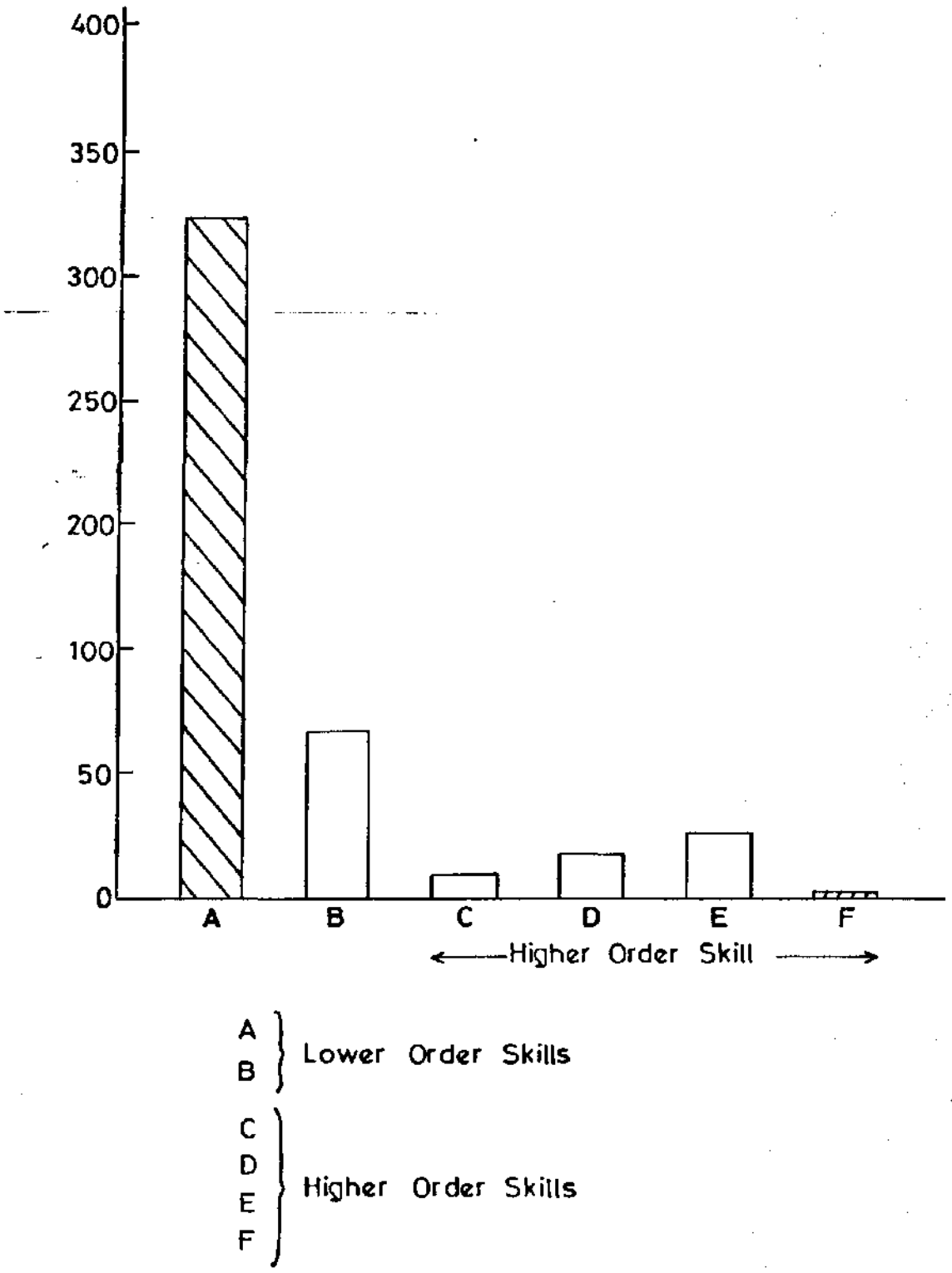
Table of Gradation of Skills in the STAN Biology Programme

		No. of Activities
1.	Lower Order Skills/Activities	
A.	2.0 PERFORMANCE	
	2.1a Carry out qualitative observation	90
	2.1b Carry out quantitative observation	39
	2.2 Manipulate apparatus, develop technique	91
	2.3 Record results describe observation	75
	2.4 Perform numeric calculations	29
	2.5 Work according to own design	0
		324
B.	3.0 ANALYSIS & INTERPRETATION	
	3.1a Transform results into standard form (other than graphs)	19
	3.1b Graphs data	5
	3.2a Determine qualitative relationships	6
	3.3 Determine accuracy of experimental data	0
		67
2.	Higher Order Skills/Activities	391
C.	1.0 Planning & Design	
	1.1 Formulates a question or problem to be investigated	0
	1.2 Predicts experimental results	0
	1.3 Formulates hypothesis to be tested in this investigation	0
	1.4 Designs observation or measurement procedure	10
	1.5 Designs experiment	0
		10
D.	2.0 PERFORMANCE	
	2.5 Explain or make decisions about experimental technique	18
		18
E.	3.0 ANALYSIS & INTERPRETATION	
	3.4 Define or discuss limitations and/or assumptions that underlie the experiment.	0
	3.5 Formulate or propose a generalization or model	0
	3.6 Explain a relationship	26
	3.7 Formulate new questions or define problem based upon result of investigation	0
		26
F.	4.0 APPLICATION	
	4.1 Predict based upon result of this investigation	0
	4.2 Formulate hypothesis based upon results of this investigation	1
	4.3 Apply experimental technique to new problem or variable	0
		1
		55

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Table 9 presents a gradation of the skills required of students in the biology practicals into Lower Order and Higher order skills/activities (See Technical Report, pp. 30). It shows that, of a total of 446 behaviours checked, 391 qualify as lower order activities while only 55 can be regarded as Higher order activities. It is obvious from this that the practical activities require more of lower order skills from the students.

Fig. 1. Histogram showing activities in the different skill levels in STAN Biology.



4.2 TESTING OF THE HYPOTHESES

In order to test the research hypotheses stated in section 2 of Chapter 1 of this report, the total number of tallies for each organizational category and behaviour category were summed up and their proportions or percentages calculated. For the organizational categories the proportions were calculated out of the total number of 113 activities. To establish whether the differences between these calculated proportions are significant, the F-test for the Analysis of variance was computed for Hypotheses 2, and 3. The F-test was considered more suitable than a t-test because it is applicable to more than two variables. For hypothesis 1 the Binomial test was done. The F-test could not be computed for Hypotheses 4 and 5 because the data here could not be subjected to such treatment. Hypothesis 4 was tested using the Mann-Whitney U-test. Hypothesis 5 was tested intuitively after comparing with the stated objectives of the programme.

HYPOTHESIS 1

To test the hypothesis that there is no significant difference in the proportion of laboratory or practical experiences that are highly structured and those that are open-ended as measured by the Laboratory Structure and Task Analysis Inventory (LAI), the data in Tables 1 (Page 86) and 2 (Page 88) were considered. The proportions showed that 65.5% of the activities are highly structured while 34.5% are open-ended. From these it is clear that there is some difference between the proportions of highly structured activities and lower-structured ones. A Binomial Test was carried out to test the difference between the number of activities that are highly structured and those that are "open-ended". The binomial test assumes that the two groups of figures are not different i.e.

P under Ho = 0.5 $\Longrightarrow$ q = 0.5

N = 113

X_1 = 74

X_2 = 39

In view of the size of N i.e. 113 the binomial distribution could not be used directly. Using the normal distribution approximation to the binomial, and Continuity Correction;

$$Z = \frac{X_1 + .5 - NP}{\sqrt{Npq}} = \frac{74.5 - 113 \times 0.5}{\sqrt{113 \times .5 \times .5}}$$

$Z = 3.20$

This value was checked in a normal distribution table.

Prob. = 0.0007

This value is high.

From the Binomial test result and the data in Table 1 we can conclude that there is a significant difference between high-structured and low-structured activities in the STAN Biology. There are more highly structured activities in the programme.

To test whether the programme encourages students to generalize from data gathered in an experiment (inductive approach) or to verify principles already presented (deductive approach), the data in Tables 1 and 2 were considered. The proportions show that students are asked to generalize from experimental data in 89.4% (101 out of 113) of the activities according to criteria used in this study. Students follow a deductive approach in portions of 10.6% of their investigations. An analysis of variance (shown in Table 10) indicates an F-value of 105.08. This value is significant at 0.01 ($p < 0.01$) level. From these results and the data in Table 1 we can conclude that the STAN Biology programme has adopted an Inductive approach.

TABLE 10

Anova Summary Table of Approach of Laboratory/Practical Activities

Source of Variation	Sum of Squares	Df	Mean Squares	F	Significance level
Between groups	60539.8	1	60539.8	105.88*	0.0001
Within groups	24014.6	42	571.776		
TOTAL	84554.4	43			

* $P < 0.01$

HYPOTHESIS 2

To test this hypothesis that the proportion of laboratory experiences that are integrated with the text and those that follow text discussion of the concepts is the same, the data in Tables 1 and 2 were considered. The proportions showed that all the activities (100%) follow the text, 28.3% are integrated with the text and none precedes the text. This is so because while category b.1 (Precedes Text) and b.2 (Follows Text) are mutually exclusive, category b.3 (Integrated with Text) may be checked with either category b.1 or b.2 (See Technical Report P.14). So, while all the activities in the text follow the text, some are integrated with it. Table 11 displays the analysis of variance summary for this relationship. The analysis indicated an F-ratio of 176.963. This value was interpreted as indicating a significant difference in the relation of practical activities to the text ($p < 0.01$). Considering the analysis of variance result and the data in Table 1, we reject the null hypothesis and conclude that the proportion of laboratory experiences that are integrated with the text and those that follow the text are not the same. We can therefore conclude that more of the practical activities follow the text discussion of the concepts in the STAN Biology programme.

TABLE 11

Anova Summary Table of Relation of Laboratory/ Practical Activities to Text

Source of variation	Sum of Squares	Df	Mean Squares	F	Significance Level
Between groups	62303.2	1	62303.2	176.963 *	0.0001
Within groups	14786.9	42	352.069		
TOTAL	77090.1	43			

*P < 0.01

HYPOTHESIS 3

This hypothesis states that the proportion of individual and group practical activities are the same. To test this hypothesis the data in Tables 1 and 2 were used. The proportions showed that 96.5% of the activities require students to work individually, a meagre 1.8% require them to work on a common task and pool their results, while another 1.8% require them to work in pairs. It is obvious from these figures that the students work individually in most of the activities. The analysis of variance (See Table 12) gave an F-value of 1235.47. This difference is significant at 0.1% level of significance ($P < 0.01$). We therefore reject the null hypothesis and conclude that the proportion of individual and group practical activities are not the same.

TABLE 12

Anova Summary Table of Cooperative Mode Required in Laboratory/Practical Activities

Source of Variation	Sum of Squares	Df	Mean Squares	F	Significance Level
Between groups	132174.05	2	66087	1235.47*	0.0001
Within groups	3369.95	63	53.491		
TOTAL	135544				

*P≤ 0.01

HYPOTHESIS 4

To test the hypothesis that there is no significant difference in the proportion of laboratory tasks demanding high level skills and those demanding low level skills, the skills were graded into Higher order activities and lower order. activities (See Table 9, Page 101). The total for each group was calculated and the proportions determined. The Mann-Whitney U-test (a non-parametric test) was applied to the data (See Table 13). The U-value was found to be 24. This is significant at 1% level $P\ (U \leq 24) \leq 0.01$. From the results of the U-test and the data in Table 9, the null hypothesis is rejected and conclude that there are more of lower order activities than higher order activities in the STAN biology programme analysed.

TABLE 13

Mann-Whitney U-test (Non-parametric test)

$n_1 = 11$
$n_2 = 13$
$R_1 = 115$

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1 = 24$$

$P(U \leq 24)$ 0.01%

More of low order activities then high order activities (Sign. level 1%)

HYPOTHESIS 5

This hypothesis could not be subjected to statistical treatment by the criteria of the study so the expected behaviours in the 113 activities were checked with the objectives of the programme as stated in the teaching syllabus. These objectives were grouped as:

(1) Cognitive

(2) Affective

(3) Manipulative or psychomotor.

Cognitive activities include the following:

(1) develop an awareness of the variety of living things.

(2) develop an understanding of the interactions between living and non-living things.

Affective:-

(1) develop an awareness (of historical and some biological concepts and skills).

(2) develop awareness of aesthetic qualities in nature.

Manipulative:-

(1) develop ability to use and, when necessary, improvise tools and equipment to solve biological problems.

TABLE 14

Distribution of the practical activities found in the STAN Biology into cognitive, affective and psychomotor domains.

	CHAPTER																								%
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total		
	No. of Activities																								
	7	1	11	8	7	8	8	6	4	2	9	7	9	3	3	2	3	3	4	3	3	2	113		
Cognitive	-	1	-	2	1	-	-	-	1	1	3	-	2	-	2	1	3	-	2	2	-	-	21	18.6	
Affective	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	2.6	
Manipulative & Psychomotor	7	-	11	6	5	8	8	6	3	1	6	7	7	3	1	1	-	3	2	1	3	-	89	78.8	

Out of a total of 113 practical activities in the text 21 (18.6%) are within the cognitive domain, 3(2.6%) in the affective domain, and a majority of 89 (78.8%) are in the manipulative or psychomotor domain. With these findings one can conclude that the behaviours demanded of students in this programme reflect the goals and objectives enunciated by the developers of the programme.

CHAPTER FIVE

5.0 D I S C U S S I O N

5.1 Introduction

The main purpose of this study was to examine the laboratory activity/practical work organization and analyse the structure and skill levels of the tasks students are expected to be engaged in during the practical work phases of the new STAN Biology programme. This chapter contains a discussion of the study's findings in relation to the results of other related studies. The STAN Biology programme, like the BSCS Biology, has no separate laboratory handbook. This researcher assumes that this is a deliberate attempt by the writers of the programme to integrate the laboratory/practical work into the body of the text. This, hopefully, will ensure a high level of "integration" of practical activities within the text.

The pattern of the discussion of the results is as follows:

5.2 Laboratory Structure and Organization;

- 5.2.1 Structure
- 5.2.2 Approach
- 5.2.3 Relation to Text
- 5.2.4 Cooperative Mode

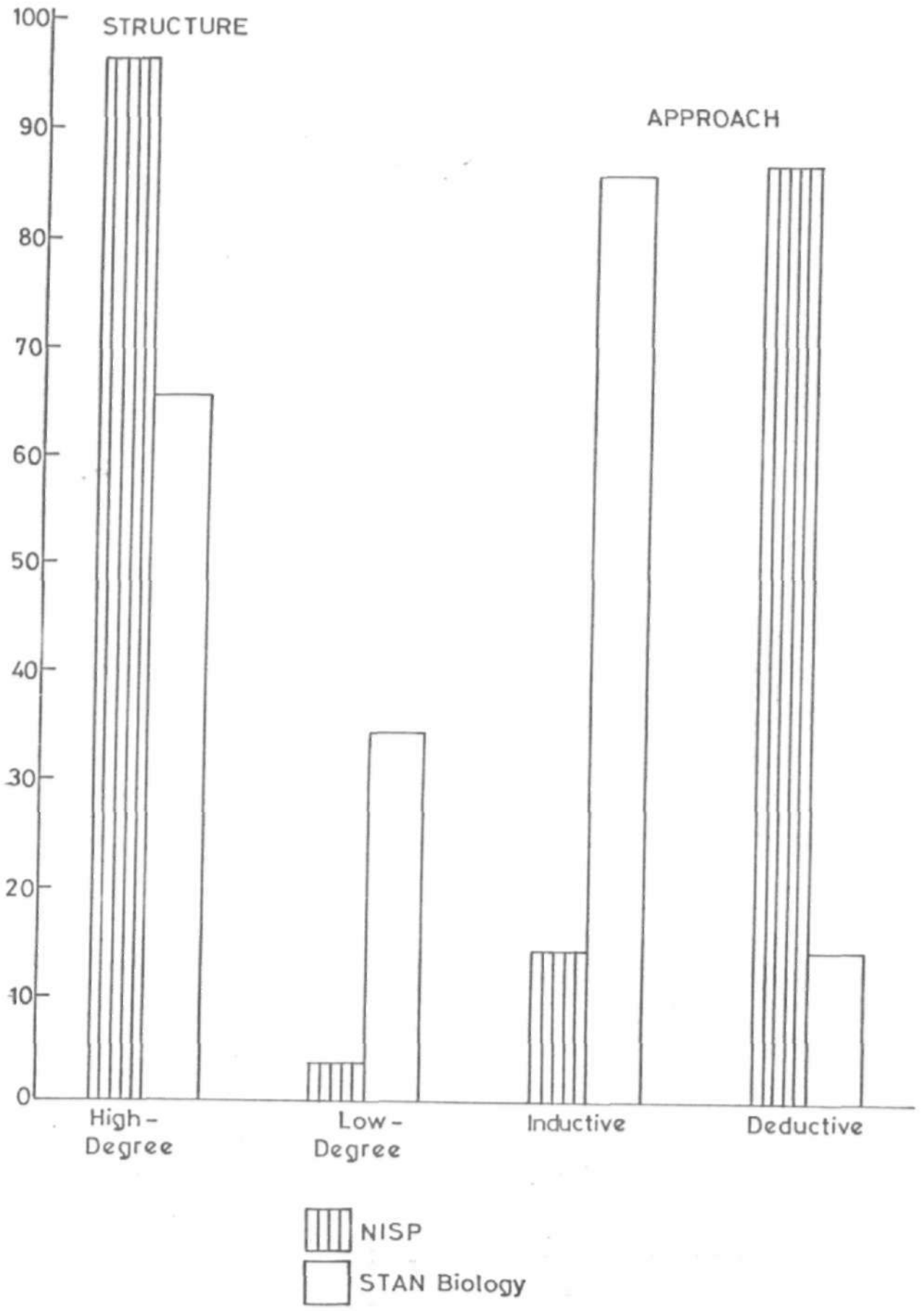
5.3 Task Analysis

5.2 LABORATORY STRUCTURE AND ORGANIZATION.

5.2.1 Structure

Tables 1 (Page 86) and 2 (Page 88) present data related to the organization and integration of the practical work within the course. They show that a greater percentage of the suggested practical activities are highly structured (65.5%), providing detailed step by step instructions for students. Detailed guidance is often given to students to eliminate difficulty and to guard against students making "mistakes" that may lead to unanticipated results. Low-structure exercises designed to encourage extended student exploration are fewer (34.5%) in comparison. It is consoling however, to note that this is a better picture than that of the NISP (See Table 15 Page 123 and Fig. 2). It shows 96.2% high structure, and 3.8% low-structure exercises for the NISP. Figure 2 gives a pictorial comparison of the two sets of data. One may justify this situation by the fact that the users of the NISP are fresh from the primary school and a good measure of guidance is appropriate to groom the students in the skills necessary for solo experiences in later years (Okebukola, 1983). The STAN biology programme is however, for students who have been exposed to the NISP materials in the Junior Secondary School.

Fig. 2 Comparative presentation of Laboratory activity organization of the NISP and STAN Biology.



It is reasonable to expect that at the Senior Secondary School these students would have had enough experience to be able to explore on their own unguided. No assertion is however being made here that the biology programme provides enough low-structured activities. The picture is just better than that presented by the NISP.

These findings are similar to those by Tamir & Lunetta (1981). In their review of analyses of inquiry - related tasks in High School Science Laboratory Handbooks, they found that almost all investigations are highly structured. In their opinion, the laboratory handbooks of contemporary curricula do not provide students with extended opportunities to investigate and to inquire. This runs counter to the goals of communicating the method and spirit of scientific inquiry that have been espoused by science educators and curriculum developers. Fuhrman, Lunetta & Novick (1982), in their analysis of laboratory handbooks of contemporary chemistry curricula using the LAI, found that the laboratory investigations in general, are highly structured, providing detailed step-by-step instructions for students. Low-structure exercises designed to encourage extended student exploration are not provided in the laboratory handbooks, even in small numbers. They found 100% High structure for all five chemistry programmes. A comparison of the IAC and CHEMS-Cotton with the BSCS Yellow version reveals a stronger inquiry orientation in the biology curriculum. The STAN biology can be said to have a stronger

inquiry orientation than the chemistry programmes mentioned. However, no data on this aspect is available for the BSCS to enable a quantitative comparison of the BSCS with the STAN Biology.

5.2.2 Approach.

It is apparent from the data presented in Table 1 that students are encouraged to adopt the inductive approach in solving proffered tasks in their practical work i.e. to generalize from data gathered in an experiment or a particular investigation. Students are asked to generalize from experimental data in 89.4% of the activities (101 out of 113) according to criteria used in this study. They follow a deductive approach in 10.6% of their investigations. A similar analysis of the NISP (Okebukola, 1983) revealed that students commonly follow a deductive approach in 86.7% of their investigations. While no case will be made for the superiority or otherwise of either the inductive or deductive approach, one might presume that there is a deliberate shift from the deductive to inductive approach by STAN from the NISP to the Biology programme. The greater emphasis on deduction in the NISP, according to Okebukola (1983). "is ad contra to the objectives of the project as spelt out in the Curriculum Development Newsletter No. 1 and the Core Curriculum on Integrated Science on which the NISP is based". This is presumably being rectified in the new Biology programme.

The chi-square analysis applied to the data in this organizational category (See Table 15) showed a significant difference between the two programmes at 0.01 level ($P < 0.001$).

TABLE 15

Laboratory Organization Analysis Comparison Between NISP & Biology: Percent of Investigations.

ORGANIZATIONAL CATEGORIES	Revised NISP % of 155	STAN Biology % of 113	df	X^2	P
A. STRUCTURE					
1. High Structure	96.2	65.5	3	144.4	* P 0.001
2. Low Structure	3.8	34.5			
3. Inductive approach	14.3	89.4			
4. Deductive approach	85.7	10.6			
B. RELATION TO TEXT					
1. Precedes text	25.8	0.0	2	27.9	* P 0.001
2. Follows text	54.8	61.7			
3. Integrated with text	19.3	28.3			
C. COOPERATIVE MODE					
1. Students work on a common task and pool results	2.6	1.8	2	0.3	** P 0.5
2. Students work on different tasks and pool results	2.6	1.8			
3. Students work individually	94.8	96.4			

* Significant

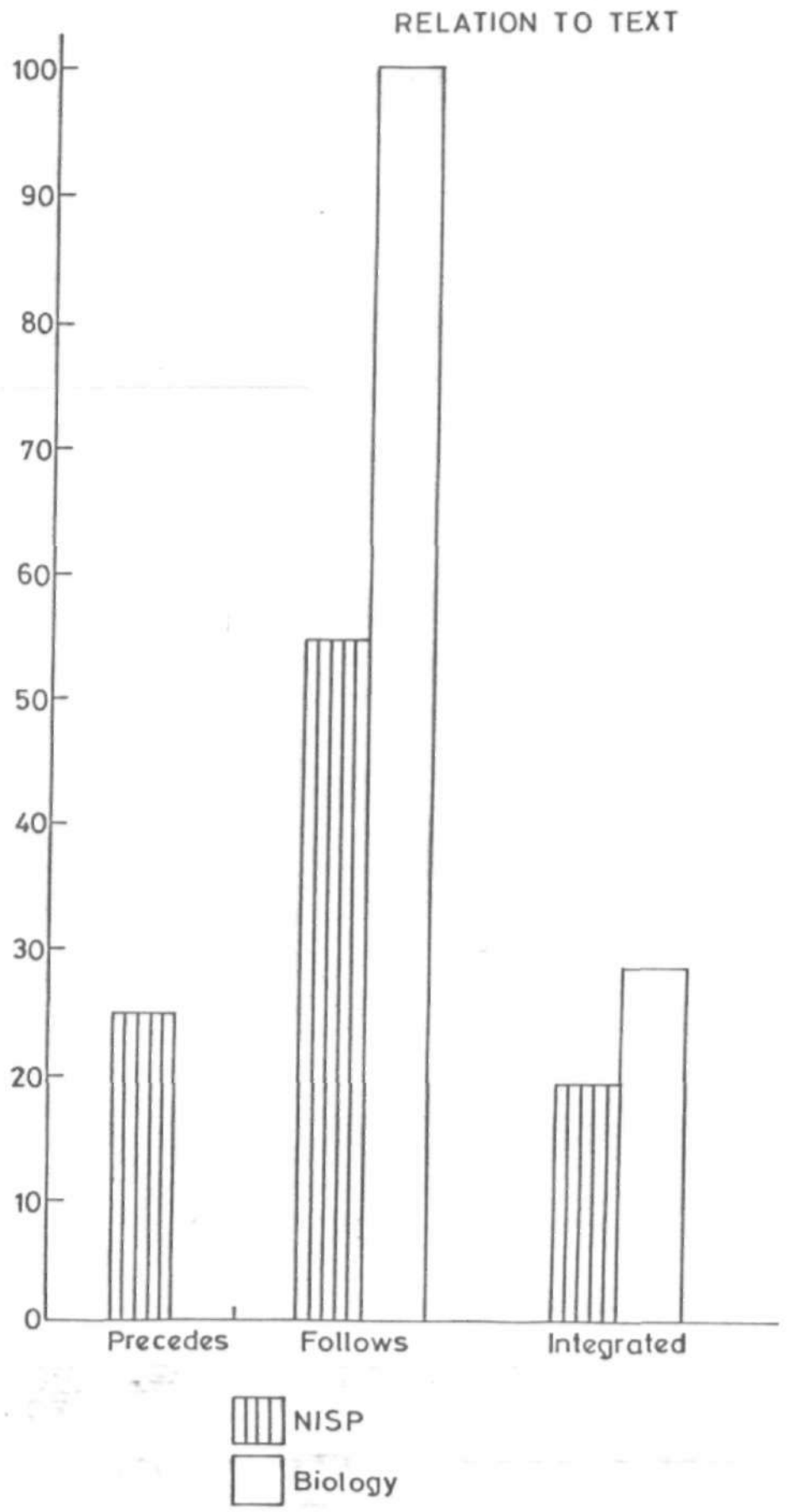
** Not significant

5.2.3 Relation to Text.

The investigation shows that all the suggested practical work (100%) follow the text. This means that the topic is presented and discussed and all the related practical activities are presented at the end of the chapter. This, in this researcher's opinion, is contrary to what is expected of an inquiry-oriented programme, as it does not give students opportunities to discover things through inquiry. This arrangement, moreover, does not agree with the inductive approach encouraged by many of the investigations. This, however, is in line with the expository nature of science teaching in many Nigerian classrooms. Some of the investigations are however, integrated with the text (25.3%). This enhances the possibility of an integrated learning experience, and more of this kind of integration would be desirable.

An analysis of the BSCS Yellow version by Tamir & Lunetta (1978) in contrast, showed that the Laboratory inquiries are set to precede the text, thereby giving students opportunities to discover many things through inquiry. Moreover, because most of these inquiries are coordinated with the text, they enhance the possibility of an integrated learning experience.

Fig. 3. Comparative presentation of Laboratory activity organization of the NISP and STAN Biology.

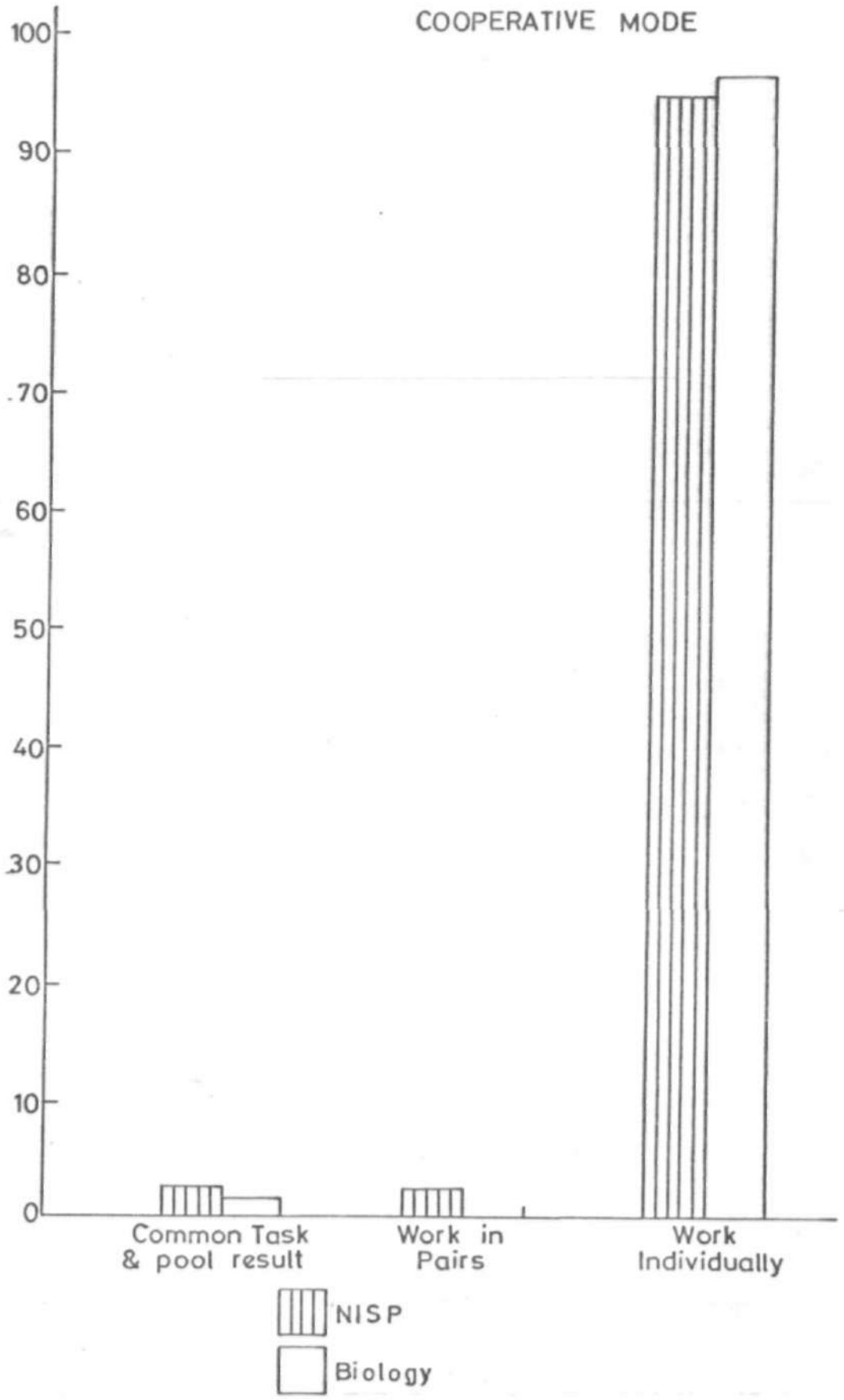


A good number of the activities in the NISP, it was found (Okebukola, 1983) follows the text (54.8%). Some are integrated within the text (19.3%), while very few precede the text (25.8%) (See Table 15 and Fig. 3). In comparison, it would be said that the NISP gives students more opportunities to discover than the STAN Biology because there are some activities in the NISP that precede the text and less follow. One would have thought that the Biology, with its slant towards the inductive approach would have had a good number of investigations preceding the text. The chi-square analysis applied to the data in this category (See Table 15) showed a significant difference at 0.01 level ($P < 0.001$). One could interprete this to mean that the NISP is more inquiry-oriented than the Biology. In similar research, Lunetta & Tamir (1979) also found that few laboratory activities necessarily precede textbook discussion of concepts.

5.2.4 Cooperative Mode

The data from this study showed that for a greater part of the practical sessions (96.4%), students are required to work individually, independent of others. Only in very few cases (1.8% i.e. 2 out of 113) are students required to work in pairs. An equal number of cases (2 out of 113) require students to work on common tasks and pool the results of the whole class for analysis and interpretation.

Fig. 4. Comparative presentation of Laboratory activity organization of the NISP and STAN Biology.



Considering the perennial problems of poor laboratory facilities and meagre resources in Nigerian schools, one questions the desirability of such an arrangement. Similar findings were made by Okebukola (1983) in his study of the NISP. A look at his data (See Table 15) shows that for 94.8% of the activities in the revised NISP, students are required to work individually. Only very few activities require students to work cooperatively on the task. The chi-square analysis for this category showed no significant difference between the two programmes (See Fig. 4 for a pictorial presentation of this closeness). This interaction pattern is characteristic of the Nigerian culture which encourages individualistic and competitive endeavours.

These findings are in direct opposition to claims by researchers (see Okebukola, 1984) that the cooperative interaction pattern is better for promoting achievement in students than both the competitive and individualistic interaction patterns (See Chapter 1, page 11). In the light of findings of contemporary studies (See Humphreys, Johnson & Johnson, 1982; Johnson, 1976; and Tjosvold, Marino & Johnson, 1977), one wonders whether demanding students to work individually is the best interaction pattern to propose if as we claim, we really want to promote achievement in Biology.

In addition, no guidance is given regarding post-laboratory discussions. There is no reference to such discussions at all even in the few cases where students are expected to pool their results. Similar findings were made by Tamir & Lunetta (1978) and Lunetta & Tamir (1980). They claim that although many teachers use the results of laboratory work for discussion, many others may assume that the students' written responses to the many questions in the laboratory exercises are sufficient. According to them, teachers often feel too pressed for time to conduct post-laboratory discussions. Unless the laboratory instructions explicitly encourage such discussions for the processing of generalizations and alternative explanations, some of the potential value of inquiry-oriented laboratory work may be lost.

TASK ANALYSIS.

Table 3 and 4 present data concerning the nature of the tasks that students are expected to be engaged in when carrying out the practical work. Table 8 displays an ANOVA summary between the sub-sections. Some important inferences based on the data in these tables can be deduced.

In a large proportion of the practical activities students are actually required to carry out qualitative/quantitative observations or measurement (28.9%), manipulate apparatus (20.4%), record results and describe observations (16.8%). A look at Table 4 reveals that the practice of these skills is distributed over the various investigations in the text. It is gladdening to note that opportunities for the acquisition of these process skills like observing, measuring, manipulating, recording are provided for the students.

However, few activities require students to perform numeric calculations (6.5%). Fewer still expect students to make decisions about experimental technique (4.0%) and practically no opportunities to work according to their own design. A look at Tables 3 and 6 show that of the grand total of 446 tallies for the whole text, 342 (i.e. 76.6%) of the behaviours checked fall within sub-section 2.0 performance.

These are activities requiring mostly lower-order skills.

The percentage of activities requiring higher order skills in the Analysis, Interpretation and Application categories are remarkably low, and in this researcher's judgement, insufficiently represented. A total of 21.0% of the activities fall within the Analysis and Interpretation subsection. Of these, 4.3% of the activities require students to transform results into standard forms e.g. diagrams. A token 1.1% of the activities require students to transform results into graphs. While 8.4% of the activities require students to determine qualitative relationships, only 1.3% require them to determine quantitative relationships. Practically no opportunities are provided for students to determine accuracy of experimental data, define/discuss limitations and/or assumptions underlying experiments, formulate or propose a generalization or model while 5.8% require them to explain a relationship. In the Application sub-section, there are no opportunities for students to apply experimental technique to new problem or variable, and only in one instance (0.2%) are the students required to formulate hypotheses based upon results of investigations.

The percentage of activities calling for behaviour in the higher order categories of Planning & Design is not any better. Not even one of the 113 practical activities requires students to formulate a problem to be investigated. Thus, in practically

all of the laboratory/practical activities the text provides the problems and the means to perform the investigations. Out of the 113 practical activities only 10 (2.2% of total tallies) require students to design observation or measurement procedures. No opportunities are provided for students to predict experimental results, formulate hypotheses to be tested and design experiments.

A breakdown of the skills required of students (See Table 6, Page 96) shows that of the 446 tallies of behaviour, 10 (2.2%) fall under Planning and Design, 342 (76.6%) under Performance, 93 (21.0%) under Analysis & Interpretation. Of these 93, 67 could be classified as observational skills and 26 of them are of truly interpretational type. Of the Application type of behaviour, only 1 (0.2%) activity calls for it.

A gradation of the skills required in the biology text analysed (See Table 9, Page 101) shows that of the 446 behaviours checked, 391 (87.7%) call for lower order skills while only 55 (12.3%) call for higher order skills.

The data in this section were compared with those of similar analysis of the NISP by Okebukola (1983). A chi-square analysis was applied to the data to see the difference between the two programmes (See Table 16 Page 133).

TABLE 16

Task Analysis Comparison Between NISP & Biology:
Percent of Investigations

	Revised NISP % of 155	STAN Biology % of 113	df		
A. PLANNING & DESIGN					
1. Problem to be investigated is formulated in the activity.	19.4	0.2			
2. Experimental result is predicted in the investigation.	1.9	0.0			
3. Procedures for observation, measurement and calculations are spelt out in the activity	4.5	3.4	2	9.11	P<0.02*
B. PERFORMANCE					
1. Carry out qualitative and/or quantitative observation and measurement.	29.3	29.4			
2. Manipulate apparatus	64.5	21.7			
3. Record results, describe observations	99.3	16.7			
4. Perform numeric calculations	8.3	6.7			
5. Explain or make decisions about experimental technique	1.9	5.8			
6. Work according to their own design	0.6	0.6	5	20.99	P<0.001*
C. ANALYSIS & INTERPRETATION					
1. Transform results (e.g. into graphs)	0.6	5.2			
2. Determine qualitative/quantitative relationship	1.2	10.1			
3. Determine accuracy of experimental data	1.9	0.0			
4. Define/discuss limitations or assumptions underlying experiment.	0.6	0.0			
5. Formulate or propose a generalization or model	1.3	0.0			
6. Formulate new questions based on the results of the investigation	0.6	0.6	5	13.74	P<0.02*
D. APPLICATION					
1. Predict based upon results of the investigation	3.8	0.0			
2. Formulate hypotheses based upon results of the investigation	3.2	0.2			
3. Apply experimental technique to new problem or variable	3.2	0.0	2	.31	P<0.5**

* Significant
** Not significant.

The chi-square analysis for the Planning & Design sub-section gives a X^2 -value of 9.11 ($P \lesssim 0.002$). This value is significant at the .01 level meaning that the NISP provides more activities in this level than the Biology programme. For the performance level, the X^2-value is 20.99 ($P \lesssim 0.001$). This is significant at the .01 level and we can conclude that the NISP provides more activities that require the students to engage in performance activities than the Biology. For the Analysis and Interpretation level the X^2 -value is 13.74 ($P \lesssim 0.02$). This value is not significant at the .01 level. The X^2-value for the next level i.e. Application is .31 ($P \lesssim 0.5$). This value is also not significant at the .01 level. It could be concluded from this analysis that the two programmes are similar in the provision of activities for these two sections. The NISP and Biology do not provide adequate opportunities for students to engage in activities in the higher cognitive domains.

Advancing a reason for this general semblance of the STAN biology and the NISP is not difficult. Both programmes were written by comparable teams of Nigerian science teachers drawn from the membership of STAN. The two teams invariably have similar backgrounds and general orientation. They have similar ideas of what science is and this determines how they think it should be taught.

It is evident from the data available that only limited opportunities are provided in the new biology curriculum for students to engage in higher-level activities. The analysis leads one to conclude that in a majority of the practical activities that students will perform in this new STAN Biology course, the problem is designed for them and specific instructions on how to perform the practical work are provided. None of these qualifies for levels 3 or 4 of the four levels of "openness" in the teaching of inquiry suggested by Herron (1971) (see chapter 2.5). This analysis implies that students more often than not are required to work as technicians, following explicit instructions and concentrating on the development of lower level skills. It is very doubtful if this will successfully prepare them "to solve problems through application of the intellect" which this programme aspires to do.

These findings are not very different from those of similar analyses of other science curriculum programmes. Results of task analysis studies of some of the new curriculum programmes like the:

BSCS

Project Physics

PSSC Physics

Modern Chemistry

CHEM Study

IAC.

have come out with similar findings (See 2.6.3). This may be due to the fact that the biology programme under study, as already mentioned (See 2.3.2) has a similar orientation to these programmes developed in the U.S.A. and Britain.

CHAPTER SIX

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 INTRODUCTION.

This chapter contains the conclusions that have been made from the results and the discussion on them, the recommendations made regarding a revised phase of the Biology programme and certain implications of the study that would need looking into by further research.

6.2 SUMMARY.

The aim of this study was to ascertain whether the STAN Biology programme is achieving the objectives for which it was designed. Since the programme has not actually been tried out in the schools, it was not possible to find out how the programme operates in the classroom. Therefore, it was considered most appropriate to look at the text and ascertain the relationship between the actual materials and the stated goals of the curriculum developers and others. This was to help determine the extent to which the objectives of the programme are incorporated in the actual structure of the textual materials. To do this, the study attempted to analyse the tasks students are expected to be engaged in during the practical work phases of the programme and to examine the laboratory activity/practical work organisation. The study tried to describe the structure and skill levels of the tasks in the suggested practical activities of the biology text.

The study specifically sought to answer the following questions.

(1) how "open-ended" are the suggested practical activities?

(2) are students encouraged to generalize from data gathered in an experiment (inductive approach) or to verify principles already presented (deductive approach)?

(3) How well are the practical exercises integrated with the development of ideas found in the text?

(4) How often are students asked to work together or pool results?

(5) What tasks are students asked to engage in during these practical work phases. What are the skill levels of these tasks? Are they expected to carry out activities demanding higher order skills like formulating hypotheses, designing observations etc. or do the tasks emphasize lower order skills like observation, measurement, apparatus manipulation, etc.

To answer these questions, the Laboratory Structure and Task Analysis Inventory (LAI) developed by Tamir & Lunetta (1978) was used for data gathering. All the suggestions for practical work at the end of each chapter of the Biology text was analysed using the LAI.

The results showed that there are more highly-structured exercises than open-ended or low-structure ones. Students are encouraged to adopt an inductive approach in solving proffered tasks (i.e. to generalize from data gathered) in the programme. It was also found that all the practical activities follow the text discussion of the concepts and in only a few cases are the practical activities integrated within the text. On no instance do the practical activities precede the text. The programme also requires students to work individually and only in very few cases are they required to work in pairs, never in groups. There are very few opportunities provided for them to pool their findings and no pre- or post-laboratory group discussions are encouraged.

For the tasks students are expected to engage in, the programme generally expects students to perform a variety of observational, measurement, apparatus manipulation and reporting procedures. However, rarely are they asked to predict experimental results, to design observation, measurement, and experimental procedures, to work according to their own design, or to formulate a new question or apply an experimental technique based on the investigation they performed. In none of the suggested exercises are students required to formulate a question to be investigated or to formulate a hypothesis to be tested.

6.3 CONCLUSION.

Generally, one would conclude from this analysis that this new Biology course is a commendable attempt at presenting students and teachers with a truly Nigerian approach to biology that is in keeping with current trends in biology teaching. Among other things, the study revealed a number of skills which purport to lead to the development of an understanding of the nature of scientific inquiry as being apparent in this new biology programme. The programme appears to emphasize the acquisition of scientific skills like observing, manipulating, recording and describing observations, etc. However, many other skills like formulating a problem or hypothesis to be tested, determine accuracy of experimental data, determine accuracy of experimental data are insufficiently represented.

In keeping with current trends, the programme exhibits very impressive progress in the development and use of practical work. The programme thus requires each student to carry out the suggestions for practical work at the end of each chapter. Whether the teachers responsible for executing the programme will ensure that these exercises are actually carried out and if our limited resources will permit the proper implementation of these lofty ideas are different issues. If properly implemented, the programme hopefully, will make "today's young Nigerian biologist not only able to describe phenomena, but also to undertake firsthand investigations as mature scientists do" (STAN Biology, 1983).

While the programme has stressed the use of practical work in biology teaching and the laboratory has taken on a new importance, the required practical activities do not live up to important goals of science educators in the development of experimental awareness of "scientific inquiry". Higher order skills in analysis, conceptualization, application and experimental design on which much of science is based are not emphasized in the curriculum. Moreover, since no specific guidance is provided in the text to indicate that some laboratory activities should precede rather than follow discussion of topics in the text and since very limited attention is given to planning and design questions, many of the laboratory/practical exercises in this curriculum are at the zero level of inquiry in the system suggested by Herron (1971). This conclusion is supported by the absence of recommendation that students engage in post-laboratory discussions and the rare instructions to pool the results of class members.

The study reveals certain important deficiences in the programme:

(1) Students do not engage in identifying and formulating problems or in formulating hypotheses.

(2) Students have relatively few opportunities to design observation and measurement procedures.

(3) Students have practically no opportunities to design experiments and work according to their own design.

(4) Students are not required at all to define or discuss limitations and/or assumptions that underlie their experiments.

(5) Students are not encouraged to share their efforts in practical activities and engage in cooperative ventures.

(6) Explicit provisions do not exist for post-laboratory discussions to facilitate consolidation of findings and understanding.

6.4 RECOMMENDATIONS

With omissions such as these, it will be right for those skilled hands involved in revising the Biology programme to structure the activities in subsequent books/editions in a way that is consistent with the goals of communicating the method and spirit of scientific inquiry that have been espoused by science educators. They should include more activities requiring higher order skills.

For example:

(1) Students should be required to engage in identifying and formulating problems or hypotheses.

(2) Students should be given opportunities to design observation and measurement procedures.

(3) Students should be required to design experiments and work according to their own design.

(4) Students should be required to define or discuss limitations and/or assumptions that underlie their experiments.

(5) In addition, one would like to see more activities that will encourage group work by students. Two advantages could be derived from this arrangement: Firstly, the limited facilities for science teaching can be put to use by the large number of students working in groups. Secondly, group-based practical work has been shown to have a facilitative effect on achievement in science and the acquisition of practical skills by students (Okebukola, 1984).

(6) Explicit provisions should be made for post-laboratory discussions to facilitate consolidation of findings and understanding.

(7) In the interim some of the discrepancies identified in this study could be remedied by concerned and knowledgeable teachers. A teacher who believes that laboratory/practical experiences should enable students to develop and practice inquiry and problem-solving skills may wish to assure that the higher level skills

are emphasized. Such teachers may thus find ways to increase the student behaviours that are not adequately provided for in the curriculum. They may use supplemental handouts, pre-lab/post-lab group discussions, and teacher initiated questions. Unfortunately, these teachers are in short supply.

(8) Science teachers have multiple responsibilities. They need to pass on accumulated information and also help develop skills for the acquisition and discovery of new information. Although, the development of scientific inquiry skills is only one portion of the array of goals of biology teaching, yet, it is an important part of this array of goals. If students are to develop these skills, they must have opportunities to practise such behaviours. Thus it is appropriate in the pursuit of certain goals to provide explicit instructions. On the other hand, if one believes in the importance of fostering inquiry and problem-solving skills, a different strategy is required. All of the goals are important in a science and technology oriented culture Nigeria is striving to get into. It is therefore important that we review both our goals and activities from time to time in order to ensure that we are enabling our students to engage in those activities that are consistent with our more important goals.

6.3 IMPLICATIONS FOR FURTHER STUDIES

This Biology programme is a new one and is yet to be tried out in the classrooms. Unfortunately, like its predecessor, the NISP, it did not go through a pilot-testing phase. It is vital therefore that other evaluation studies be carried out to look into other areas of the programme to ascertain whether the programme is achieving the objectives for which it was designed. The type of analysis in this report has looked at only one aspect. It is suggested that similar studies be conducted for the other STAN programmes like the Chemistry and Physics. A similar study has been conducted for the NISP (Okebukola, 1983) and the present study is a response to a call for an extension of the study to other programmes. It is hoped that the findings and suggestions of this study will be considered in subsequent revisions of the programme.

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

By Pinchas Tamir and Vincent Lunetta with the assistance of Shimshon Novick and Marlene Fuhrman

AUTHOR _____
TITLE _____
EDITION OR YEAR _____
PUBLISHER _____
NAME OF EVALUATOR _____

Organisational Categories \ Investigation Number										
A. STRUCTURE										
a.1 High-structure										
a.2 Low-structure, open										
a.3 Inductive approach										
a.4 Deductive approach										
B. RELATION TO TEXT										
b.1 Precedes text										
b.2 Follows text										
b.3 Integrated with text										
C. COOPERATIVE MODE										
c.1 Students work on a common task and pool results										
c.2 Students work on different tasks and pool results										
c.3 Postlab discussion required										
D. LABORATORY SIMULATIONS										
d.1 Student performs "dry lab" - data given by authors										
d.2 Student performs task that simulates or models phenomena										
d.3 Student performs experiment by gathering data from a secondary source										
d.4 Student performs simulated experiment by in-										

Laboratory Structure and Task Analysis Inventory

Tamir, Lunetta, Novick, Fuhrman

Task Categories \ Investigation Number					
1.0 PLANNING & DESIGN					
1.1 Formulates a question or defines problem to be investigated					
1.2 Predicts experimental result					
1.3 Formulates hypothesis to be tested in this investigation					
1.4 Designs observation or measurement procedure					
1.5 Designs experiment					
2.0 PERFORMANCE					
2.1a Carries out qualitative observation					
2.1b Carries out quantitative observation or measurement					
2.2 Manipulates apparatus; develops technique					
2.3 Records result, describes observation					
2.4 Performs numeric calculation					
2.5 Interprets, explains or makes a decision about experimental technique					
2.6 Works according to own design					
3.0 ANALYSIS & INTERPRETATION					
3.1a Transforms result into standard form (other than graphs)					
3.1b Graphs data					
3.2a Determines qualitative relationship					
3.2b Determines quantitative relationship					
3.3 Determines accuracy of experimental data					
3.4 Defines or discusses variables, limitations/ or assumptions that underly the experiment					
3.5 Formulates or proposes a generalization or model					
3.6 Explains a relationship					
3.7 Formulates new questions or defines problem based upon result of investigation					
4.0 APPLICATION					
4.1 Predicts based upon result of this investigation					
4.2 Formulates hypothesis based upon results of this investigation					
4.3 Applies experimental techniques to new problem					

APPENDIX II

CATEGORY DEFINITIONS AND EXAMPLES

C	CATEGORY AND DEFINITION	EXAMPLES*
a.1	High-Structure Investigation in which the student is explicitly directed in all aspects of the experiment.	Chp. 1. b) 1) Use a wooden spatula to collect a scape of cheek cells. Place the cells on a microscope side. Look at the unstained cells. Add a few drops of methylene blue. Look at the stained cells. Draw a diagram to show the organelles present in the human cheek cells.
a.2	Low-Structure, open. These investigations may make an initial suggestion or statement but otherwise the design and extent of the experiment is, for the most part, left to the student.	Chap. 2. 1) Look at as many living and preserved organisms as possible. Try to identify the phylum of each organism using the information in the chapter.
a.3	Inductive approach. The investigation involves developing generalizations from data or from individual cases.	Chap. 1 c) i) Put a drop of black ink on a filter paper or piece of blotting paper. Add water drop by drop to the ink blot. Observe and explain what happen.
a.4	Deductive approach. The investigation involves the testing of phenomena or relationships that have been predicted based upon principles or processes that have previously been stated.	Chap. 2 i) Look at as many living and preserved organisms as possible. Try to identify the phylum of each organism using the information in the chapter.
b.1	Precedes text The laboratory investigation precedes significant discussion of the topic in the text.	None

*The examples are taken from the S.T.A.N. Biology text.

Appendix II (Cont'd)

b.2	Follows text. The laboratory investigation follows significant discussion of the topic in the text.	Chp. 1 a) ii) Use the microscope to examine prepared slides of cheek cells, cork slices, leaf epidermis, longitudinal and transverse sections of a stem and mounted specimens of examples of Monera and Protista.
b.3	Integrated with text This category is checked if there are substantial references in the text to the topic of the investigation or if the narrative in the investigation refers to the text. Note that while b.1 and b.2 are mutually exclusive b.3 may be checked with either category b.1 or b2.	Chp. 1. a) i) Set up a microscope as instructed on p.6.
c.1	Students work on a common task and pool results. See Rule i-1; in order for this cell to be checked, it should be clear from the laboratory investigation being analysed that students are to pool their results of the task.	Chp. 12 a) v) Record your body temperature using a clincial thermometer. Collect the data from the rest of your class and construct a histogram of the body temperature variation in your class.
c.2	Students work on different task and pool results. See Rule i-1; in order for this cell to be checked, it should be clear from the investigation that students are to pool their results of the various tasks.	None
	Work in pairs.	Chap. 12 a) ii) Work with a partner. Shine a bright light into the eye. Record what happens to the iris and pupil. Blindfold your partner for 5 minutes. Remove the blindfold and observe the eyes at once. Explain the changes you observe.

Appendix II (Cont'd)

1.4 Designs observation, measurement or calculation procedure The student must be asked to design and carry out or describe procedure for part of a laboratory investigation; if asked to develop the overall design of the investigation, then category 1.5 is more applicable and should be checked instead.	Chp. 3. a) i) For an area near your school, set up and use appropriate apparatus to compile a record of rainfall from month to mo th.
1.5 Designs experiment. This category is at a higher level than category 1.4 and is more encompassing. The student is asked to design an entire experimental procedure, not just part of it. The student need not be asked to actually perform the experiment in order for this category to be checked.	None
2.1b Carries out qualitative Observation The student does what can be termed observation.	Chp. 1. a) ii) Use the microscope to examine prepared slides of cheek cells, cork slices, leaf epidermis, longtudinal and transverse sections of a stem and mounted specimens of examples of Monera and Protista.
2.1b Carries out quantitative observation or measurement This category is checked only when the observation involves counting or numeric measurement.	Chap. 3. c) i) Select a tall tree or building near your school. Using the method described on p. 42, measure the height of the object.

Appendix II (Cont'd)

2.2 Manipulates apparatus: develops technique — Chp. 1. a) i)

When a statement specifies or implies the use of a specific laboratory technique, this category applies.

Set up a microscope as instructed on p. 6.

2.3 Records result, describes observation — Chp. 3. b) i)

In order for this category to be marked, it must be stated or strongly implied that the student write something, i.e. record what he/she is doing sometime during the course of the laboratory investigation. The result may be a quantitative or a qualitative observation, or the student may be asked to describe what occurred, what he/she saw, etc. This category should be checked if subsequent treatment of the data clearly requires that it was recorded.

Make an anemometer as instructed on p. 39. Use the anemometer to record relative wind speeds in your selected area each day for one month.

The student ...

2.4 Performs numeric calculation — Chp. 4. d) i)

The student is directed to calculate a numerical quantity from data obtained in the laboratory i investigation.

Make clay or plasticine cubes with side-lengths of 1cm, 2cm, 3cm and 4cm. For each cube calculate the surface area and volume and complete a table with heading as the one below.

Cube side length cm	Surface area cm^2	Volume cm^3	$\frac{SA}{V}$

2.5 Interprets, explains or makes a decision about experimental technique — Chp. 1. c) i)

The student is required to make an analytical or critical statement concerning a technique used in the laboratory investigation.

Put a drop of black ink on a filter paper or piece of blotting paper. Add water drop by drop to the ink blot. Observe and explain what happens.

Appendix II (Cont'd)

2.6 Works according to own design In order for this category to be marked, the student must be required during the course of the laboratory investigation to actually perform the experiment (category 1.5) or the procedure (category 1.4) that he/she designed.	None
3.1a Transforms result into standard form (other than graphs) Standard form refers to a standard ordering rprocess, such as generating a table, a classification scheme, a diagram, a sketch (to the exclusion of diagrams or sketches of apparatus); included also are chemical equations when the identity of reactants and products is given by the laboratory text rather than determined experimentally. This category is not checked if students are merely directed to fill in table, without exercising judgement.	Chp. 1. b) ii) Collect some strands of green alga from a pond or stream. Place the cells on a microscope slide. Look at the unstained cells. Draw a diagram to show the organelles present in a plant cell.
3.1b Graphs data This category is checked only if the student is required to graph quantitative measurements (whether previously tabulated or not). Vector diagrams drawn to scale are also included in this category.	Chp. 13. b) iv) Place any seed in a jar as shown in the figure. Keep a diary of any changes you observe. Record the height of the stem and length of the root every day for 2 weeks and then plot line graphs of the data. Repeat for as many seeds as possible.
3.2a Determines qualitative relationship The student is required (explicitly or implicitly) to make an inference (arrive at a decision or opinion by reasoning from evidence), or draw a conclusion that does not involve mathematical manipulation.	Chp. 1. b) iii) Squash the tip of a fine growing root between a slide and cover-ship. Look at the specimen under the microscope. Draw a diagram showing how the cells of the root divide, enlarge and specialize.

Appendix II (Cont'd)

3.3 Determine accuracy of experimental data. This category is checked when the student is required to determine a numeric value that describes the amount of error. Examples include determining percentage error, estimating how much error is inherent in data, determining the uncertainty of measurements or results, or comparison with a standard.	None	
3.4 Defines or discusses variables, limitations or assumptions that underlie the experiment. This category is checked only when the student must respond to a direction or a question by defining or discussing variables, limitations or assumptions that underlie the observation or the interpretation of experimental data. It is not checked when a variable, limitation or assumption is merely specified or implied in the text.	None	
3.5 Formulates or proposes a generalization or model This is a more global requirement than category 3.2, in that it goes beyond the data and specific instance at hand and asks the student to generalize to or about other instances outside the immediate laboratory, results. In this respect, it differs from drawing conclusions that pertain only to the phenomena sampled in the laboratory.	None	
3.6 Explains a relationship This category requires making relationships clear and intelligible. The explanation involves a discussion of relationships that fit the results of the experiment. It differs from categories 4.1 and 4.2 which ask the student to make predictions or propose alternate hypotheses based upon laboratory data. Comparing with a model (qualitatively or quantitatively) also this category.	Chp. 5. b) ii) If your school has any vertebrate (mammal) skulls, examine the definition and jaw movement. Relate your findings to the animal's mode of feeding.	

Appendix II (Cont'd)

3.7 Formulates new questions or defines problem based upon result of investigation. The student is directed to come up with his/her own formulation of new questions or a problem for further investigation as a result of the laboratory work.	None	
4.1 Predicts based upon result of this investigation The student is required to make a prediction on the basis of his/her findings in the experiment or on the basis of previous knowledge combined with the findings. The prediction does not require testing for validation - thus it differs from category 1.3 (formulates hypothesis to be tested) and category 1.2 (predicts experimental result). Here too, a prediction can be made by logical deduction from what has been learned in the investigation.	None	
4.2 Formulates hypothesis based upon results of this investigation The student is required to formulate a hypothesis on the basis of his/her findings in the experiment, or on the basis of previous knowledge combined with the findings. A hypothesis offers a tentative explanation or proposes a relationship. This category may be checked even if the experimental test is not required. Hypothesis formulation implies alternatives.	Chp. 3. d) i)	Using the procedure sequence outlined on p. 29 make a full investigation of your study area.

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 1

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)						(d)			
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
A. Structure.																				
1. High-degree	+					+	+	+			+	+								
2. Low-degree i.e. open		+																		
3. Inductive approach	+	+									+	+								
4. Deductive approach						+	+	+												
B. Relation to Text																				
1. Precedes text																				
2. Follows text	+	+				+	+	+			+	+								
3. Integrated with text	+																			
C. Cooperative Mode																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+	+				+	+	+			+	+								
4. Post-lab discussion required																				

KEY

* - Instructions call for this students behaviour at least once

\- - " do not call for this student behaviour.

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER:---1--------

SECTION 2: Laboratory or Practical Tasks.

1.0 *Planning & Design*	Suggestions for practical work																			
A. The suggested practical work	(a)					(b)					(c)					(d				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
2.0 *Performance*																				
B. The suggested practical work expects students to																				
i) carry out qualitative observation		+				+	+	+			+	+								
ii) Carry out quantitative observation or measurement.																				
iii) Manipulate apparatus, develop technique.	+	+				+	+	+			+	+								
iv) Record results, describe observation.											+	+							-	
v) Perform numeric calculations																				
vi) Explain or make decisions about experimental technique											+	+								
vii) Work according to own design																				
3.0 *Analysis.*																				
i) Transform results into standard form (other than graphs)						+	+	+												
ii) Graphs data																				
iii) Determine qualitative relationships								+												
iv) Determine quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship																				
ix) Formulate new questions or define problem based upon result of investigation.																				
4.0 *Speculation*																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 2

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree																				
2. Low-degree i.e. open	+																			
3. Inductive approach																				
4. Deductive approach	+																			
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+																			
3. Integrated with text	+																			
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+																			
4. Post-lab discussion required																				

KEY

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER:---2---

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design .1. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)						
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	
i) Formulates a question or problem to be investigated																					
ii) Predicts experimental results																					
iii) Formulates hypothesis to be tested in this investigation																					
iv) Designs observation or measurements procedure																					
v) Designs experiment																					
.0 Performance																					
. The suggested practical work expects students to																					
i) carry out qualitative observation	+																				
ii) Carry out quantitative observation or measurement.																					
iii) Manipulate apparatus, develop technique.																					
iv) Record results, describe observation.																					
v) Perform numeric calculations																					
vi) Explain or make decisions about experimental technique																					
vii) Work according to own design																					
.0 Analysis.																					
i) Transform results into standard form (other than graphs)																					
ii) Graphs data																					
iii) Determine qualitative relationships																					
iv) Determine quantitative relationships																					
v) Quantify accuracy of experimental data																					
vi) Define or discuss limitations and/or assumptions that underline the experiment.																					
vii) Formulate or propose a generalization or model.																					
viii) Explain a relationship																					
ix) Formulate new questions or define problem based upon result of investigation.																					
.0 Application																					
i) Predict based upon result of this investigation																					
ii) Formulate hypothesis based upon results of this investigation.																					
iii) Apply experimental findings to new problem or																					

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.I.S.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 3

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
A. *Structure.*																				
1. High-degree						+	+				+			+	+					
2. Low-degree i.e. open	+	+	+			+						+	+		+					
3. Inductive approach	+	+	+			+	+				+	+	+							
4. Deductive approach						+								+	+	+				
B. *Relation to Text*																				
1. Precedes text						+									+					
2. Follows text	+	+	+			+	+				+	+	+	+	+	+				
3. Integrated with text						+	+				+			+	+					
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+	+	+			+	+				+	+	+	+	+	−				
4. Post-lab discussion required																				

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THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 3

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design .. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) formulates a question or problem to be investigated																				
ii) predicts experimental results																				
iii) formulates hypothesis to be tested in this investigation																				
iv) designs observation or measurements procedure	+	+	+																	
v) designs experiment																				
.0 Performance . The suggested practical work expects students to																				
i) carry out qualitative observation														+	+	+				
ii) carry out quantitative observation or measurement.	+	+	+			+	+				+	+	+	+		+				
iii) manipulate apparatus, develop technique.	+	+	+			+	+				+	+	+	+	+	+				
iv) record results, describe observation.	+	+	+			+	+				+	+	+	+		+				
v) perform numeric calculations	+	+	+			+	+				+	+	+			+				
vi) explain or make decisions about experimental technique																				
vii) work according to own design																				
.0 Analysis. i) transform results into standard form (other than graphs)																				
ii) graphs data																				
iii) determine qualitative relationships														+		+				
iv) determine quantitative relationships																+				
v) evaluate accuracy of experimental data																				
vi) explain or discuss limitations and/or assumptions that underline the experiment.																				
vii) formulate or propose a generalization or model.																				
viii) formulate relationship																+				
ix) formulate new questions or define problem based upon result of investigation.																				
.0 Application i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																+				
iii) Apply experimental techniques to new problem or example																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: II

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	Instructions for practical work																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+	+				+	+	+			+									
2. Low-degree i.e. open																+	+			
3. Inductive approach	+	+				+	+	+			+					+	+			
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+	+				+	+	+			+					+	+			
3. Integrated with text							+				+									
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work in pairs	+																			
3. Students work individually		+				+	+	+			+					+	+			
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 4

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 Performance . The suggested practical work expects students to																				
i) carry out qualitative observation	+	+				+	+	+			+						+			
ii) Carry out quantitative observation or measurement.																+				
iii) Manipulate apparatus, develop technique.	+	+				+	+	+			+					+	+			
iv) Record results, describe observation.	+	+				+	+	+			+					+	+			
v) Perform numeric calculations																+				
vi) Explain or make decisions about experimental technique																				
vii) Work according to own design																				
.0 Analysis. i) Transform results into standard form (other than graphs)								+												
ii) Graphs data																				
iii) Determine qualitative relationships	+	+				+	+	+									+			
iv) Determine quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship																				
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.I.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 5

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
A. Structure.	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+		-			+		-												
2. Low-degree i.e. open		+					+		-											
3. Inductive approach	+	+	+			+	+	+	+											
4. Deductive approach																				
B. Relation to Text																				
1. Precedes text																				
2. Follows text	+	+	+			+	+	+	+											
3. Integrated with text	+		+																	
C. Cooperative Mode																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+	+	-			+	+	-	+											
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 5

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 Performance . The suggested practical work expects students to																				
i) carry out qualitative observation	+	+	+			+	+	+												
ii) Carry out quantitative observation or measurement.			+					+	+											
iii) Manipulate apparatus, develop technique.	+	+	+					+												
iv) Record results, describe observation.	+	+	+			+	+	+	+											
v) Perform numeric calculations			+					+	+											
vi) Explain or make decisions about experimental technique																				
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (other than graphs)																				
ii) Graphs data																				
iii) Determine qualitative relationships		+																		
iv) Determine quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship							+	+	+											
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 6

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)				(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v i	ii	iii	iv	v i	ii	iii	iv	v
A. *Structure.*																				
1. High-degree	+	+	+	+		+	+	+	+											
2. Low-degree i.e. open																				
3. Inductive approach	+	+	-	+		+	+	+	+											
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+	+	+	-		+	+	+	-											
3. Integrated with text			+					+	-											
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+	+	+	+		+	+	+	-											
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 6

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+		+	+		+	+	+	+											
ii) Carry out quantitative observation or measurement.		+				+			+											
iii) Manipulate apparatus, develop technique.	+	+	+	+		+	+	+	+											
iv) Record results, describe observation.	+	+				+	+		+											
v) Perform numeric calculations		+							+											
vi) Explain or make decisions about experimental technique								+												
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (other than graphs)						+	+													
ii) Graphs data																				
iii) Determine qualitative relationships	+		+				+	+												
iv) Determine quantitative relationships		+																		
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
iii) Explain a relationship	+	+	+																	
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.H. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 7

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	-	+	+			+	+		+	+										
2. Low-degree i.e. open								+												
3. Inductive approach	-	+	+			+	+	+	+	+										
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+	+	+			+	+	+	+	+										
3. Integrated with text								+	+	+										
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-	+	-			+	+	+	+	+										
4. Post-lab discussion required																				

KEY

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER:---7---

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design / A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)						
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	
i) Formulates a question or problem to be investigated																					
ii) Predicts experimental results																					
iii) Formulates hypothesis to be tested in this investigation																					
iv) Designs observation or measurements procedure																					
v) Designs experiment																					
.0 Performance																					
. The suggested practical work expects students to																					
i) carry out qualitative observation			+			+	+	+	+	+											
ii) Carry out quantitative observation or measurement.	+	+								+											
iii) Manipulate apparatus, develop technique.	+	+	+			+	+			+											
iv) Record results, describe observation.	+	+	+			+	+														
v) Perform numeric calculations	+	+								+											
vi) Explain or make decisions about experimental technique																					
vii) Work according to own design																					
.0 Analysis.																					
i) Transform results into standard form (other than graphs)																					
ii) Graphs data																					
iii) Determine qualitative relationships			+			+	+		+												
iv) Determine quantitative relationships																					
v) Determine accuracy of experimental data																					
vi) Define or discuss limitations and/or assumptions that underline the experiment.																					
vii) Formulate or propose a generalization or model.																					
viii) Explain a relationship									+												
ix) Formulate new questions or define problem based upon result of investigation.																					
.0 Application																					
i) Predict based upon result of this investigation																					
ii) Formulate hypothesis based upon results of this investigation.																					
iii) Apply experimental technique to new problem or variable.																					

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.I.S.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 8

SECTION : Laboratory or Practical Tasks.
SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
A. Structure.	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+	-	+			+														
2. Low-degree i.e. open				+		+														
3. Inductive approach	+	+	+	+		+	+													
4. Deductive approach																				
B. Relation to Text																				
1. Precedes text																				
2. Follows text	+	+	-	+		+	+													
3. Integrated with text			+																	
C. Cooperative Mode																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+	+	+	+		+	+													
4. Post-lab discussion required																				

KEY

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 8

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Defines observation or measurements procedure																				
v) Designs experiment																				
.1 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+		+	+		+	+													
ii) Carry out quantitative observation or measurement.	+	+				+														
iii) Assemble apparatus, develop techniques.	+	+	+	+		+	+													
iv) Record results, describe observation.	+	+	+			+														
v) Perform numeric calculations	+	+				+														
vi) Explain or make decisions about experimental technique																				
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (other than graphs)			+			+														
ii) Graphs data																				
iii) Determine qualitative relationships		+																		
iv) Determine quantitative relationships		+																		
v) Discuss accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship																				
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental techniques to new problem or situation.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 9

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
A. Structure.	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree					+					+					-					
2. Low-degree i.e. open	+																			
3. Inductive approach	+				-					+					+					
4. Deductive approach																				
B. Relation to Text																				
1. Precedes text																				
2. Follows text	-				-					+					-					
3. Integrated with text																				
C. Cooperative Mode																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-				+					-					+					
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 9

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																					
	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+					+					+					+					
ii) Carry out quantitative observation or measurement.	+																			
iii) Manipulate apparatus, develop technique.						+					+					+					
iv) Record results, describe observation.	+										+					+					
v) Perform numeric calculations	+																				
vi) Explain or make decisions about experimental technique																					
vii) Work according to own design																					
.0 Analysis.																					
i) Transform results into standard form (other than graphs)																					
ii) Graphs data																					
iii) Determine qualitative relationships																	+				
iv) Determine quantitative relationships																					
v) Determine accuracy of experimental data																					
vi) Define or discuss limitations and/or assumptions that underline the experiment.																					
vii) Formulate or propose a generalization or model.																					
iii) Explain a relationship																	+				
ix) Formulate new questions or define problem based upon result of investigation.																					
.0 Application																					
i) Predict based upon result of this investigation																					
ii) Formulate hypothesis based upon results of this investigation.																					
iii) Apply experimental technique to new problem or variable.																					

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 10

SECTION : Laboratory or Practical Tasks.

SECTION 1. Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree																				
2. Low-degree i.e. open	+					+														
3. Inductive approach	+					+														
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					+														
3. Integrated with text																				
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-					-														
4. Post-lab discussion required																				

KEY

\+ - *Instructions call for this students behaviour at least once*

\- - *" do not call for this student behaviour.*

0 - *" are vague and this student behaviour may or may not result*

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 10

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work (a) i ii iii iv v	(b) i ii iii iv v	(c) i ii iii iv v	(d) i ii iii iv v
i) Formulates a question or problem to be investigated				
ii) Predicts experimental results				
iii) Formulates hypothesis to be tested in this investination				
iv) Designs observation or measurements procedure				
v) Designs experiment				
.0 Performance . The suggested practical work expects students to				
i) carry out qualitative observation	+	+		
ii) Carry out quantitative observation or measurement.				
iii) Mantout [illegible] apparatus, develop technique.		+		
iv) Record results, describe observation.	+	+		
v) Perform numeric calculations				
vi) Explain or make decisions about experimental technique		+		
vii) Work according to own design				
.0 Analysis.				
i) Transform results into standard form (other than graphs)				
ii) Graphs data				
iii) Determine qualitative relationships	+	+		
iv) Determine quantitative relationships				
v) Determine accuracy of experimental data				
vi) Define or discuss limitations and/or assumptions that underline the experiment.				
vii) Formulate or propose a generalization or model.				
viii) Explain a relationship	+	+		
ix) Formulate new questions or define problem based upon result of investigation.				
.0 Application				
i) Predict based upon result of this investination				
ii) Formulate hypothesis based upon results of this investination.				
iii) Apply experimental technique to new problem or variable.				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.I.S.M. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 11

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+	+	+		+					+	+									
2. Low-degree i.e. open						-	+	+												
3. Inductive approach		+	+			+	+	+		+	+									
4. Deductive approach	+												-							
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+	+	+			+	+	+		+	+									
3. Integrated with text						+	+		+		+									
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-	+	+			+	+	+	+	+	+									
4. Post-lab discussion required																				

KEY

* - *Instructions* call for this student behaviour at least once

\- - " do not call for this student behaviour.

0 - " are vague and this student behaviour may or may not result

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER:--11---------

SECTION 2. Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Defines observation or measurements procedure																				
v) Designs experiment																				
.0 Performance . The suggested practical work expects students to																				
i) carry out qualitative observation	+	+	+			+	+		+		+	+								
ii) carry out quantitative observation or measurement.																				
iii) meet with some problems, develop techniques.	+	+	+			+			+		+	+								
iv) record results, describe observation.	+		+			+														
v) perform numeric calculations																				
vi) initiate or make decisions about experimental technique	+		+			+														
vii) [illegible] to own design																				
.0 Analysis. i) Transform results into standard forms (other than graphs)								+			+	+								
ii) Organise data																				
iii) Determine qualitative relationships		+				+		+												
iv) Determine quantitative relationships																				
v) Consider accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Use data or propose a generalisation or model.																				
viii) Explain a relationship	+	+	+			+		+												
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental techniques to new problem or problems.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 12

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
A. *Structure.*																				
1. High-degree	+	+	−	+	−	+	+													
2. Low-degree i.e. open																				
3. Inductive approach	+	−	+	+	+	+	+													
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	−	−	−	+	+	−	+													
3. Integrated with text			−																	
C. *Cooperative Mode*																				
1. Students work on common task and pool results.					−															
2. Students work in [illegible]		+																		
3. Students work individually	+		+	+		+	+													
4. Post-lab discussion required																				

KEY

\+ - Instructions call for this students behaviour at least once

\- - " do not call for this student behaviour.

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 12

SECTION 2: Laboratory or Practical Tasks.

	Suggestions for practical work																				
	(a)					(b)					(c)					(d)				
A. The suggested practical work	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
.0 *Planning & Design*																				
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 *Performance*																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+	+	+	+		+	+													
ii) Carry out quantitative observation or measurement.					+															
iii) Manipulate apparatus, develop technique.	+	+	+	+	+		+													
iv) Record results, describe observation.		+			+	+	+													
v) Perform numeric calculations					+															
vi) Explain or make predictions about experimental techniques		+				+	+													
vii) Make assertions in own design																				
.0 *Analysis*																				
i) Transform results into standard form (often this example)	+																			
ii) Process data					+															
iii) Determine qualitative relationships		+		+			+													
iv) Determine quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Decide on critical limitations and/or assumptions that underlie the experiment.																				
vii) Decide on how to use a mathematical model.																				
viii) Explain experimental findings	+		+			+														
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 *Application*																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental techniques to new problem or situation.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 13

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)						(d)			
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
A. *Structure.*																				
1. High-degree	+	+				+		-	+		+	+								
2. Low-degree i.e. open							+			+										
3. Inductive approach	+	+				+	+	+	+		+	+								
4. Deductive approach										+										
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	-	+				+	+	-	+	+	+	-								
3. Integrated with text	-					+		-			-	-								
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+	+				+	-	-	+	-	-	+								
4. Post-lab discussion required																				

KEY

\+ - *Instructions call for this students behaviour at least once*

\- - " *do not call for this student behaviour.*

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER:--13--------

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design	Suggestions for practical work																				
A. The suggested practical work	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in the investigation																				
iv) Defines the relationship between experimental variables																				
v) Designs experiment																				
.0 Assessment																				
B. The suggested practical work expects students to																				
i) carry out qualitative observation	+	+				+	+	+	+	+	+									
ii) Carry out quantitative observation or measurement.									+											
iii) Formulate hypothesis, develop methods.		+					+		+		+	+	+							
iv) Record results, describe observation.						+	+		+	+										
v) Perform numeric calculations									+											
vi) Explain or make predictions about experimental technique										+										
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form before drawing graphs	+	+				+				+		+								
ii) Graphs data									+											
iii) Determine qualitative relationships																				
iv) Determine quantitative relationships																				
v) Describe trends in data, or observations made																				
vi) Explain observations in terms of theory and/or previous knowledge, or suggest explanations based on the experiment.																				
vii) Use data to propose a generalization or model.																				
viii) Critically evaluate results										+										
ix) Formulate new questions or define problem based upon results of investigation.																				
.0 Application																				
i) Predict based upon result of this specific item																				
ii) Predict trends based upon results of this investigation.																				
iii) Apply experimental techniques to a problem or task.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 14

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+					+	-													
2. Low-degree i.e. open																				
3. Inductive approach	+					+	+													
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					-	-													
3. Integrated with text	+																			
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+					+	+													
4. Post-lab discussion required																				

KEY

* - Instructions call for this students behaviour at least once

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0 - " are vague and this student behaviour may or may not result

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: JA

SECTION 2: Laboratory or Practical Tasks.

	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
A. The suggested practical work	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Identifies one, two, or more variables																				
v) Controls experiment																				
B. Observation. The suggested practical work expects students to																				
i) carry out qualitative observation						+														
ii) Carry out quantitative observation or measurement						+	+													
iii) Identify variables, develop techniques						+	+													
iv) Draw records, describe observations						+	+													
v) Perform numeric calculations						+														
vi) Explain or make decisions about experimental technique							+													
vii) Work accurately to own design																				
C. Analysis.																				
i) Transform results into standard form (tables, data graphs)							+													
ii) Process data						+														
iii) Determine qualitative relationships																				
iv) Determine quantitative relationships																				
v) Identify source of error in experiment																				
vi) Suggest improvements or modifications that would improve the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain relationships																				
ix) Formulate new questions or define problems based upon result of investigation.																				
D. Application.																				
i) Use of learnt open result in investigation																				
ii) Suggest ways in which knowledge gained in this investigation.																				
iii) Apply learnt skill/techniques to new problem or context.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 15

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
A. *Structure.*																				
1. High-degree		+			+															
2. Low-degree i.e. open	+																			
3. Inductive approach		+			+															
4. Deductive approach	+																			
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+	+			-															
3. Integrated with text	-	+																		
C. *Cooperative Mode*																				
1. Students work on common task and pool results.		+																		
2. Students work on different tasks and pool results																				
3. Students work individually	-				+															
4. Post-lab discussion required																				

KEY

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 15

SECTION 2. Laboratory or Practical Tasks.

.0 Planning & Design	Suggestions for practical work																				
A. The suggested practical work	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure	+					+														
v) Designs experiment																				
.0 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+					+														
ii) Carry out quantitative observation or measurement.		+				+														
iii) Manipulate apparatus, develop technique.		+				+														
iv) Record results, describe observation.	+	+				+														
v) Perform numeric calculations		+				+														
vi) Explain or make decisions about experimental technique						+														
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (other than graphs)																				
ii) Graphs data		+																		
iii) Determine qualitative relationships						+														
iv) Determine quantitative relationships						+														
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
iii) Explain a relationship																				
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.B.I. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 16

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+																			
2. Low-degree i.e. open						+														
3. Inductive approach	+					+														
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					+														
3. Integrated with text																				
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+					+														
4. Post-lab discussion required																				

KEY

* - *Instructions call for this students behaviour at least once*

\- - " *do not call for this student behaviour.*

0 - " *are vague and this student behaviour may or may not result*

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 16

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design	Suggestions for practical work																				
A. The suggested practical work	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation						+														
ii) Carry out quantitative observation or measurement.	+																			
iii) Manipulate apparatus, develop technique.	+																			
iv) Record results, describe observation.	+					+														
v) Perform numeric calculations	+																			
vi) Explain or make decisions about experimental technique	+																			
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (other than graphs)																				
ii) Graphs data	+																			
iii) Determine qualitative relationships						+														
iv) Determine quantitative relationships	+																			
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
iii) Explain a relationship	+					+														
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I. BIOLOGY PROBABLE TASK ANALYSIS

CHAPTER: 17

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree																				
2. Low-degree i.e. open	+					-					+									
3. Inductive approach	+										+									
4. Deductive approach						-														
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					-					+									
3. Integrated with text																				
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-					-					+									
4. Post-lab discussion required																				

KEY

* - Instructions call for this mode of behaviour at least once

\- - " do not call for this mode of behaviour.

0 - " are vague and this or that behaviour may or may not result

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 12

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure	+																			
v) Designs experiment																				
.0 Performance . The suggested practical work expects students to																				
i) carry out qualitative observation	+					+					+									
ii) Carry out quantitative observation or measurement.	+					+														
iii) Manipulate apparatus, develop technique.	+					+					+									
iv) Record results, describe observation.	+					+					+									
v) Perform numeric calculations																				
vi) Explain or make decisions about experimental technique																				
vii) Work according to own design																				
.0 Analysis. i) Transform results into standard form (other than graphs)																				
ii) Graphs data																				
iii) Determine qualitative relationships	+					+					+									
iv) Determine quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship	+					+														
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application i) Predict based upon result of this investigation																				
ii) Formul. hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I. BIOLOGY PROGRAMME TASK ANALYSIS

CHECKER: ---\F---

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree																				
2. Low-degree i.e. open	+					+					+									
3. Inductive approach	+					+					+									
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					+					+									
3. Integrated with text																				
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-					+					+									
4. Post-lab discussion required																				

KEY

* - *Instructions call for this students behaviour at least once*

\- - " *do not call for this student behaviour.*

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER:---IX---

SECTION 2: Laboratory or Practical Tasks.

.0 *Planning & Design* / A. The suggested practical work	Suggestions for practical work (a) I	(a) II	(a) III	(a) IV	(a) V	(b) I	(b) II	(b) III	(b) IV	(b) V	(c) I	(c) II	(c) III	(c) IV	(c) V	(d) I	(d) II	(d) III	(d) IV	(d) V
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 *Performance*																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+					+					+									
ii) Carry out quantitative observation or measurement.																				
iii) Manipulate apparatus, develop technique.	+					+					+									
iv) Record results, describe observation.						+					+									
v) Perform numeric calculations																				
vi) Explain or make decisions about experimental technique						+					+									
vii) Work according to own design																				
.0 *Analysis.*																				
i) Transform results into standard form for/or from original																				
ii) Graphs data																				
iii) Determine qualitative relationships																				
iv) Infer the quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
iii) Explain a relationship						+					+									
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 *Application*																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.S.A.I. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 13

SECTION : Laboratory or Practical Tasks.
SECTION 1: Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree											+					+				
2. Low-degree i.e. open	+					+														
3. Inductive approach	+					+										+				
4. Deductive approach											+									
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					+					+					+				
3. Integrated with text											+									
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	-					+					+					+				
4. Post-lab discussion required																				

KEY

\+ - *Instructions call for this students behaviour at least once*
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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 12

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design / A. The suggested practical work	Suggestions for practical work (a) i	(a) ii	(a) iii	(a) iv	(a) v	(b) i	(b) ii	(b) iii	(b) iv	(b) v	(c) i	(c) ii	(c) iii	(c) iv	(c) v	(d) i	(d) ii	(d) iii	(d) iv	(d) v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure	+																			
v) Designs experiment																				
.0 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation	+					+					+									
ii) Carry out quantitative observation or measurement.	+															+				
iii) Manipulate apparatus, develop technique.											+					+				
iv) Record results, describe observation.	+															+				
v) Perform numeric calculations																+				
vi) Explain or make decisions about experimental technique	+															+				
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (other than graphs)																				
ii) Graphs data																				
iii) Determine qualitative relationships	+										+									
iv) Determine quantitative relationships																+				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship																+				
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 23

SECTION : Laboratory or Practical Tasks.

SECTION 1 : Organisation of Activities.

Organizational Categories.	Suggestions for practical work																				
	(a)					(b)					(c)					(d)				
A. Structure.	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree																				
2. Low-degree i.e. open	+					+					+									
3. Inductive approach	+					+					+									
4. Deductive approach																				
B. Relation to Text																				
1. Precedes text																				
2. Follows text	+					+					+									
3. Integrated with text																				
C. Cooperative Mode																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+					+					+									
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 2S

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design A. The suggested practical work	Suggestions for practical work																				
	(a)					(b)					(c)					(d)						
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	
i) Formulates a question or problem to be investigated																					
ii) Predicts experimental results																					
iii) Formulates hypothesis to be tested in this investigation																					
iv) Designs observation or measurements procedure	+					+					+										
v) Designs experiment																					
.0 Performance . The suggested practical work expects students to																					
i) carry out qualitative observation	+					+					+										
ii) Carry out quantitative observation or measurement.						+					+										
iii) Manipulate apparatus, develop technique.						+															
iv) Record results, describe observation.						+															
v) Perform numeric calculations																					
vi) Explain or make decisions about experimental technique																					
vii) Work according to own design																					
.0 Analysis. i) Transform results into standard form (other than graphs)																					
ii) Graphs data																					
iii) Determine qualitative relationships																					
iv) Determine quantitative relationships																					
v) Determine accuracy of experimental data																					
vi) Define or discuss limitations and/or assumptions that underline the experiment.																					
vii) Formulate or propose a generalization or model.																					
viii) Explain a relationship																					
ix) Formulate new questions or define problem based upon result of investigation.																					
.0 Application i) Predict based upon result of this investigation																					
ii) Formulate hypothesis based upon results of this investigation.																					
iii) Apply experimental technique to new problem or variable.																					

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.I.R BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 21

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	*Suggestions for practical work*																			
	(a)					(b)					(c)					(d)				
A. *Structure.*	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
1. High-degree	+					+					+									
2. Low-degree i.e. open																				
3. Inductive approach	+					-					+									
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					+					+									
3. Integrated with text																				
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+					+					+									
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 21

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design	Suggestions for practical work																				
A. The suggested practical work	(a)					(b)					(c)					(d)					
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																					
ii) Predicts experimental results																					
iii) Formulates hypothesis to be tested in this investigation																					
iv) Designs observation or measurements procedure																					
v) Designs experiment																					
.0 Performance																					
. The suggested practical work expects students to																					
i) carry out qualitative observation						+					+										
ii) Carry out quantitative observation or measurement.						+															
iii) Manipulate apparatus, develop technique.	+					+					+										
iv) Record results, describe observation.						+					+										
v) Perform numeric calculations																					
vi) Explain or make decisions about experimental technique																					
vii) Work according to own design																					
.0 Analysis.																					
i) Transform results into standard form (other than graphs)																					
ii) Graphs data																					
iii) Determine qualitative relationships																					
iv) Determine quantitative relationships																					
v) Determine accuracy of experimental data																					
vi) Define or discuss limitations and/or assumptions that underline the experiment.																					
vii) Formulate or propose a generalization or model.																					
iii) Explain a relationship																					
ix) Formulate new questions or define problem based upon result of investigation.																					
.0 Application																					
i) Predict based upon result of this investigation																					
ii) Formulate hypothesis based upon results of this investigation.																					
iii) Apply experimental technique to new problem or variable.																					

LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: 22

SECTION : Laboratory or Practical Tasks.

SECTION 1: Organisation of Activities.

Organizational Categories.	Suggestions for practical work																			
	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v i	ii	iii	iv	v i	ii	iii	iv	v
A. *Structure.*																				
1. High-degree																				
2. Low-degree i.e. open	+					+														
3. Inductive approach	+					+														
4. Deductive approach																				
B. *Relation to Text*																				
1. Precedes text																				
2. Follows text	+					+														
3. Integrated with text																				
C. *Cooperative Mode*																				
1. Students work on common task and pool results.																				
2. Students work on different tasks and pool results																				
3. Students work individually	+					+														
4. Post-lab discussion required																				

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LABORATORY STRUCTURE AND TASK ANALYSIS INVENTORY

THE S.T.A.N. BIOLOGY PROGRAMME TASK ANALYSIS

CHAPTER: ---22------

SECTION 2: Laboratory or Practical Tasks.

.0 Planning & Design	Suggestions for practical work																			
A. The suggested practical work	(a)					(b)					(c)					(d)				
	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v	i	ii	iii	iv	v
i) Formulates a question or problem to be investigated																				
ii) Predicts experimental results																				
iii) Formulates hypothesis to be tested in this investigation																				
iv) Designs observation or measurements procedure																				
v) Designs experiment																				
.0 Performance																				
. The suggested practical work expects students to																				
i) carry out qualitative observation																				
ii) Carry out quantitative observation or measurement.							+													
iii) Manipulate apparatus, develop technique.																				
iv) Record results, describe observation.	+																			
v) Perform numeric calculations																				
vi) Explain or make decisions about experimental technique																				
vii) Work according to own design																				
.0 Analysis.																				
i) Transform results into standard form (e.g. draw graphs)																				
ii) Graphs data																				
iii) Determine qualitative relationships																				
iv) Determine quantitative relationships																				
v) Determine accuracy of experimental data																				
vi) Define or discuss limitations and/or assumptions that underline the experiment.																				
vii) Formulate or propose a generalization or model.																				
viii) Explain a relationship																				
ix) Formulate new questions or define problem based upon result of investigation.																				
.0 Application																				
i) Predict based upon result of this investigation																				
ii) Formulate hypothesis based upon results of this investigation.																				
iii) Apply experimental technique to new problem or variable.																				