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Strategies and tactics of Nigerian Science teachers

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BY

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DEDICATION

This thesis is dedicated to all my family with love especially Doubara, Charlene, Ndutimineri, Mercy and my mother - Madam Hope Buseri, who have all been my constant source of the inspiration that spurred me on. Equally, I am grateful to all my personal friends who have been most helpful.

ABSTRACT

This study commenced by surveying factors likely to affect the effectiveness of teaching. Subsequently the main aim became to develop an instrument for evaluating the effectiveness of expository teaching.

Analysis of data obtained by means of Science Teaching Observation Schedule from 54 science lessons taught by 42 teachers in Rivers State confirms that science teaching in Nigerian schools is expository and didactic as practical work and higher-order intellectual transactions based on formulating and testing hypotheses, solving of problems, and interpretation of data have been very limited. Four main teachers' groups representing four main instructional styles were distinguished. Cluster 4 was found to consist of lessons coded from transcripts rather than insitu suggesting higher sensitivity to variations in style.

The Science Teaching Observation Schedule on its own provides no means of evaluating expository teaching as it fails to differentiate the clear from the confusing, the well structured from the incoherent. To appraise expository lessons using internal criteria, the Explanation Appraisal Schedule was developed. It consists of 18 positive and negative characteristics of which 1-9 are pedagogic characteristics and 10-18 expository. Of the pedagogic characteristics three are structural, two content-related and four interactional, and the remaining nine expositional consisting of features of teacher talk which are almost instinctive, as against the pedagogic characteristics which display an element of choice. Cluster analysing data obtained by means of the E.A.S. from 12 science lessons transcripts, two teachers' clusters emerged: Cluster X (Soft-pedalling) and Cluster Y (Fast-pedalling). Though negative characteristics are by no means absent in Cluster X, Cluster Y is clearly identified as containing the less coherent and effective expositors. The E.A.S. is found to be an effective discriminating instrument.

An analysis of 490 questions asked by teachers shows that the less intellectually demanding questions based on Comprehension/Recall predominates in both clusters. Pupils are not encouraged to ask questions and the few asked appeared to be in response to the less effective teaching of Cluster Y.

Some recommendations to improve expository skills through training using the Explanation Appraisal Schedule and the Science Teaching Observation Schedule as skills development instruments, have been made.

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NOTE: (...) Three dots in any lesson excerpts from transcripts as shown above represent pauses. This use is different from the conventional use of three dots to indicate break in a quotation.

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PREFACE

This study is divided into two sections of which the first three chapters serve as background to the remaining chapters. Chapters 1 and 2 deal with factors which teachers need to bear in mind during teaching as they are likely to affect their performance on the one hand, and pupils' on the other. Chapter 3 reviews a number of methods used to study classroom cognitive interactions (including the results of such studies) which have contributed to our knowledge of what goes on in classroom especially during science teaching.

Chapter 4 discusses the specific problem area to be investigated in this study and justifies the use of the Science Teaching Observation Schedule (STOS) as the preliminary instrument used to establish a baseline for a more detailed study undertaken of selected lessons. The result of the STOS analysis of 54 lessons is presented in full in this chapter, identifying four clusters of teachers.

Chapter 5 describes the development of the Explanation Appraisal Schedule (E.A.S.) which is the novel and original aspect of this thesis, and its application to the full transcripts of twelve selected lessons. The E.A.S. is derived from previous work by a number of authors but is here constituted into a quantitative sign system analysis schedule with a one minute time sampling interval providing quantitative data suitable for cluster analysis. In this context two distinct clusters of teachers emerge providing evidence of associated negative characteristics in teaching tactics, and demonstrating the usefulness of the schedule. Chapter 6 may be regarded as a qualitative appendix to Chapter 5 illustrating in more detail the positive and negative characteristics included in the schedule.

Chapter 7 investigates in more detail the types of questioning strategies adopted the teachers, and in Chapter 8, the results of the investigation are summarized and their implications for science teaching and science teacher education in Nigeria considered.

The reader will find the main thread of the investigation described in Chapters 4, 5 and 7, and the summary in Chapter 8.

Chapter 1

1. TEACHING EFFECTIVENESS AND FACTORS THAT ARE LIKELY TO DETERMINE IT IN SCHOOLS

1.0 Introduction:

Teaching effectiveness is essentially about the facilitation of some sort of conceptual change in the learner, and this change is expected to be to the learner's advantage since no facilitator of conceptual change would do so with the intent to reverse learning. Hence Adams (1979 p54) insists that just as a teacher is a teacher anywhere, "the general picture of the universalized teacher is one of a considerate and socially sensitive person seeing as his prime task the mediating of subject matter to pupils in such a way that they understand it, and doing so under benign but controlled conditions. The teacher seems then a mildly benevolent and not too tyrannical despot." For Jackson (1962,1979) "teaching, characteristically is a moral enterprise. The teacher, whether he admits it or not, is out to make the world a better place and its inhabitants better people."

Be this as it may, it is not surprising that everyone should want to know what the teacher is doing, what effects his presence or absence has on the pupils that come regularly or irregularly in contact with him. The pessimistic aspect of this interest is the unwarranted assumption that learning is only acquired in the school by pupils with the help of teachers. This is certainly incorrect. It is necessary to point out that this assumption is very generally accepted in the developing world owing to the high level of ignorance that abounds about the way children learn. The importance of a child's environment in learning is only now being accepted in many parts of the world. In consequence all the pupils' short-comings or failures in school are attributed to the teacher. This again, is not surprising. Since the teacher gets the pat on the back when pupils pass examinations, it is only civil to ask a teacher to accept any other outcome which may, rightly or not, be attributable to schooling. This author does not intend to indict teachers nor exonerate them from blame for pupils' failure, but wishes to trace the roles assumed by all concerned with a child's intellectual development.

Mani (1980) argues that in accepting the challenge of preparing effective Science teachers, we have to comprehend fully the implications of effectiveness. He further argues that the two critical dimensions of effective teaching are intent and achievement, and hence the effective teacher is the one who is able to bring about intended learning outcome. Whereas effective teachers are thought to be fair, democratic, responsive, understanding, kindly, stimulating, original, alert, attractive, responsible, steady, poised and confident, the ineffective teacher is thought to be partial, autocratic, aloof, restricted, harsh, dull, stereotyped, apathetic, unimpressive, evasive, erratic, excitable and uncertain, Ryans (1960).

In another major study, Wragg (1984a) reports what in the pupils' - eye view teaching is. In his words, "Children prefer teachers who are enthusiastic, know their stuff, can keep order, and are fair and friendly without being overfamiliar. Above all, they appreciate key professional skills like the ability to explain things clearly." From this study also emerged that pupils particularly hated teachers who are bossy, or not interested in them. In view of these suggestions about the teacher, it may be necessary to investigate some of the professional skills which the teacher needs to possess in order to show certain degree of effectiveness in teaching.

It is difficult to discuss teaching without implying learning even though Hirst (1971) argues on philosophical grounds that teaching is logically distinct from the learning process in the sense that teaching does not necessarily always produce learning even when so intended.

He takes this case further by arguing that many, if not all, of the specific activities which occur within teaching, also occur when one is certainly not teaching. Even so, Hirst maintains that "... the notion of teaching is totally dependent for its characterization on the concept of learning," and hence teaching/learning effectiveness must be viewed as determined by a number of factors. Before going further, it may be necessary to point out that a number of studies have been undertaken aimed at determining the effectiveness of teaching. Most of these early studies according to Morrison & McIntyre (1969,1973) "were restricted in the number of variables examined, but later developments in computer processing have made possible the analysis of very large amounts of data obtained from assessment on perhaps a hundred variables." Some of these studies involve the selection of potentially relevant personal characteristics (such as general ability, personal traits, attitudes and interests, and social class origin), deciding upon criteria of effectiveness, finding and applying appropriate assessment techniques to samples of students or practicing teachers, and then computing correlations between the preditors and the criteria.

It has, of course, been realised that there are a number of difficulties which cannot readily be minimised when employing certain criteria. These centre on the fact that criteria are not absolute. They depend on the valuation of interested parties and upon the type of pupils, teaching subject, or stage in educational career that one is considering. Further, while some criteria are readily open to objective assessment, others such as social maturity, personal adjustment or critical ability are extremely difficult to measure. In realisation of the difficulties inherent in the determination of teaching effectiveness Berliner (1979) as if to call researchers to order, argues that we should never talk of effective and non-effective teachers, unless criterion referenced achievement standards for teachers are used. The importance of this argument cannot be overemphasized. Yet this does not preclude the importance of determining factors that could improve teaching effectiveness and influence the nature of interaction.

In the attempt to determine those factors that affect effective teaching/learning, four groups of characteristics will be dealt with. They have been considered worthy of discussion in view of the fact that they appear to be based on criteria that are readily open to objective assessment. They are the characteristics of the Learner, the teacher, the curriculum offered, and the school itself. In doing so, it is hoped that all the crucial factors affecting teaching, and the nature of the interaction which are not readily separable from learning will be included.

1.1 Characteristics of the Learner:

1.1.1 Introduction:

In suggesting that the characteristics of the learner (which includes the learner's cognitive level of development, motivation, prior knowledge, cultural/environmental background, learner's pre-concept of 'learning', and of 'subject', communication skills, and health, and others which equally impinge on the learner) are probably the most important factors in the determination of effectiveness in teaching/learning, consideration needs be heavily given to Jean Piaget's work. Though Piaget himself is thought to have been perhaps less interested in the purely educational measures that can be developed from his approach, a great deal of relevance has been attached to his work by numerous educators.

1.1.2 Cognitive Level of Development:

The concept of cognitive levels of growth or development was first put forward by Piaget. Accordingly, he suggests that in the development of thought proper, four principal stages, from the emergence of the symbol functions to the thought operative groupings, that is, the theoretical intelligence can be distinguished. These four stages are the result of the child's mental structures or schemes going through a particular pattern or hierarchical sequence of development and the four stages are described as the: 1. Sensori-motor Stage, 2. Pre-operational Stage, 3. Concrete-operational Stage and 4. The Formal Operational Stage.

The first stage (sensori-motor) is characterised by the child experiencing the world he is born into through the use of his hereditary reflexes and senses. By the continuous use of these reflexes and senses, the child progresses from the use of these reflexes with which he is born, to the development of habits and recognizing of effects or results to finally acting with a view to reproducing the particular result. From this stage he progresses to the second - which is the pre-operational. This stage is encountered at ages between 18 and 24 months. This stage is characterised by the child beginning to think about his actions and no longer has to carry them out to see their effect. Piaget calls this 'representation'. Within this stage the child is able to imitate objects and people who are not present according to Lovegrove (1979). This means that the child has become able to rely on his own observations and perceptions of the world around him. However, his perceptions are usually misleading as they usually take into account only one or two factors in the drawing of conclusions. Whenever the child shows signs, Piaget claims, that he no longer bases his judgement solely on his own self-centred perceptions and is also able to take into account more than one facet of a situation, then he has progressed to the next stage.

This next stage is the concrete operational stage. This is the stage commencing about 6-7 years, when the child is thought to have at his command an integrated and coherent system of mental operations which will help him to organize and interpret his new experiences. He is able to apply logical mental operations to new experiences and thus acquire concepts such as number, order and measurement. This, however "... does not imply ability to arrive at logical conclusions independent of actions" writes Sandström (1979).

For the Formal operational stage to commence the child is thought to have grown to about the age of between eleven and thirteen years. In this stage the child becomes capable of thinking hypothetically deductively. In other words, he is able to draw conclusions on the basis of simple assumptions or hypothesis which need not necessarily have any connections with reality or be related to what the person believes, and by relying on an internal power of judgement instead of having to make reference to experience.

As earlier pointed out, the educational value of Piaget's work began to be recognized following work on his basic concepts by others. One such person is Michael Shayer. After observing that the Nuffield O-Level chemistry materials were too intellectually demanding for many of their pupils, Shayer and Adey (1981) decided to carry out studies to estimate the conceptual levels necessary for particular age groups in schools to comprehend the various O-level, science curriculum packages in use in selected schools. In the words of Shayer and Adey (1981) "the powerful attraction of the Piagetian model for the present purpose is that it should be possible to develop from it two sorts of measuring instruments, 1. for measuring the level of development of pupils' mental schemas and 2. for determining the level of cognitive complexity of curriculum materials." Thus, working on a premise founded on Piagetian theory of cognitive development, they observed that the Nuffield O-level physics was more accessible at all points to pupils with I.Q. of 125+, and that only half of what Shayer and Adey (1981) describe as the selective school population, that is, pupils who showed evidence of high I.Q., would be able to gain profitably from the fourth year's work of the project. In essence, they noted that virtually all the pupils investigated at the beginning of secondary education at about 11+ were at the stage of concrete operational thinking which they labelled 2A.

The most significant overall revelation is that a reasonably high proportion of secondary school pupils in classes 1, 2, 3, 4 and 5, and probably beyond, encounter learning situations in which they do not grasp much. Their cognitive levels of operation happen to be still functioning at a lower level than we generally anticipate, and even admit. Consideration of cognitive level as an important factor in teaching/learning effectiveness centre around observations that pupils of the same chronological age in the same teaching/learning situation do not necessarily perform equally well. Some perform comparatively well and better than others, and sooner. But later, some of those who were less successful in their early school work become quite successful even at some higher classes.

In view of the available knowledge of pupils' developments cognitively, teachers will have to become a bit more concerned with their teaching to ensure that material is presented to pupils in the most appropriate way. This is necessary because many of the mistakes pupils make when tackling problems are now known to be due to problems presented to them which are thought to be unsuitable to their levels of thinking.

Further, in his work on pupils' cognitive entry behaviour, Bloom (1976) argues that a student enters each new task with a particular history which determine the nature of the student's interaction with the learning task and the learning outcomes of that interaction. School learning tasks typically represent some developmental sequences in which later tasks assume prior learning on the part of the student. To this effect, a student's cognitive level of growth must be a factor to reckon with as it will be most inappropriate to subject this student to learning tasks thought to be above his comprehension and level of intellectual development.

1.1.3 Motivation and Pupil's Self-Concept:

As a characteristic of the learner, motivation is thought to have important implications in the determination of effective teaching and learning. In the words of Fontana (1981 p154) "satisfactory school learning is unlikely to take place in the absence of sufficient motivation to learn." As a result, motivation will be seen from two perspectives even if there are three, as will be seen shortly.

First, motivation is seen from the point of view of maturation. The more maturity a learner attains the more motivated a learner is likely to become, and thus more willing to undertake a learning task. This state of pupil motivation is evident in Nigerian Schools as in others. Although willingness to learn may not be said to be directly linked to intellectual development, it is a factor that ensures that pupils participated in learning tasks, and the consequence of this is effective teaching and learning. It is argued that for better student participation in learning, it is necessary that the pupils should show willingness to learn. This is sometimes tied up with rewards or incentives he derives from it. Hence when a student anticipates some sort of reward from learning a task, he devotes more time and effort to learning it. Most parents motivate their young ones to go to school and participate in learning tasks by reference to the highly educated around - a hero. They do this and the children hope that it would work out for them. This has both intrinsic and extrinsic reward effects.

Essentially, there are three types of motivation based on needs to be satisfied. A need for achievement is just one of them. The chief principle of human motivation is the arrangement of needs in a hierarchy of priority. In general, a higher-order need does not emerge until a lower-order one is largely, but not necessarily, completely satisfied. Winsberg & Ste-Marie (1976) designed a study to investigate how the individual student's achievement in physics relate to his measured strength in each type of motivation. They hypothesized that one type of motivation - motivation to satisfy unfulfilled needs for security and belonging - would be negatively related to achievement, whereas the other two types of motivation - motivation to satisfy esteem needs such as attainment of status within the society through access to higher education, higher social status, higher income etc, and motivation to satisfy growth needs such as the individual's needs to self-actualize, to create and direct his energies into intellectual, cultural or humanitarian outlets - would be positively related to pupils' achievement in physics.

This study by Winsberg & Ste-Marie (1976) centres on physics 302, a mandatory course for all 85 less 7 second year students enrolled in the health service programme. While each student's motivation to satisfy security needs, esteem needs and growth needs, was measured using the Merritt College Motivation Inventory (MCMI) developed by Caughren (1972). This test measures the subject's motivation and the degree to which he relates to others. It contains four scales - Intrinsic motivation (Scale 1), Self-enhancement (Scale 2), person orientation (Scale 3) and Goal-Deficiency motivation (Scale 4).

The results of this study show that: the motivation to satisfy needs is negatively related to academic achievement in physics. That is, those who are not self-confident are not successful in physics. Secondly, contrary to expectations, motivation to satisfy esteem needs, and motivation to satisfy growth needs are not related to academic achievement in physics. For the first finding - negative relationship to academic achievement by non-self-confident students, Winsberg & Ste-Marie (1976) suggest that what teachers need to do is to make special effort to respond to their security needs. This may be achieved by providing them with easier tasks which they can perform successfully, in order to improve self concept. Then they could advance from that stage. While the absence of correlation between motivation to satisfy esteem needs, and academic achievement in physics was contrary to expectation, Winsberg & Ste-Marie suggest that the mere desire to succeed is not, in general, sufficient. Thus willingness and desire to succeed must be accompanied by protracted efforts directed toward success. Also, the lack of correlation between motivation to satisfy growth needs and achievement in physics occurred contrary to expectation. Yet they attributed this absence of correlation to the evaluation procedures used in the course. The way and manner the reasons for any lack of correction have been advanced suggest the strong feeling in Winsberg & Ste-Marie that their hypothesis ought to be proven. In effect, strong relationships exist between the forms of motivation and individual achievement in physics, all things being equal.

All these however, depend further on the learner's self-concept or more explicitly, knowledge of self. How does the learner see himself/herself, and how does this learner estimate his/her learning capabilities and try to hold fast to that positive (or may be, negative) self-concept or self esteem? The significance of self-concept in teaching and learning effectiveness lies in the fact that the individual has a separate identity of which he himself alone is uniquely conscious. Also, the ability of the learner to uphold his self-concept, especially if positive is particularly important. There are students who after failing to do well in class tests become demoralized and begin to doubt their ability or chances of success at subsequent times. And because self-concept has become doubtful and low, performance drops. Viewed from a different side, learner's self-concept is affected by the degree of success or failure this learner meets with.

While it is recognized that some learners may need more successful or unsuccessful learning experiences before they come to accept a particular view of themselves, it may well be seen that it is a matter of degree for various learners. Given a number of unsuccessful learning experiences, almost everyone must seemingly succumb to an acceptance of self-view about learning which is negative or simply inadequate. In the same way, given enough successful encounters with learning experiences, the one must eventually come to a positive view of self as a learner. Acceptance of adequacy or inadequacy is commonly noticeable in school classes where 'streaming' is the case as those pupils placed by teachers as members of the bottom class almost always succumb and accept that classification. Bannister (1981) argues that we succumb and accept a particular self view by deriving "... our picture of ourselves through the picture which we have of other people's picture of us." In effect, the central evidence which a pupil uses in understanding himself or herself is other pupil's or teacher's reaction towards him/her, both what they say of him or her, and the implications of their behaviour towards him or her.

There is further evidence, Nash (1973) that a child's or student's self-perception is strongly influenced by the teacher's perception of him. In effect, teacher's expectations do affect a child's school performance in so far as they affect the development of the child's self-image. Nash, in his work concludes that in the classroom, there is common agreement therefore about the relative positions in the class of all its members; each child knows his position with respect to that of everyone else. And taken as a whole, the estimates of the class closely match ability rankings made by the teacher. In Nigerian Schools where mixed ability teaching is generally practiced, students go to the extent of passing judgement on themselves. Some would say: 'Sir, I can't do this maths,' or 'I cannot do this work; it is too difficult.' While the successful ones bounce up to announce 'Sir, I have done it' or 'I have finished.' Even so, one thing is certain. It is that we do not know in Bloom's (1976) words "... what level of objective success or failure will be interpreted by the individual as success or failure. But, in general, we believe that to be in the top third, or top fifth of his class group over a number of years in a variety of school subjects is likely to be interpreted by the student as adequate or success. Also, to be in the bottom third or fifth of his class group over a number of years must leave the individual with a negative self-view, at least, in the academic area." Thus, it may be possible to encourage pupils to develop an unshaken and possibly high self-concept. This may be achieved by being motivating and encouraging, and when students' difficulties are approached with sympathy and willingness to help them.

From the above, it will be realised that motivation and self-concept are very important factors worthy of adequate consideration when thinking of achieveing effective teaching and learning.

1.1.4 Pupils' Prior Knowledge:

The achievement of effective teaching/learning situations on the part of the teacher, partly depends on the use to which this teacher puts pupils' prior knowledge of what is to be taught. Unfortunately, teachers do not, in general, attach adequate importance to this aspect. In talking about prior knowledge of pupils, and how this may have been acquired, that it, whether the learner was taught or whether it was acquired instinctively or incidentally etc, is not usually important. What on the whole appears important in most teachers' terms of practical applicability is simply the assumption that some prior knowledge exists which should be important in learning.

In this author's view point, prior knowledge, that it, what the learner already knows before embarking on that not yet known, must and should always be the pre-requisite to further teaching and learning. This is so in all subject areas and more so in the areas where what is specified for learning in the words of West & Fensham (1974) "Consist of highly systematic knowledge in which there is a sequential development and an intricate network or related facts, concepts, principles and processes." There are two ways by which prior knowledge can affect learning particularly in science. First, prior knowledge is a determinant of what further learning can occur. Secondly, it influences the process whereby this learning occurs. The importance of these possible influences can be appreciated in the ensuing analysis.

That prior knowledge is a determinant of what further learning is to occur relates to how the effective teacher commences to teach only after finding out, in relation to what he is about to teach what the student already knows in the form of facts, concepts, principles and even processes. This is done by testing the learner to reveal what has already been learned and thus constitutes the pre-requisites for the new learning. Also, it is by reviewing what is to be learned next and so on, so as to provide the learner with an insight into the pre-requisites he does not already possess or remember. Reference is also made to lesson notes and schemes of work planned and used by the former teacher. Because knowledge is complex, it requires a systematic approach to bring about effective learning. The point that prior knowledge is a determinant of what further learning occurs has to do with the issue of hierarchy of learning advanced by Gagné (1965) in his book - The Conditions of Learning. In this system, it is suggested that there are eight types of learning processes. Each higher type is dependent upon completion of the lower types. In other words, if a high level learning skill is being attempted it will not succeed unless all the preceding relevant lower learning types have been acquired. For example, one cannot write a balanced chemical equation like the ones given below:

$$KNO_3(s) + H_2SO_4(l) = KHSO_4(s) + HNO_3(g)$$

or

$$Cu(s) + 4HNO_3(l) \rightleftharpoons Cu(NO_3)_2(s) + 2NO_2(g) + 2H_2O(l)$$

and calculate the molecular mass unless he has first learned the atomic symbols of the elements, atomic numbers, and masses, and the number of replaceable electrons, in that hierarchical order. Even where he does rote-learn, it may not be firmly fixed as rote-learning is thought to be at the lower end of the meaningful learning continuum. Equally, prior knowledge influences the process by which this learning occurs. This deals with how new learning is organized and stored in the cognition. This is achieved by the two processes of 'assimilation' - a process whereby new object or situation or information is incorporated into the existing knowledge of objects, or situation or information, and 'accommodation' - the process of modifying an already existing thinking to take in the new. In the words of Lovegrove (1979) "the process of becoming intelligent or acquiring knowledge is a function of the process of assimilation, accommodation and adaption." One important point to note is that the process of acquiring knowledge remains the same throughout life, but the product of this process changes constantly. This is attributable to the mental schemes or structures which vary from time to time owing to differences in experiences and situations or circumstances.

Ausubel (1960) proposed that the learner's prior knowledge plays an organizing or subsuming role in facilitating meaningful learning. He contends that by deliberately introducing relevant and appropriately inclusive subsuming concepts into cognitive structure, a helpful ideational structure will have been provided which will enhance learning and retention. These 'advance-organizers' - the deliberately introduced subsuming conceptual structures, are now thought to be essential equivalents of prior knowledge. In a study designed to investigate whether a learner's existing knowledge plays a subsuming or organizing role in subsequent learning, and whether the role played by such an external organizer was equivalent to the role played by the learner's prior-knowledge, West & Fensham (1976) conclude that "there is an apparent equivalence in terms of learning outcome between whatever role is played by the learner's relevant prior knowledge and the advance organizers." The implication of this study is that whereas doubts are not being raised as to the value of the role of prior knowledge in achieving effective teaching/learning, the facilitating effect of advance organizers - the equivalence of prior knowledge, may well be beneficial. This is in view of the fact that both are now known to provide some sort of structural framework upon which learning is based.

From the above accounts, it might be desirable to try and determine what prior knowledge a student possesses and make same the springboard for further teaching since our object is to achieve effectiveness both in teaching and learning. Where the prior knowledge appears to be inadequate and inappropriate then Ausubel's advance organizers' strategy may be employed to provide ideational anchorage or scaffolding as the material may therefore be new to the learner.

1.1.5 Cultural and Environmental Perspectives of the Learner:

Every society or environment is endowed with its own characteristic culture which affects all its members. Basically, culture impinges on a society in three ways. One of these relates, in the words of Williams (1983) to "the way in which we think about, and understand the world around us." This is to mean that every member of one culture (except those members who by chance inhabit other peoples' environment and encounter a different culture), visualizes and thinks, and infact, understands the world around, in almost the same way. This is also thought to be linguistically determined.

Secondly, the culture of a learner which affects him includes dance, drama, literature, art, sculpture etc by which he expresses his "perception of himself, his relationships with his fellows and with the environment" in the words of Williams (1983). The importance of this aspect of culture in relation to learner is implicit in the way teaching/learning goes on in most societies. The third way by which a learner's cultural or environmental perspectives affect him is in the use made of resources around him.

The direct relationship of these perspectives and how they constitute a factor in the determination of effective teaching/learning situation can be appreciated in a number of ways. First, given that a learner is of a particular culture should immediately dawn on us that he may have ways of thinking, of doing things and probably, of understanding which are characteristic of that culture. And only when these are properly or adequately harnessed should good results in the area of teaching/learning occur. Further, the ability to exploit meaningfully the learner's probably distinct ways of understanding of his culture as against what the second party understands should be particularly helpful in developing teaching strategies and materials. This is the basis of Vance's (1984) argument. He insists that "... students should find some explanations of their origins, practices and physiology within the biology curriculum (and) ... ensure that these explanations include a range of views from differing cultures, including pupils' own." The same issue but viewed from the context of chemistry has been advanced by Williams (1984).

Education is culturally determined and historically lodged. From this perspective, it is not surprising that concepts or ideas taken for granted in some parts of the world are of particular concern to others elsewhere. Concepts of seriation of objects, analysis of perspective and the co-ordination of the horizontal with the vertical, which formed the bulk of the test given to some two hundred Nigerian school children and to their European/ American counterparts as reported by Mani (1983) amplifies the point of concern. In Mani's (1983) study, the performance of the Nigerian group compared unfavourably with the European/American group. The great difference in performance on the part of the Nigerian Children is attributable to eco-cultural demands. In effect, the test used was based on Euro-American cultural set ups. These, by implication are Scientific and Technological, thus the now-culture of those parts as against the traditional culture still strongly prevalent in Nigerian Society. This is not to suggest that concepts as earlier listed are strange to Nigerian children who certainly group things using some familiar characteristics or criteria. Taiwo (1976) studied the nature and amount of incidental physical science knowledge possessed by elementary school children in a Western State of Nigeria and concludes as follows: "Knowledge does appear to be acquired incidentally. This shows that Nigerian children, like their counterparts anywhere in the world, do not live in a social vacuum but in a cultural environment full of interactions with other members of their society." Further, Taiwo (1976) maintains that teachers and curriculum designers and developers should therefore strive to make science concepts that the child has been able to come to grips with the springboard of the science experiences of the child. What must be pointed out in view of all these is that, the more scientific and technological these concepts become, the more likely the sense of alienation it gave to those Nigerian children.

In an earlier study, Okeke & Wood-Robinson (1980) reported the cultural influence evident in their study aimed amongst others to shed light on the question of what fundamental misconceptions Nigerian biology pupils hold in the areas of a) growth, b) reproduction and c) transport mechanism within living organisms. They concluded among other things that "a cultural influence evident in the study was the absence of any qualitative approach to growth. They approached the concept in a very general and 'observational' way and appeared unable to conceptualize it in terms of increase in length, mass, volume or any other parameter." This feature was not found in the British pupils questioned in their pilot study and may be attributable to the lack of use of precise measurement in a non-technological society, maintained Okeke & Wood-Robinson (1980).

This study which was designed to shed light on pupils' misconceptions however, arrived too urgently at such a conclusion. This is because most of the parameters used by some non-sophisticated communities in Nigeria as elsewhere to determine growth are implicit in the Western parameters based on increase in length, height, circumference, mass, volume and age. It is further so, when it is realized that people in these non-sophisticated communities including traders, farmers, fishermen and other occupational groups in addition to pupils who grow up from such communities very much conceptualize growth and sizes as they weigh objects (or food items) etc by balancing them in their palms which serve as weighing scales. They are also capable of appreciating growth in living organisms for example, man, from the view point of age, height and growth and robustness. No society could do better without precise instruments normally accessible to the pupils in the Western culture.

Hence it may be viewed more from the failure of teachers to capitalize and build on what amounts to correct concepts that the pupils already had. After all, the sample students of Okeke & Wood-Robinson (1980) ranged between 12-16 years of age and must have encountered these concepts at various school levels. Further, it may be viewed from some other perspectives such as the level of validity and reliability of the oral questions used which was the basis of determining the pupils' understanding of each of the concepts or ideas within the broad biological areas.

Some attempt will be made in later chapters especially in Chapter 7, to explore the nature and types of questions asked by teachers and the levels of thinking required of them.

The third effect of cultural/environmental pressures on a learner hinges on the conflict of experiences which is now commonly noticable in the classrooms. It occurs in the form of speech, gesturing, initiation of talk or dialogue, and in the ways of thinking etc. Teachers from other linguistic communities in Nigerian Schools exhibit gaps which may be blamed on their cultures. Pupils, especially in secondary educational institutions where they teach find it difficult to communicate with these teachers much less understand what is taught. Experience has, however, shown that with time and regular contact this particular difficulty is minimised. Yet the fact remains that, to an extent, it could have adverse effects on teaching/learning effectiveness.

The cultural/environmental characteristics being discussed equally affect pupils' study habits. It is a fact that every culture has educational opportunities which are either beneficial or not, to its inhabitants. Although a pupil's study-habit becomes largely his responsibility as he grows older, the culture either encourages or discourages full utilization of the pupils existing potentials in various ways. The degree of concentration, amount of rest-time before resuming the next study period, all have to bear with the influences of culture.

There are other ways by which cultural influences impinge on the learner over and above what has so far been suggested. In one way, the learner's culture exerts influences based on religious beliefs and philosophical dispositions or presuppositions. In the words of Wilson (1981 p69) "Sometimes they act in support of science, at others they take the form of beliefs apparently at variance with some scientific assertions." It is interesting, however, to point out that no society is without such widely shared presuppositions, even though there may be considerable variation in the belief systems of individual members of that society.

The Nigerian Cultural facets provide for some form of unquestionable authority over the younger by the older members, and teachers being older members in relation to their pupils appear to enjoy an almost unqualified loyalty in terms of pupils' acceptance of what the teacher has said. Attempts to flaunt or challenge teacher's notions by pupils who read chapters of some texts in advance often times meet with sanctions by the teachers.

All these aspects of culture, undoubtedly, impinge on the learners and sometimes have debilitating effects when viewed from a teaching/learning effectiveness standpoint.

1.1.6 Learner's Preconcept about Learning:

This is another important factor within the learner's characteristics which plays an influential part in determining teaching/learning effectiveness. It is thought to be important as it has to do with what the student or learner thinks, intuitively or instinctively, that learning involves. Learners in schools particularly, and depending on their mental levels of development have preconceptions about learning. Some think teaching/learning means the presence of pupils in the classroom during the lesson. Others do also think that it involves participating in all classroom activities. Yet others think that learning involves rote-memory and regurgitation of what had previously been so rote-learned. In fact, while learning includes participation in classroom activities and some amount of rote-learning and regurgitation, much more than it involves being present, it is a necessary pre-requirement to actually learning in an organized setting as school. Be this as it may, it will not be complete to say that being present in class, participation, and rote-memory and regurgitation are all that constitute learning. Ausubel, according to West & Fensham (1974) distinguishes between 'rote-learning' and 'meaningful' learning and postulates that meaningful learning occurs when the learner's appropriate existing knowledge interacts with the new learning.

while rote-learning of the new knowledge occurs when no such interaction takes place. Still, depending on the nature of the learner's existing knowledge and how it interacts with the new knowledge, so there will be varying degrees of meaningful learning.

If, however, the learner perceives learning to mean a modification of behaviour as a result of the conscious and goal-directed influences of other individuals, in the first place parents, and then teachers, then the learner will be adequately inclined to present himself to learn. While so, it is possible that the learner may view learning as a process of recognizing a particular relationship between certain objects and events. Another way of stating this idea or concept of learning is that, "learning is the perception of new relationships," in the words of Lovegrove (1979). As long as the learner thinks that learning involves the above, and all other things being equal, he may be willing sometimes to learn.

1.1.7 Learners' Preconcept of the Subject:

Today learning is not simply perceived from the points of view of new relationships, or rote-memory or participating in classroom activities. It now includes a thinking in the way of 'what the subject is all about'. Teaching/learning effectiveness cannot ignore this aspect.

At the primary classes and at the lower forms at secondary level of education, a number of subjects are grouped together. For example, physics, chemistry, biology and possibly, geology etc are grouped together as 'General' or 'Integrated' science. At secondary level it is only from the third year that the various branches begins to be taught as separate subjects. Whereas this work is not necessarily concerned with the values or importance or otherwise of subject integration, it is important to realize that what students think of any subject is significant as we talk about teaching/learning effectiveness.

Some students believe that the Science Subjects are more useful and thus more relevant in real live situations than the arts subjects. The reverse is also true of others, while, yet others realize the importance of any subject in its own right. Sympathy for, or liking for a particular subject can have very positive effects in the teaching/learning effectiveness per that subject. It is common for form four secondary school students in Nigeria to decide to opt for the sciences, if not properly counselled, as they accept these subjects to be more important than any others. Even when some of them are considered 'weak' in the subjects, from available performance records, they insist.

Accepting that any individual tends to like those subjects or activities which he believes he has done or can do successfully, why should students like those subjects in which they do not perform well? While the simple answer to this question does not require much space here, it might be relevant to point out that some sort of illusion under which these students may be existing prevails. They may be living under the illusion that their work has been good enough but they are not just getting the teacher's sympathy or kindness, or even liking.

1.1.8 Communication:

Another element that makes up the characteristics of the learner in the determination of teaching/learning effectiveness is in the student's ability to communicate in the language used for learning. In the case of Nigeria the language of learning is officially the English language. As environment is of importance in the development of language so the Nigerian environment is no exception. It influences the learning of a foreign language in two ways - positively and negatively.

Positively, the Nigerian environment aids the learning of English language in the schools and by its use in public places. Yet the learner is handicapped by the inadequacies of the teachers who are not themselves native speakers of the language. Even language teachers have their own difficulties in the area of phonetics coupled with their own linguistic and cultural influences. Negatively, the language of learning is not a major constituent of the language of communication in the homes. This is due to the fact that there may be no need to speak English, especially where either or both parents are not literate or educated.

Some students are thought to be naturally gifted in their ability to communicate (speak, write and understand) while others are more capable of one of the skills. But the problem posed by the insistence in science teachings on formal reporting has adverse effects on the students both scientifically and linguistically insofar as understanding and proficiency are concerned. In effect, the more formal the approach to communication insisted on by teachers, the less proficient the learner may become.

Further, accepting that the effectiveness of classroom communication depends upon more than skills in the choice of appropriate content and exposition, it is also a function of the compatibility of the linguistic modes of teacher and student. Teachers are usually widely separated from students in age, social and educational experiences. Such differences produce situations in which teachers and some students have little in the way of common experiences and understanding. This can reduce the development of skilful communication. The next chapter will deal more on the issues about communication.

1.1.9 Health:

The general state of the learner's health is without doubt a major factor in the determination of teaching/learning effectiveness. The saying 'health first' is not an over-statement of the obvious.

No teacher can keep his position or job if all the pupils are in bad health and out of school. Thus, the poor state of health of pupils can have all sorts of direct and indirect effects on teaching and learning. One way by which this is noticed is pupils' showing signs of discontent, anger or discomfort such as screams, facial gestures, pouting of the lips, inattentiveness and so on. Good teachers will always watch out for some of these signs especially as many may be shy to report their problems to teachers and remain in the class and fail to benefit from class activities.

Although student health appears to be taken for granted especially in Nigerian schools, its importance in the determination of teaching/learning effectiveness is overwhelmingly acknowledged everywhere.

1.2 The Characteristics of the Teacher:

1.2.1 Introduction:

As the second major characteristics in the determination of teaching/learning effectiveness, factors emanating from the teacher's training such as knowledge and skills, and others will be examined. By increasing the general competence of the teacher in respect of his level of knowledgability and teaching skills, and also of his ability to appreciate the situation of his pupils, he is likely to become a better and more effective teacher.

1.2.2 Grasp of Subject-matter to be Taught:

Apart from the politics involved in who should be hired as teacher, the next most important factor that should normally be given the highest consideration is the candidate's knowledge of the subject matter he/she is to teach. Even so, it is now realized that good teaching is never derived simply from the consideration of subject matter. In the words of Marsh (1973) "it needs to be derived from consideration of opportunities for experience and expression - opportunities to encourage understanding, imagination, insight, perseverance and effort. The subject becomes so intermingled with the dynamic psychological matrix of teacher and learner that concern for subject as such is the least significant element in the activity."

In reality, it has become more difficult to describe the qualitative skills of teachers even in what may be called suitability for teaching or potential for effective teaching, owing to the above concern. Bruner (1966) argues that the ultimate aim of teaching a subject is to help 'children' understand its structure: that is, the basic principles that help define it, give it identity, and allow other things to be related to it meaningfully. Without a thorough specialist knowledge of the subject himself, the teacher can neither understand its structure nor help others achieve such an understanding. It is only by knowing the structure of his subject that the teacher is able to abstract from it material that is suited to the level of comprehension of his class, and that represents coherent, logical and meaningful elements of the whole. Little wonder, Amalaha (1979) points out that "it is not enough to manifest interest in teaching without the intellectual skills to see it through." By the same token, it is not enough to be competent only with subject matter without equipping one-self with the skills of teaching. It is on these bases that teacher educators now seek to ensure that prospective teachers become competent both in subject-matter and teaching skills. For, it is only by doing so that this essential aspect of teaching could be made realistic and relevant to the profession.

Apart from the desire to have teachers equipped both in subject-matter and teaching skills, the personal qualities that teachers bring to their job appears to underlie all. In a study designed to assess how well newly trained teachers in general in England are equipped for the work they are assigned and the personal qualities that these teachers bring to their jobs, HMI (1982 p80) found "that the personal qualities of the teachers were in many cases the decisive factor in their effectiveness." Among the personal qualities commonly mentioned were: energy, enthusiasm, commitment (including willingness to participate in extracurricular activities), conscientiousness, confidence, imagination, resourcefulness, good relations with pupils and staff, willingness to seek advice and receptiveness to advice when given. Adaptability and the ability to "fit in" were also stressed.

The significance of this find lies in the assumption by HMI (1982) that personal qualities developed (or that could be developed) by training and subsequently by experience gained on the job are vital to effective teaching.

1.2.3 Understanding Curriculum Process:

To understand and appreciate what subject-matter one should teach implies an understanding of what curriculum processes are open to the teacher. This follows the specification of some curriculum processes along with a curriculum package. This process, however, may serve as guide, in most cases to how the course content may actually be taught. More often than not, the practical situations vary to the extent that it becomes almost impossible to employ the recommended process.

When this happens, the teachers adopt other processes which may be conducive to their peculiar environment. It is usually under such circumstances that the teacher's professional competence comes into play. Thus the teacher should be sufficiently knowledgeable about the current questions and debates about designing a school curriculum. In the same way, it is the business of the classroom teacher to appraise any curriculum processes according to how they suit the students he is teaching.

It is common knowledge that some teachers just teach their subjects without paying attention to suitable processes. If teachers cannot find a problem situation in which their subjects could be taught with advantage, then these subjects may not be important in student's lives. Teachers should thus relate all teaching to some specific real-life situation. It is also the business of the teacher to take interest in students' entering behaviours. The point to be raised here is close to prior knowledge discussed under learner's characteristics. The difference being that it is here being viewed from teacher's perspective. As it is the business of the teacher to teach his students, he is expected to know what the students have already learned or should have learned in relation to the subject or lesson as the pupils present themselves for further instruction and learning.

In the quest for better teaching procedure the teacher must start with entering behaviour cum entry prerequisites because it is the foundation upon which future teaching/learning is built. The above points out that the teacher must be willing to set out a set of objectives in behavioural terms (cognitive and affective) to enable him find out where the students are and thus commence from there.

1.2.4 Teacher's Understanding of Pupils' Characteristics:

An understanding, on the part of the teacher, of the importance of pupil characteristics especially as discussed earlier, and just how they influence what is taught is half the battle won. This is because it is thought to be very important in the determination of teaching/learning effectiveness.

There are two ways by which a teacher can get an understanding of the characteristics of the pupils and how they can affect what is taught. They are through 1) experience in teaching and hence coming regularly in contact with pupils and 2) by the training received prior to becoming a teacher or during further in-service training programmes. Of these two ways - experience and training, the latter is preferred as it enables whoever becomes a teacher to minimise trial-and-error type situation. This is not to say that understanding derived from such on the job experience is not vital. It certainly is. A reason for emphasizing the training aspect lies in the numerous opportunities it affords the teacher while they are placed in the position of pupils. During this training certain essential teaching guides, educational theories and pre-requisites are bound to be learned which prospective teachers should fallback at in time of need. Among these will be theories and skills to be employed in various areas.

For example, an understanding of the devastating effects of constant failure upon pupils will certainly be of help to teachers. This will help teachers to minimize and modify their frequent criticism of pupils' work. Fontana (1981) has pointed out that "a child who is frequently criticized by a teacher, especially if he is already inclined to be low in self-esteem, will lose confidence in his own ability and will tend in consequence to underachieve." Thus a conscientious teacher who believes in pressurizing children to come up to a certain standard could conceivably do more long-term harm to the progress of particularly vulnerable children than a teacher who seems less conscientious and more inclined to let children find what he chooses to describe as their own level.

1.2.5 Skills in Structuring the Content:

Teaching is one thing, deciding upon what to teach and structuring it adequately is certainly, another. More often teachers do not appear to realize or understand the relevance of sequencing what is to be taught. As a result many teachers decide on what to teach without any principles or theories behind that decision. Teachers are also known to have been involved in hand-picking topics from very general syllabuses without regard for the need to structure them into a suitable form. This approach results in teachers picking topics for teaching on the simple basis of ease and interest, and never on relevance and sequence. The development by teachers of the skills necessary for structuring content to be taught, is a step towards effective teaching and learning. A further basis for this argument lies in the fact that there are many educational experiences which are worthwhile in their own right, for example, reading a poem, listening to music, solving a mathematical problem etc. But while recognizing the importance of such experiences, the skilled teacher will try to select and structure experiences which will tend to lead on to other worthwhile experiences rather than simply be enjoyed for their own sake. Thus, the structured content is a contributory factor towards teaching/learning effectiveness.

Besides, the effects of structuring pupil experiences overall have an important place in teaching/learning effectiveness. The provision of structured experiences as a factor in effective teaching/learning is emphasized by Bruner (1966). His theory of Instruction talks of specifying the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner. Much as this calls on the curriculum developers, the teacher is certainly implied as he is the ultimate curriculum developer. The teacher requires the skill to bring about a compromise between the characteristics of the learner and what is to be taught. This is a view also expressed by Lawton (1981). In his view, there should be a compromise or relationship between the knowledge which the teacher thinks should be acquired by the pupils, and the nature of the learner as a particular individual.

1.2.6 Planning to Build Upon Pupils' Experiences:

In the end, it is the set of experiences acquired by pupils as an aftermath of effective teaching that counts. In this wise it becomes necessary for teachers to possess the skills essential for planning and carrying through these experiences in the most profitable manner for the pupils.

As Tyler (1949 p63) points out, learning experience happens to be the interaction between the learner and the external conditions in the environment to which he can react. Learning takes place through the active behaviour of the student. In effect, "it is what he does that he learns, not what the teacher does", Tyler (1949) emphasizes. As this reference shows, it is this activity, that is, what the pupils have done that the teacher should be attempting to build upon. The question may be raised as to how far it is possible for a teacher to provide an educational experience for a pupil since this pupil must carry on the action which is basic to the experience? Indeed, the teacher can provide an educational experience through setting up an environment and structuring this situation so as to stimulate the desired type of reaction.

This means that teacher must have some understanding of the kinds of interests and background the pupils have so as to be able to make some predictions as to the likelihood that a given situation will bring about a reaction from the pupils; and furthermore, bring about the kind of reaction which is essential to the learning desired. For example, the teacher should not start teaching the alcohols in organic chemistry unless he has succeeded in making the pupils think of drinks, wines and beers etc with which they are already familiar. At some stage, the pupils may even want to know what kinds of alcohol the teacher drinks! This type of stimulation and response certainly has provided the desired reaction type to build upon.

To be able to identify a topic to be taught and get it structured properly is only an aspect of planning pupils' experiences. What follows this structuring depends on what resources are available for use, the pupils' prior knowledge or entry behaviour as learned by teachers and other factors. Where these experiences are planned in layers of relevance they become beneficial to the pupils. But where they are haphazardly planned they are of little value to the learner as he may be unable, by his level of cognitive development, to rearrange these experiences in beneficial sequences. In view of all these, the teacher needs to be able to plan well so as to effectively build upon pupils' experiences. This has become an important corollary of effective teaching/learning, hence the emphasis on this in recent times.

1.2.7 Presentation and Management of Materials and Activities:

In a way, this is tied up with the planning of pupil experiences. This is the aspect of teaching which most clearly reveals teacher's effectiveness in terms of skills, and competence in regard to capability and suitability to teach. In presenting materials to learners it is assumed that all the major difficulties on the one hand, and benefits on the other have been considered. Apart from pupil experiences, matters relating to class size, resources and others should also have been considered.

When the classroom tempo has become conducive to the presentation of material, the skilful teacher does so in levels and stages so as not to overload pupils with information and activities. Further, he ensures that no further difficulties arising from his role as teacher befalls the learner in addition to those difficulties arising from the learner's own cognition and motivation.

In the presentation of materials by teachers, pupils take particular note of teacher's behaviours and utterances. Also, teachers realize this and do their best to be in control of the entire situation including themselves. This was partly the basis of Kounin's (1970) work on Discipline and Group Management in classrooms. In that work Kounin traced the relationships between teacher behaviours and pupil involvement in class work. The study was undertaken following his experiences with a student who was reading a newspaper during a lesson. Following this he became aware that the behaviour of other students had changed markedly. So he thought: why were students who weren't targets of the reprimand affected by it? etc.

From this work of Kounin (1970) derived terminologies like: withitness, overlappingness, jerkiness, smoothness, momentum, slow down etc. The most salient teacher behaviours in maintaining involvement in class teaching situations were: withitness (demonstrating that teacher knows what was going on); overlappingness (attending to two issues simultaneously); transition smoothness (teacher behaviours which maintained a smooth flow of classroom activities particularly at points of transition) and group-alerting (maintaining attention of non-responding pupils). The assumption arising from these teacher characteristics is that, in minimizing disciplinary problems by the teacher being alert and in control, pupils' work involvement rate would increase. It further implies that teaching effectiveness has to do with teacher's ability to maintain harmony in the process of classroom interaction. So it is important that in presenting materials to students in a class, the timing must be adequate, while being in control of the overall situation does not require overstatement.

1.2.8 Communication:

Effective teaching and learning are affected by teacher's ability to communicate effectively with the students. This pertains to teaching/learning in the form of reading, writing, speaking and gesturing. Other forms of communication may be achieved through use of signs and objects. All the same what is of concern at the moment is linguistic communication in school classrooms which takes the form of talking and writing.

It is essential that both teacher and learner should be in a position to understand what they respectively say to each other, and not forget that purpose is very important to both ends of communication. Yet, most often, teachers are caught doing all the talking and increase the temptation to talk students into insensibility. This results because most teachers 'talk to' students instead of 'talking with' students. This idea is expressed by Bennett & Martin (1980 p48) in this way: "They (pupils) may have experienced you (teacher) talking at them, when you thought you were talking to them, and should have been talking with them." Situations of this sort must be very common in schools especially in Nigeria where the language of learning is learned in addition to the knowledge to be acquired.

In Lawton's (1981 p57) words, "one of the most important skills for a teacher in encouraging learning is the ability to manipulate language. This includes the teacher's own ability to use language appropriately, and also the ability to encourage children to develop their competence." In some Nigerian schools, it is common to find teaching and learning situations where pupils may want to express themselves in 'pidgin' English or in other familiar or unfamiliar languages when they are unable to find an appropriate word or terminology. Teachers tend to disallow this and attempt to encourage the use of appropriate language at such times. However this approach may be questionable if the student is denied an opportunity to explore and express his own ideas.

What is to be emphasized is that teachers should know more about language processes especially in places where the language of learning is foreign, and be trained to practise these skills in the classroom for the greater benefit of the learners. It is only when the development of linguistic skills of communication is seen by teachers to relate expression and negotiation to meanings that its importance to pupils in relation to teacher (the expert) can be appreciated. This is treated further in Chapter 2, dealing with Communication in the Classroom.

1.3 Characteristics of The Curriculum Offered:

1.3.1 Introduction:

Even though Bruner (1960,1977 p33) argues that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development," it is necessary that the teacher should be able to determine the conceptual level, difficulty level and abstractness of whatever he intends to teach. What should be taught must relate to pupils' intellectual levels and entering behaviour, that is, what the students have already learned. Knowledge of these by teacher must be the first step towards achieving teaching effectiveness.

1.3.2 Conceptual Level of Subject-matter:

The School syllabus is usually made up of concepts, some simple and others abstract. Hence, it is the responsibility of the teacher to select experiences (concepts) which will tend to lead on to important concepts. It is further, the responsibility of the teacher to determine the degree of abstractness of these concepts and try and make them more relevant, and accessible, to the learners.

As pointed out earlier, Bruner (1960,1977) urges teachers to make whatever concepts are to be learned relevant to the learner's intellectual level of growth. This is the essence of being a teacher. What is implied is that, the subject matter must be matched to pupils' intellectual levels and ensure that all necessary pre-requisites to the development of any concepts are grappled with at the appropriate time. This was one of the concerns of Shayer & Adey (1981 p85). Nonetheless, they argue that "Since the first act of chemistry involves formal modelling, this science has a high 'entrance fee' compared with the other two traditional Sciences," and hence "cannot be represented in a form simple enough so that any particular learner can understand it."

Yet, a considerable body of descriptive chemistry can be learnt without involving any higher level of cognitive demand.

1.3.3 Information Load:

Another factor which is necessary for consideration within the characteristics of the curriculum offered is information load. How much information do pupils need in view of the existence of what is known about short-term and long-term memories? Some curriculum developers and teachers who are unaware of the importance of child psychology, intellectual development and learning may assume that a particular amount of information may be comprehended by pupils. This may be correctly or incorrectly assumed, especially in the absence of any reliable yardstick to determine information load.

However, the terms 'information overload', 'working memory' and 'chunking' have been used and subsequently developed by A.H. Johnstone and his associates. Johnstone & Kellet (1980) sought to provide answers to pupils' inability to comprehend certain specific scientific concepts, after working on the mole-concept and lonic equation and drawing from experiences derived from their teaching. Also basing their work on the reported two different working memory mechanisms of which one is effective over short retention times and working memory (of Massaro (1975)), and the other which is less sensitive to retention times, and also arguing from the already suggested short memory capacity of 7 ± 2 chunks of Miller (1956), and on the fact that individuals differ in their ability to organize or 'chunk' information, Johnstone concluded that 'memory over-load' could be the major reason for pupils' failure to comprehend those concepts. For Johnstone, 'memory overload' is the continued bombardment of pupils with information of steadily increasing complexity for which only limited time is available for processing. To be able to process information, the information must be chunked down into retainable bits while making some nonessentials redundant. This ability is thought to vary from person to person, and depends also on previous knowledge and experience. Johnstone illustrates this further with children's inability to give meaning to sentences which they have read. That is so as most of the available processing time is taken up with perceiving the spoken words, so that processes aimed at understanding cannot take place as the earlier words have passed from the 'working memory'. According to Johnstone & Kellet (1980 p178) "to obtain an improvement in performance under these circumstance, it is necessary for the pupil either to develop a degree of understanding, which enables him to chunk the many pieces into a workable load or to be given some 'trick' which enables him to lighten his load without extra understanding." This is the alternative memory saving device or strategy which allows for sequential treatment or processing.

While 'information overload' as above is thought to be capable of hampering learning, it is also felt that the ability to 'chunk' (a process of load reduction to bring about the task of memorising and reproducing the formula, the unit, the instance, word, letter or symbol, digit which a person perceives and recognizes well within the pupil's or learner's short-term memory capacity), varies from learner to learner. Although certain obvious factors such as previous knowledge or experience, already acquired conceptual pre-requisites, subject's mental age, ability to think, reason and learn, affect the ability to chunk, it is thought that ability to chunk is substantially reduced by any unnecessary increases in size of the amount of load being fed to pupils. Recalling an earlier work by Fensham (1973), Johnstone (1982) points out that students had little conceptual understanding of functional groups and their role in Chemistry because the students were unable to chunk information effectively.

Thus the strategy of teaching any sequential sets of learning, such as the sciences, must consider among other things, the amount of information to be fed to pupils in relation to time available to them for processing.

1.3.4 Sequencing of Subject-matter:

This is another aspect of the characteristics of the curriculum which is important but receives very little attention in real teaching situations. As many teachers particularly, in Nigerian Schools, select topics to be taught on the bases of ease and interest, it can hardly be said that what is taught is sequential. This author's experience in secondary school was traumatic. This is because at different periods of time we (pupils) had one chemistry teacher after the other and most of them started from a different part of the syllabus. While one would start from an inorganic chemistry topic and go some distance, the other would arrive to start from an organic chemistry topic. There was no sequence in topic selection at all.

As Bruner (1960,1977 p82) points out "there are certain orders of presentation of materials and ideas in any subject that are more likely than others to lead the student to the main idea." More so for the science subjects that are usually described as being 'sequential sets of learning'. Bruner is known for his theory of instruction which also emphasizes the specification of some sequence for learning specific kinds of knowledge. This sequence is thought to be of two kinds. The one related to logical sequence within the subject matter and the second which refers to the kind of sequence which the teacher should be aware of in the pupil's mind, that is, proceeding from the concrete to the abstract or symbolic.

1.3.5 Aims and Objectives of the Curriculum Offered:

No organized teaching and meaningful learning is likely to take place in the absence of knowledge of why the subject-matter is to be taught and what effects the teaching of such subject-matter will have on the students. Even where learning occurs knowledge of whether it has actually occurred may be difficult to evaluate in the absence of some clear intentions. Thus, what it is hoped to achieve by teaching particular topics and what terminal behaviours are to be looked for should usually be predetermined. For most inexperienced teachers, this can be difficult.

Equally so, it is essential to have basic ideas as to why particular courses should be taught and what benefits the learners may derive by being so taught. All these should enable the teacher to streamline his teaching procedures.

There are basically two schools of thought in curriculum design, development and practice. One school advocates the process model which in the words of Stenhouse (1975 p84) "... attempts to arrive at a useful specification of curriculum and educational process without starting by pre-specifying the anticipated outcome of that process in the form of objectives." While the other school of thought as also depicted by Stenhouse (1975 p57) argues that since "... objectives provide a common, consistent focus for the multifarious activities we call the curriculum, so the objectives model provides a logical pattern of co-operative action and intellectual synthesis for those engaged in educational research and the academic study of education."

The various arguments advanced by both schools are usually so impressive that some may be tempted to think of a middle path. However, it is difficult to find such compromise.

In practice, it is more convenient to ally with those who believe in prespecification of behavioural objectives for a number of reasons. One such argument derives from Hirst (1971) that "the intention of all teaching activities is that of bringing about learning, ... that any activity is characterised by an intention, but many intentions cannot, logically cannot, be ascribed unless certain observable conditions hold." He went on to assert that "there is no such thing as teaching without intention to bring about learning and that therefore one cannot characterise teaching independently of characterising learning." Thus it is only when we appreciate the intention of learning can we know the intention of teaching. When one bases the argument for prespecification on Hirst's thinking, it immediately becomes evident that we cannot preempt teaching without first establishing, if only vaguely, what learning outcomes stated behaviourally we want to see at the end of such teaching.

A knowledge of the workability of a given curriculum is best derived from the aims and objectives of such a curriculum stated behaviourally. When so stated, the teacher should be in a position to assert the success of the course. Even Stenhouse (1975 p83) at one point admits that "basically the objectives approach is an attempt to improve practice by increasing the clarity about ends." Who then is against it? Finally, for the teacher who does the teaching, it is essential that he should know where his students are, in terms, of what they already know, and what else they are expected to learn at the end of each teaching act. It is only by doing so that teaching/learning can be systematic, effective and in the end, meaningful.

1.4 Characteristics of the School:

1.4.1 Introduction:

Although it is claimed that some teaching and learning, thought to be informal, goes on outside school, formal teaching and learning are almost always associated with a school. Thus, what is meant by a school is that setup or institution (comprising of a house or houses, a head and his teaching and non-teaching staff, seats and tables for all pupils and staff, facilities such as space, books, technical equipment, chemicals for science lessons and others to aid teaching and learning) to which a great deal of responsibility in the way of preparing youngsters morally, socially and above all, intellectually, have been designated. Some may describe its functions as similar to that of a factory where 'raw' materials are fed in from one end, and refined and finished products, coming out from the other end.

In this section, I shall seek to discuss the extent to which the various components of school affect teaching and learning. It may be recalled that earlier some important characteristics as they pertain to the learner, the teacher and the curriculum have been discussed. What is of interest now centres on school facilities, class sizes, allocation of teachers and continuity of teaching.

1.4.2 Facilities Available in The School:

In every school, apart from the human resources available the facilities provided are next in importance. Sufficient space in classrooms with seats and writing desks/tables, books provided in the libraries and any equipment to assist teaching and learning are all defined as facilities.

An examination of the significance of space was carried out by Rutter et al (1979 p100) on the basis of pupils per 100 square feet of total floor space including corridors, offices, halls and gymnasia. The indication was that several schools in London were much more crowded than the average of 1.39 per 100 square feet. Most surprisingly, Rutter et al (1979 p101) assert that "this measure of density of occupation emerged as having negative relationships with both academic and delinquency measures - meaning that overcrowded schools tended to have somewhat better outcomes." Even so they point out that "we do not wish to suggest that overcrowding was actually an advantage ...". In many Nigerian classrooms, both in primary and secondary schools, a high level of overcrowding is very noticeable even as seats for two maybe shared by three or even more.

The difficulties that such a situation might pose are easy to visualize. Writing becomes a lot more difficult to undertake and delinquency is likely to be on the increase. Other facilities such as laboratories for science, mathematics, geography and language etc, and the necessary equipment are essential and thus beneficial for the achievement of teaching/learning effectiveness. Where the schools fail to provide these facilities, teaching and learning situations may have to experience untold difficulties and hinderances.

1.4.3 Class Size:

The discussion of facilities which led into the effects of space overlaps into the problem of class size in schools. In the study by Rutter et al (1979 p102) on staff provision and class size, no significant association with outcome was found. At the same time, the pupil/teacher ratio for three years - 1975-1978 averaged from 14.02 to 16.30. In effect, one teacher to about 15 pupils on the average is felt adequate to achieve effective teaching/learning in the developed world.

The case in Nigerian schools is certainly different. Except in secondary schools owned by the Federal Government where the teacher/pupil ratio should be better, most State and Community owned schools need teachers badly. In State and Community own schools, the teacher/pupil ratio is more likely to be between 1:45 and 1:55.

While there is continued improvement in the contact time between teacher and individual pupils in the United Kingdom due largely to the increase in the number of qualified teachers and also to the drop in school enrolment, the situation in Nigerian schools appears to be the other way round. Whereas school enrolments keep rising, the teacher output from Colleges and Universities is not necessarily catching up fast enough to tilt the balance. Thus, even where it is realised that teachers need to give more time to individual students, in view of differences that exist in their intellectual, emotional and psychological developments, it is hard to imagine that class sizes will drop so fast as to have a significant effect on the existing situation.

1.4.4 Time Allocation For The Subject:

In discussing the characteristics of the curriculum earlier, time allocation was mentioned. Now, it will be dealt with in the context of timetabling for school subjects and give account of, if only briefly, how it constitutes an issue in the determination of teaching/learning effectiveness.

The essence of a timetable is to ensure that sufficient time is given to teach each subject. Sufficient attention and care are needed to provide a timetable which should be able to give emphasis to the different aims and objectives of a school. To prepare a timetable without criteria is like sending a child to a school without teachers. Hence schools must draw up their aims and objectives clearly for timetablers to be able to provide the best in terms of balance for the school.

The above does not exclude the chances of large amounts of time being lost. Time is lost through a number of activities not directly contributing to the achievement of school aims and objectives, such as teachers' strikes, school riots, and planned activities such as games and sports etc. In the work of Rutter et al (1979 p118), a study of teacher actions in lessons, and, total teaching time was undertaken. It was found that "schools where most lessons started promptly tended to have better outcomes with better behaviour." While schools where lessons were late to start and probably stopped even earlier were thought to have worse outcomes for the children in terms of behaviour, class attendance and academic attainment. In the light of this, it is necessary to ensure that timetables are suited to what the school can sustain and not devise a timetable which requires lessons to start at impossible times or times which cannot be enforced by the school authority.

On the allocation of teachers to subjects and classes a national policy is necessary. Teachers allocated to classes on political bases soon discover how unproductive they have been. But then the damage may have already been done to the pupils, and to the school's aims and objectives. Meaningful teaching/learning will result even in classes considered weak where specialist teachers armed with necessary skills and tools are correctly deployed.

Continuity of teaching with respect to both teacher and subject-matter has already been referred to.

1.5 Summary:

So far, a number of factors thought to have important effects in teaching/learning effectiveness have been discussed under four broad characteristics - the learner, the teacher, the curriculum, and the school itself. But it must be recognized that several other factors which impinge on classroom interactions are inexhaustible. This follows from the realization that the human factor element may be difficult to predict owing to its changing responses to a particular stimulus at different times. However, it must be acknowledged that in the effort to achieve effectiveness in teaching/learning, the characteristics thus discussed must be held largely responsible. Where there is failure, a re-examination of each characteristic will be required; for there must lie the root of failure or success.

Chapter 2

2. COMMUNICATION IN THE CLASSROOM

2.1 Introduction:

In order to achieve both balance and emphasis, language curricula in schools focus on the teaching of particular skills. Thus, a portion of the school day may be devoted to the teaching of pronunciation skills, another to the expansion of grammatical structures, and still another to the enhancement of sequencing skills etc. This division is clearly important for research and teaching purposes.

However, in the instance of real language usage, all the elements occur simultaneously. Thus, in one sense, the compartmentalization of teaching units violates essential elements of natural language functioning. Yet language is itself only one aspect of communication as it occurs in the classroom. Tough (1977) distinguishes communication as the activity in which meanings are effectively expressed, shared and understood by those taking part. This is achieved principally by talk, which is the process by which meanings are conveyed through the use of language. Language consists of a system of signs by which meanings are represented, and speech is the activity of articulating and ordering sounds to produce words. Thus, in a classroom communication study, all the elements of communication such as talking, writing, reading and somehow, listening need to be taken seriously into account if an understanding of what goes on in the classroom is to be appreciated. This does not mean that there are no other forms of communication. Certainly other forms such as gesturing, beckoning, eye movements, facial expressions etc do have their functions in communication which are generally important.

Science teachers in Nigerian Schools still retain the tradition of placing emphasis on the use of impersonal language in the teaching of science. The belief is, first, that this maintains objectivity and second, that such language is the language of scientific discourse and record which they should not alter no matter their level of knowledge or competence in teaching. It is also observed that the few teachers who attempt to break that tradition are thought of as unqualified by the pupils themselves. And as every teacher wants to retain his or her credibility, they quickly revert to the status quo.

Teachers require pupils to record their experiences in the classroom, field or laboratory in that formal manner that hardly distinguishes individual experiences. The tradition of reporting school science work under the headings: Aim, Apparatus, Method, Observation, Results and Conclusions, could be acceptable if such reports were personalized to some point or even left open to pupils to report in the best way they can. Yet it is not the case. The effect of this trend has been to remove scientific experience from the everyday experience of the students. This could have inhibiting effects on learning. The A.S.E. (1981) has remarked that one important distinction often not drawn is between the language we use when establishing relationships and concepts and that used in reporting them. In view of this, the Association argues that as the main emphasis in the teaching of Science is on establishing fundamental relationships, it is necessary that a premium be placed on the use of the personal language of everyday life even in Science lessons.

Bruner (1966) also points out that teaching is vastly facilitated by the medium of language which ends by being not only the medium for exchange but the instrument that the learner can use himself in bringing order into the environment. As spoken language is the form of communication most used in the classroom, its importance further derives from the fact that it makes knowledge and thought-processes readily available to introspection and revision, (Barnes, 1975). Barnes further argues that language is not the same as thought but that it allows us to reflect upon our thoughts. In effect, what we say and write mirrors our thought and its processes, and enables us to take responsibility for them.

2.2 The Teacher and the use of Spoken Language:

Spoken language (talk) is the most essential medium of classroom exchanges between teacher and pupils, and pupil and pupil. However, teachers think and speak in more complex ways than do most pupils. This is due to their longer years of schooling (learning) and exposure to, and use of the very language of learning now used in teaching. This situation is most evident where the language of learning, say English, is not the first language of the pupils and teacher alike. In the above circumstance, the teacher who quite early and naturally realises that he thinks and speaks in more complex ways than the pupils, will be expected to help the pupils even more.

It is appreciated that all subject teachers are also Language teachers. Yet, most non-language subject teachers for example, science and mathematics teachers are thought to teach language only indirectly. Since language is an important part of classroom communication, it is desirable that this group of teachers should seek assistance from experienced language teachers. In effect, whether the subject, biology or chemistry or physics or integrated science is to be used as a motivating subject for the use and development of pupils' language skills is clearly a matter for those teachers. Whatever a teacher decides to do, that is, whether to teach the subject without regard for proficiency in language on the part of the pupils or otherwise, it is important that he should help the pupils to enjoy self-contentment in terms of self-expression.

It is evident that everytime a pupil stands to speak in the class whether by appointment by teacher or by volunteering, one readily sees the representation of the teacher's confidence and faith in the pupil. Marsh (1973 p108) points out that the more the pupils are allowed to talk and exchange ideas, the more faith and confidence the pupils develop in themselves and in their teacher.

On the part of teachers, there is the temptation to talk pupils into insensibility, especially the new teacher anxious for good discipline. While the pupils are having to listen or appear as if they are, they cannot be getting up to mischief. This assumption probably accounts in part for the research reports that teachers talk more than half the teaching time available to them. Flanders (1970) suggests that a typical American School classroom has about 68 per cent teacher talk, 20 per cent pupil talk and 12 per cent lost in silence or confusion. Thus teachers talk a great deal. Further research studies, for example, Bellack et al (1966) have also shown teachers talking three or four times as much as all the pupils put together. This is thought to be the teacher's strategy for imposing his or her definition of the situation by talking most of the time, Delamont (1976). She argues that this teacher talk is seen as synonymous with teacher teaching, while silence on the part of the teacher will be seen as an abrogation of the teacher's role.

However, it is easily forgotten that purpose is important at both ends of communication. The receiver (mainly pupils) should be as certain about what he/she is listening to or reading for, as the sender (most often teacher) is about why he/she is saying or writing something. After all, the effects of any talk depend upon the purposes for which it is being used, the context in which it takes place, and the ideas and values that are being promoted (Tough, 1977). For it is only thus that the receiver can know how to listen or read and how much. It can also help pupils to have some idea of which bits of knowledge will help them to make sense of the communication. So when a teacher begins to speak to a student and wants him to listen or be more attentive, he must tell him why.

The more specific the teacher can be about the purpose, the better. Anyhow, it is doubtful whether many teachers take the trouble to ritualize this concept in actual teaching situation. Many teachers are thought to be just interested in saying what they have to say without ensuring that pupils (receivers) benefitted from such talks. In effect, they become too robust in speech during teaching. This situation breeds doubts, and eventually, questions about the quality of the teacher talk. Does this talking-man-machine talk sensibly to the benefit and understanding of his/her students? What proportion of this robust talk embraces subject-matter which students are supposed to be taught as against non-subject-matter or trivialities?

In a formal secondary school science lesson, the language used tends to include many technical terms. As a result, a pupil in a science lesson who has not built up the full relevance structure with which the term 'environment' for example, is now endowed will miss out much that follows its use. Thus for science teaching especially, language means more than gaining familiarity with technical vocabulary. Gaining familiarity with technical terms without an understanding of what they mean amounts to rote-memory learning which is not particularly helpful or beneficial in terms of effectiveness. Hence, it is necessary to try and bring about some understanding through explaining what the terms mean so as to ensure their correct and effective usage. To achieve this correct and effective use of terms, teachers need not discourage talk in the classrooms as long as pupils are not being rowdy and disruptive. Also, talk should be encouraged as this leads to development of language skills and competences by the pupils. This way, pupils will be comfortable and hence want to talk and learn through a systematic build-up of the sub-concepts relating to the main concept - terminology, to be consequently learned.

2.3 The Place of Explaining in Science Teaching:

Though it has been argued, (Delamont, 1976), that teaching and talking are synonymous on the grounds that both talking and teaching involve explanation, this author wishes to suggest that a teacher's ability to explain and consequently provide an understanding of the stated problem, is the key to successful and effective teaching. In science teaching, teachers often explain terms, principles, rules, concepts, functions and uses etc. What is not clear is whether the explanations are well conceived and effective.

According to Bellack et al (1966) "to explain is to relate an object, event, action or state of affairs to some other object, event, action or state of affairs; or to show the relation between an event or state of affairs and a principle or generalization; or to show relationships between principles or generalizations." If the working definition of explaining can be the attempt to provide an understanding of a problem or relationships between principles and generalizations, then failure to understand on the part of the explainee can be attributable to lack of effective explanation. Under normal learner circumstances an understanding should be gained when an effective explanation has taken place, but, the degree or level of understanding could vary from one learner to another due to the effects of learner characteristics discussed in the previous Chapter, (1.1) and on the type and method of explanation employed.

For an explanation to be understood, Brown & Hatton (1982) point out that the explainer has not only to consider the problem to be explained, but also the knowledge and characteristics of the explainees. As matching explanations to the explainees may appear easy in theory but difficult in practice, it is thought that estimates of the level of understanding of the pupils should be sought. It is usual for teachers to make estimates of the level of understanding of the pupils before and during explaining, and whenever convenient check that the explainees have understood what was explained or taught. However, the degree of effectiveness of that explanation by the teacher among other things depends on what factors he has taken into account.

Three useful factors which contribute to effective explanation have been outlined by Perrott (1982 p33). They are: Continuity, Simplicity and Explicitness.

2.3.1 Continuity:

It is important that in explaining an issue in a lesson the various points dealt with should have connections. This can be achieved if teacher ensured that the connecting thread is always clear and apparent. This point is linked to the teacher's fluency. Explanations get bogged down if the teacher is not fluent in speech and to help pupils understand an explanation, it is important that teachers use easily intelligible grammatical sentences. It is clear that the ability to talk coherently is dependent, at least in part, on mastery of subject-matter and social confidence in the class situation.

2.3.2 Simplicity:

Many teachers are known to be verbose. For effective explanation, and because explanation is partly concerned with relationships which are complex, it is advisable for teachers to keep sentences short and where possible use more visual means to explain points made. It is realized that the use of unexplained specialist terminology which is not within a pupils' vocabulary does not enhance understanding. Rather, it encourages rote-memory. So, for success in explaining, teachers should use simple language which pupils would normally understand.

2.3.3 Explicitness:

Use of phrases such as 'you know', 'of course', 'okay', 'right', etc present vagueness in what is being explained. In explaining, teachers need to be as explicit as they can possibly be. It is thought that the extent to which explanations are made explicit, is related to pupils' attainment. In effect the more explicit the explanations the better the pupils' achievement. (Perrott, 1982).

2.4 Structure in Explaining:

The structure of an explanation as in the presentation of a prepared lesson, determines the clarity and interest of the explanation. Hence an explanation must have: use of examples, organization and use of feedback as its central structure.

The use of examples, like analogies which will be dealt with later in this Chapter (see 2.4.2), are useful and help pupils to grasp new concepts and processes. They not only link a pupil's experience to some new concepts and processes but as well, link pupils' existing knowledge to concepts and processes. The use of examples, like analogies, are crucial in explaining as they also provide interest and cognitive links and thus sustain pupils' attention.

It is now understood that at its lowest level the process of explaining involves presenting sets of facts or simple instructions. While at higher levels explaining goes beyond facts to consider relationships between facts and to consider reasons, motives and causes, (Brown & Armstrong, 1984). If so, explaining, which is an important process characteristic in science teaching especially in the Nigerian School situation deserves proper appraisal. It will be necessary to define the characteristics of good explaining, the strategies of explaining and the incorporation of explanation in teaching strategies.

The works of Brown & Armstrong (1984), Brown & Hatton (1982), Brown & Armstrong (1978), Brown (1978), Brown (1981), Perrott (1982) and Dunkin & Biddle (1974) are certainly of value in this regard. In a study of P.G.C.E. biology student - teachers, Brown & Armstrong (1984) presented ten biology topics ranging from: phyla, biome, fossil, ecological succession, energy, pollution, influence of environmental factors on plants and animals etc, to ecosystems, culled from biological sciences curriculum materials to the students to prepare. The students were required to teach two of these topics to groups of 11 to 12 year olds in two 10 - minute lessons. Half the group were given training in explaining between teaching the two lessons while the remainder were trained after they had taught their two lessons. Soon after teaching the pupils were given multiple choice questions on lesson content aimed at recalling information for use in problem solving.

The outcome of this study in which the lessons were video-recorded, transcribed and transcripts subjected to both variance - and cluster - analysis, is particularly useful. There emerged the fact that there are three types of explanations which, though close to those postulated in earlier studies by Hyman (1974) and Smith & Meux et al (1970), are different contextually. The three explanation types - 'Interpretive', the 'Descriptive' and the 'Reason-giving' have the following characteristics:

Interpretive Explanation - clarifies, exemplifies or interprets the meaning of terms and answering of questions based on 'what'?

Descriptive Explanation - describes a process or structure and answering of questions based on 'How is?' or 'How does ...?'

and

Reason-giving Explanation - which offers reasons or causes, the occurrence of phenomenon and answering questions based on 'Why is?'

The outcome of the above study is based on cognitive levels which they structured as follows:

Cognitive Level	Keys (major sections of explanations)
1.	Stating, defining, describing, classifying, designating.
2.	Comparing, descriptive explanation, interpretive.
3.	Reason-giving, causes, motives.
4.	Conditional inferring.
5.	Evaluating.

This reveals that the good explainer tends to make higher cognitive demands on the pupils. Although the average group uses 'conditional inferring' (Level 4) quite frequently, the good explainer uses more 'comparing keys' (Level 2). Pauses and incomplete sentences occur very less often for good explainers. On the other hand, the poor explainer makes less cognitive demands on pupils while at the same time uses more 'causal keys' (Level 3). For the poor explainer, incomplete sentences and summaries are quite common features.

On whether training improves the ability and skill to explain, Brown & Armstrong (1984 p133) suggest that it does. Since 6 of the 12 good lessons and only 2 of the poor lessons occurred in the post-training lessons of the experimental group, and since the experimental group had significantly fewer hesitations, used more reason-giving keys and more focusing statements that is, statements that highlight the content such as brief summaries to tell pupils what is going to happen or has happened, more framing statements - statements which begin with attention seeking words as: now ..., so ..., etc indicating that one stage of the explanation has ended and another beginning, which are all associated with 'better' explanations, it will only be proper to infer that training does and can improve the explanatory ability and skills of teachers.

This inference has been made out of the degree of uncertainty which the overall results showed. In their words "In terms of low inference process variables studied, the programme yielded few significant differences between the experimental and control group on the post test." This has been attributed, in part, to the low incidence of some of the training variables studied.

The suggestion that planning strategies for better explaining should embrace: analysis of topics to be taught into main parts or keys, establishment of links between parts, determination of rules involved (if any), specification of kind(s) of explanation required and adaptation of plan according to learner characteristics, is significant in view of lack of insight on the part of some teachers of what and how an explanation should be given to a learner. It is also suggested that the basic skills in explaining should be developed in teachers along these lines culled from Brown & Armstrong (1984) and Brown & Hatton (1982):

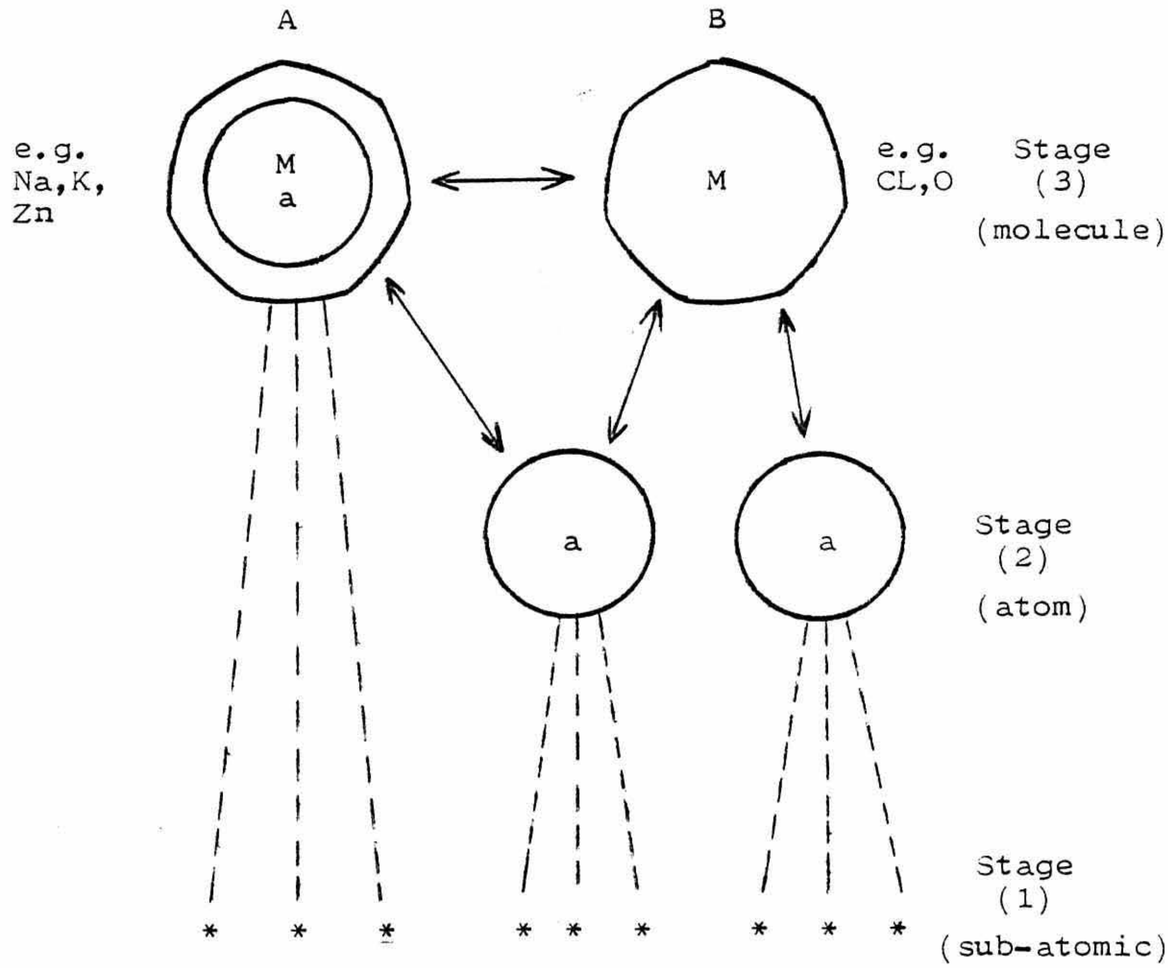
Clarity and Fluency	- through defining new terms. - through use of explicit language. - through avoiding vaguenes.
Emphasis and Interests	- by variation in gestures. - by use of media and materials. - by use of voice and pauses. - by repetition, paraphrasing or verbal cueing.
Using Examples	- clear, appropriate, and concrete. - in sufficient quantity. - positive and negative where applicable.

Organization	- logical and clear sequence. - pattern appropriate to task. - use of link words and phrases.
Feedback	- opportunities for questions provided. - understanding of main ideas assessed. - expressions of attitudes and values sought.

While some aspects of teacher education programmes in Nigeria may well be said to be in line with what obtains in developed countries like the United Kingdom, training of teachers to develop certain essential but specific skills as with questioning, explaining etc has hardly been beneficially exploited. Training is still religiously centred on the teaching of educational foundation courses in psychology, philosophy, sociology and educational history etc which, rightly or not, have little direct bearing on classroom processes and interactions. This is not to suggest that teaching specific skills can replace the educational foundation courses. Yet, it is necessary to give some prominence to the development of specific teaching skills. As Wragg (1984 p14) points out study of the foundation courses by itself "... did not necessarily make students (teachers) operational in the classroom ...". Hence if the coming, and more importantly the present generation of teachers should develop into highly skilled professional people with sharp insight into classroom life and a sustained appetite for improving their own teaching and their pupils' learning, then the development of specific skills must be embraced in teacher education programmes.

2.4.1 Use of Constructs in Explanation:

To use constructs consisting of concepts and models in explaining during science lessons, it is thought that a teacher should be accomplished both in subject-matter and language so as to be adequately explicit during teaching. For example, to distinguish between an atom and a molecule in a largely expository (descriptive and explanatory) lesson, the following construct could be used:



where M represents a molecule, 'a', represents an atom and the * (asterisk) representing the sub-atomic particles of which atoms consist. The teacher can explain the model by emphasizing the 'stages' 1, 2 and 3 existing in molecule B, and 1 and 3 existing in molecule/atom A. Further, the fact that A is represented as being $\frac{M}{a}$ will generate thought in pupils and bring about some lively exchanges between pupils and teacher. Through these exchanges pupils will build mental pictures of what distinctions exist between an atom and a molecule. This construct will enable pupils to further visualize the all too often emphasized distinction based on ability to exist independently for molecules and not atoms. As a successful explanation in science teaching requires adequate understanding of the broad and specific concepts and/or models which are to be explained, and which by man's making has become the fundamentals of science, use of modular constructs is expected to be most valuable. This probably explains why a number of science teachers teach by emphasizing acquisition of concepts which are the bases for the development of further new concepts.

2.4.2 Use of Analogy in Science Teaching:

Science teachers use analogies quite extensively during teaching without necessarily realizing its significance. The role of analogy and its place in the development of scientific knowledge, and particularly its value as a pedagogic tool is of significance to science teacher in the bid to achieve effectiveness. This significance stems from the use of conceptual models in science teaching. Analogies deal with synonyms, that is, things, objects or situations which are similar.

In science teaching, analogies are used to explain concepts, principles, laws etc. They are used in the bid to give insight to what is being learned, and in effect, they help to reduce the length of explanations. From this viewpoint, it may well be argued that we reason analogically. Whenever we try to teach, or understand or learn new concepts or phenomena, we draw parallels to old familiar concepts or phenomena. Equally, whenever something is explained using comparisons with other phenomena or concepts the situations result whereby, "instructing with analogy" in Simons' (1984) words, is the case. For example, the action of electrons in wires can be described by comparing them with human beings while dancing. This example amplifies the suggestion and thinking by Beetlestone & Taylor (1982) that since a child draws no sharp distinction between work and play, it is possible to link science and drama in school and thus integrate science learning with the rest of the child's education. Based on observed responses from the use of drama as a vehicle for science, it is thought that it has provided a stimulus and opportunity to make science interesting, understandable in common-sense and above all, fun for a wide range of pupils. Thus analogies are effective learning/teaching aids which make abstract information more imaginable and concrete. This function is that of 'concretizing'. Simons further argues that analogies function mainly to 'structurize' new information. This is exemplified as follows: in creating a new schema, an existent analogical schema may be used as a formal structure that can form the basis for the new schema. In this way the formal structure of new schema does not need to be learned. All that needs to be done is supplement this formal structure with new information.

In a set of experimental studies designed to answer some questions, that which most concerns this study being: 'does the addition (or use) of concrete analogies lead to improved performance in subjects of different ages?' Simons concludes that the use of concrete analogies leads to improved performance in elementary and secondary school pupils and in college students. In Simons' words "it is remarkable that in several of the experiments significantly better results were obtained when subjects were learning with analogies ...". In the same study, Simons concludes that use of analogies becomes effective because of the three functions they perform. These are for concretizing, structuring and active assimilation which make relevant anchoring ideas available and stimulate students to integrate actively the new information and previously learned information in the cognitive structure.

Weller (1970) also agrees with the use of analogy by teachers in a structural sense. By this Weller means the similarity or resemblances between objects or situations without including inferences or arguments. This use of analogy is similar to the way Simons (1984) used it, but it does not mean that analogy cannot be employed in an argument. Thus in the logical sense for which an analogy is also used by the teacher, it refers usually to an argument where obvious similarities between two objects are used as the basis to infer the existence of non-obvious similarities between the objects, according to Weller (1970 p113).

All the same, it must be pointed out that there are inherent dangers in the use of analogies which may prove to be more of a detriment than a help, and obstruct learning especially when invalid and inconsistent analogies are used. When this happens analogies end up propagating erroneous concepts. This situation can arise where, for example, a biology teacher employs a principle or law of mathematics to explain fertilization in mammals. In this situation, adding one to one gives two in mathematics. But in fertilization, adding (fusion) one egg (male) to another egg (female) gives one fertilized egg (zygote). This analogy, therefore, cannot be correctly employed in explaining what happens in fertilization.

Even so, analogies have legitimate functions valued as pedagogic tools. And when used with proper understanding and care, an analogy can be an excellent device to save time, energy and effort for teachers, in addition to the great insight and understanding it engenders in pupils.

2.4.3 Use of Historical Accounts in Explanatory Science Lessons:

The use of historical accounts to improve pupils' understanding in a largely expository science lesson is beginning to be given more serious consideration. Besides Ivany & Oguntonade (1972) whose study suggested amongst other things that teachers needs to "use historical accounts of scientific investigations to illustrate the epistemological foundations of physics," which was their concern, Bradley (1983) has been a leading proponent of this idea. Bradley advocates an approach to chemistry teaching for example which will reflect what he calls the "heuristic thrust" and the "history lift" to succeed in "widening the front."

Bradley argues that "without the living thought of the historian, now, as he rethinks the past, there is no genuine history; without the living, growing, creative thought as the chemist theorizes now on the otherwise dead body of chemical fact, there is no genuine chemistry."

Klopfer (1969) also argues very strongly for the need to employ historical accounts in science teaching. Using Sir Humphrey Davy's visit to France in 1813 at which time he outdid his French colleagues by the speedy and decisive discovery of iodine, Klopfer illustrates how this approach to science teaching could have appeal to pupils. On this strength Klopfer (1969) argues that "Since the insights obtainable in science history are also applicable today, science teachers may confidently use the history of science in their instruction to illuminate some of the essential aspects of the scientific enterprise." It also would enable pupils to appreciate "... the building-up of each man's investigations on the prior work of his predecessors, with the eventual result that the total fabric of knowledge and understanding is much more than any individual's contribution."

The account of Davy's work on iodine also calls attention to the function of theories in science. In the course of Davy's research, he demonstrated that hydrogen iodide, though it forms an acid in water solution, does not contain oxygen, a finding which threw out of the window Lavoisier's oxygen theory of acids which had hitherto performed quite satisfactorily.

On the question of pedagogical utilization of historical accounts, Klopfer argues like this author had pointed out that "... the historical materials must be part of an appropriate teaching strategy planned as carefully as the use of any other instructional materials."

In a historical case study in science, Klopfer points out, the evolution of some portion of a major scientific idea is followed in detail in order to illustrate aspects of the scientific enterprise and of the processes of scientific inquiry, as well as to teach the specific science subject matter.

On the whole, it is note worthy that it was on these grounds, and the fact that the use of the history of science illuminates the strategy and tactics of science teaching that its proponents fix their arguments. Further, historical case studies suitable for use in upper elementary school science classes, or in junior high school science are probably best presented in the form of a short story. Dramatizations of science concepts and stories are also gaining momentum, (Beetlestone & Taylor, 1982).

In conclusion, Klopfer argues that historical accounts of science can make the present-day learning of science more meaningful for the students, especially if the history of science materials included are well-selected, organized and strategically taught.

2.5 Effective Questioning and Science Teaching:

Questioning, another very important teaching skill is used extensively during teaching by teachers. At high school level, Bellack et al (1966) found that the core teaching sequence in the classrooms studied is teachers' questions, pupils response, and more often than not, teacher's reaction to that response. In this study, 72 per cent of classroom talk was shown to be by the teacher, and of this, slightly less than 7 per cent was devoted to responding to pupil initiated talk, the rest consisting of asking questions, focusing pupils' attention on topics and commenting on what they say.

Generally, however, it seems that teachers spend about 30 per cent of their teaching time asking questions.

In effect, depending on the subject matter, the ages and abilities of the pupils and the experience of the teachers, as many as 100 questions can be asked by a teacher within one hour, Brown & Edmondson (1984). During teaching, questions are asked by teachers for various reasons. Thus, the kinds of questions the teacher asks should reveal to the pupils the kind of, or level of thinking which is expected of them.

The above thus leads to questions like: what is a question? and, why do teachers use them? At first, the answer to "What is a question?", may appear quite obvious. Yet as Brown & Edmondson (1984) point out, "... deciding what counts as a question in the classroom may be less easy than first appears." By ordinary standards, any statements made by the teacher, as opposed to commands, requiring verbal and non-verbal responses may perform the functions of a question as long as a verbal response has been evoked. Hence, they define a question in the classroom as "any statement intended to evoke a verbal response." This implies that questions which teachers ask and continue to make their points or explanation without waiting for, or expecting an answer or response, are considered statements but more appropriately they are rhetorical questions. This point is stressed clearly as a ground rule in the use of the science teaching observation schedule. Eggleston et al (1975 p20) state that "when the teacher asks pupils a question and continues the lesson without waiting for an answer, then such questions are to be classified as statements." Hence questions become questions only when there is a response. Intention may not be sufficient.

The second part: "Why do teachers ask questions?", again, provides a wide range of levels of teachers' thoughts and concepts about use of questions during teaching. In asking questions, as Marland (1975 p74) points out, "the teacher is helping the pupil to focus and clarify, and thus to have thoughts and perceptions that he would not have had otherwise." Yet the degree of focus and clarification appears to depend on the cognitive level of the question. If the questions are of a lower-order type then the response may be also of that type.

The important characteristics of most lower-order questions are that they evoke remembering of specifics such as facts, and information. On the other hand, higher-order questions which in turn evoke higher-order thinking and responses have characteristics such as changing the form of information in order to compare, or contrast, explain or summarize, analyse or synthesize or evaluate. In the words of Perrott (1982 p48) "in order to answer a higher-order question a pupil may recall or be given information, but he must go beyond that and manipulate or use the information to produce an answer which differs in form and organization from the form in which it was previously encountered."

Thus questions serve differring and varying functions and purposes. Elizabeth Perrott (1982) has presented six levels of questioning drawn and based on the Bloom's Taxonomy of Educational Objectives. Although, there may be other ways of classifying questions, the levels she suggests - knowledge, comprehension, application, analysis, synthesis and evaluation, are clear and quite comprehensible. Invariably, other ways of classifying questions reflect these levels. They differ only in terminology and intent. Thus, as Brown & Edmondson (1984) point out, "questions may be classified in terms of the mode of delivery, such as threatening, neutral, encouraging; according to target, whether to particular individuals, groups, or the whole class; in terms of the degree of clarity of the question and, according to the type of question asked, whether the question is primarily cognitive, effective or procedural."

On the other hand, Fischler & Zimmer (1967-68 p134) have classified Teacher's Questions into five (5) types according to the type of student response. These are:

1) Recall Facts - a question requiring the student to do no more than simple recall of facts or bits of information. 2) Relationships - a question requiring a student to see and understand relationships between ideas or facts in order to explain, generalize, pick examples, etc in answering the question. 3) Make Observations - a question requiring the student to make an observation in order to answer the question. 4) Hypothesize - a question requiring the student to reason out or possibly to guess the answer, based on past knowledge or experience, and 5) Test Hypothesis - a question requiring the student to validate or think of ways to validate an answer, fact or hypothesis.

Whereas the scope of this work allows for an indepth study or analysis of the types of questions teachers ask pupils in their classes, the importance of the use of questions especially intended to evoke responses of various kinds and levels of thinking is central to effective teaching and learning and will be dealt with in Chapter 7. In a study partly aimed at determining if the inquiry questioning behaviour of teachers influenced students' achievement, Ladd & Anderson (1970) found that "... teachers' questioning behaviour strongly influences student achievement," and that the students of high inquiry teachers performed significantly better on tests which contained a) low inquiring questions, b) high inquiry questions, and c) the combination of tests a) and b).

This further supports claims by investigators such as Scott (1966) that the teacher can be a significant influence in guiding and developing the thought processes of students. These students' thought processes are influenced by the use of higher level, inquiry-provoking questioning techniques which are said to generate improvements both in the quality and quantity of the students' response.

It is also realized that the starting point of effective use of questioning in teaching is in providing classroom environments conducive for pupils to talk-on-tasks. This is what Kerry (1982) describes as "on-task talk", and not talk for the sake of it. In school systems, where pupil on-task talk is not encouraged or pupil responses characteristically limited to monosyllables such as: yes, no, and giving of one or few recall words, difficulty in the use of questions effectively as a teaching tool will be encountered.

In a brief distinction between questions, Kerry (1982) talks of 'open' and 'closed' questions. Whereas closed questions evoke responses which are monosyllabic or single correct answers, open questions evoke responses which enable pupils to give opinion, speculate and provide a generation of hypotheses, and putting up of an argument. Also, open questions allow pupils to express feelings, empathy, intuition and values, and for the teacher to put further questions. These further questions put by the teacher especially when skilfully done, should stimulate curiosity and the desire to know.

In a study undertaken by Perrott et al (1975) with some experienced teachers as sample, 47 per cent of their discussion questions were in the higher-order category before training. But after fifteen hours of training involving the study and practice of questioning skills, both the percentage of higher-order questions asked by the teachers and the percentage of higher-order responses given by pupils showed a significant increase. The percentage of higher-order questions increased from 47 to 64, while the percentage of higher-order responses by pupils increased from 50 to 67.

The outcome of the above study has shown that questioning skills can be developed in teachers to improve their ability to probe and direct pupils' minds and thoughts, and as well encourage pupils to covertly participate fully during lessons.

Whereas increases in higher-order questioning by teachers after training and responses by pupils appear to be signs of improvement in teaching skills, Brown & Edmondson (1984) point out that higher-order questioning may after all, not be that important. They argue that "higher-order questions and the use of probing questions can raise the level of class discussion but bot necessarily performance in examinations ... because examinations are testing low-level skills, and because higher-order questions have a differential effect upon pupils of different abilities." Even so, as assessment methods improve to include pupils' covert activities in the class which in turn includes discussions, the use of higher-order questions by teachers resulting in higher-order responses by pupils, is certainly a significant feature in contemporary education which should have effective communication as its main area of emphasis.

2.5.1 Some Strategies and Tactics of Effective Questioning in Science Teaching:

Teachers ask questions frequently very many in any one lesson period according to available research evidence. Yet most of these questions appear to be mostly of lower-order which centre on recall of facts. The percentage of teachers' questions which are concerned with the recall of facts is put at 60 (Brown & Edmondson 1984). This compares with Perrott et al's (1975) which was 53 per cent. Brown & Edmondson (1984) largely attribute this to information which must necessarily be acquired before it can be applied.

Hence, for questions to be effective and probing, and thus evoke any thinking on the part of the pupils, they must be adequately designed or phrased to ensure logical sequencing, timing and prompting.

One serious pedagogic error which many teachers make is the concentration on a handful of pupils in the class.

Many pupils, as a result, go through the whole day's schooling without being asked a single question. In such cases, the fault may not be the pupils', but clearly the teacher's. Kerry (1982) suggests that good questioning technique includes the teacher's ability to distribute questions around the class. Some teachers are known to be unable to break out of what Kerry (1982) describes as the teacher's "zone of maximum interaction" in the classroom to ask questions. This implies that only pupils within the teachers' arc of vision receive attention especially if the teachers appear to prefer the strategy of directing questions mainly to volunteers in their classes. In this circumstance, therefore, only the willing and capable pupils may attempt to answer questions, while the shy and slow learners may be left out.

For tactically beneficial reasons, therefore, teachers should nominate pupils to answer questions during whole-class teaching. There are times when volunteers may be appropriately invited to provide answers to problems, or questions. At the least, this may be done when it appears no one else could attempt to give the answer. Even when there are many volunteers, it may be necessary to watch out for pupils who are employing such devices to avoid being asked questions as they visualize teacher's intentions and tactics. In effect, distribute questions around the class by basing judgement on some clear yet flexible principles during questioning in whole-class teaching, not just rely on volunteers. As well, the nomination should follow a pattern not discernible by pupils to minimize the incidence of pupils' switching-off after getting what some pupils may think is their only turn for that lesson. Even so, it is thought that not all pupils will get the chance to give a response to any question or contribute to the problem of which solution is being sought.

Probably, a teacher should endeavour to encourage more pupils to respond to a question. To achieve this, it will be desirable for teachers to rephrase a question when it becomes obvious that the pupil did not understand it in the first instance. Teachers should not just pass on the same question to another pupil as many teachers do. By rephrasing the question the particular pupil and others like him who were inattentive will have the second chance to hear the question and think of a possible answer or response. But where the question is passed on to a volunteer at this stage in point, the inattentive pupil will only hear an answer or a response possibly without being able to figure out the type or level of question that merited such a response.

For tactical advantages therefore, it is necessary that teachers should ask questions which are clearly thought-out with the answers also clear in teacher's mind or in perspective. For it will be tactless for a teacher to ask questions whose answers the teacher does not clearly visualize. For another tactical benefit, it is best to appoint another pupil in the class to supply the correct response if the first or also the second pupil gave an incorrect response or answer, inspite of the clarity of the question. This point is made in realization of the haste with which some teachers provide the correct answers. Many teachers are impatient with their pupils and as a result try to provide answers even before pupils have had a fair chance to think about the questions. This leads to the next section on timing.

2.5.2 Timing and Pausing in Questioning:

When a question is asked, be it a closed or an open one, a higher-order or lower-order question, it is necessary to give pupils sufficient time, determined by the amount or level of thinking required, to produce an answer. As most pupils would rather be slow to respond and get it right than to be hasty and wrong, it is absolutely vital that teachers should allow pupils enough time to think out and organize their answers. This does not suggest that a pupil be given the whole day to think out an answer; a few seconds may be enough. Rowe (1974) studied wait-time and rewards as instructional variables etc and found that after a teacher asked a question, students have to begin a response within an average time of one second. If they did not, the teacher repeated, rephrased or asked another question or called on another student. A teacher's re-action to a pupil's response followed after an average time of 0.9 seconds. The average time of one second which lapses before the teacher either rephrases or redirects or even asks another question as Rowe found is certainly too short a time to allow for information processing to come into play. As it is realized that any undue and highly protracted silence can invite 'trouble', teachers should try in the words of Kerry (1982) "to read the signs of readiness to answer on pupils' faces, in their eyes or their gestures ..." when stating a question, so that time of waiting can be reduced to an acceptable time lapse before an answer is given by pupil. Rowe (1974) further reports that after the wait-time mean was successfully raised to 3-5 seconds through inservice training prog-rammes for the sample, the length of student responses, the numbers of inquiry-process responses and the frequency of student questions increased. The significance of this outcome adds to the need for teachers to be encouraged to exercise restraint in their rapid-fire, questioning manner approach in teaching.

For further tactical reasons, questions should be asked calmly and authoritatively with teacher's facial expression clear and certain of what should be expected. It is this expression which further encourages pupils to deepen their thoughts and to provide higher-level responses. In effect, the facial expressions of teacher provides the cues which tell pupils who understand these expressions, what level or kind of response they require to give as response.

2.5.3 Prompting in Questioning:

Prompting as a probing skill has a tactical value. It is used when a pupil gives a very weak response, a partly or completely incorrect response and/or when the 'I don't know' response is given. In such circumstance, the teacher will be expected to rephrase the question to give it precision which in turn prompts or helps pupil to organize a response. A prompting strategy of questioning is based on a series of questions containing hints or leading-questions that help the pupils to organize and develop their answers. Most often, prompting starts with what the pupils already know and progresses to the unknown. Questions dealt with in this manner are usually classified as 'leading questions' as will be realized when the attempt will be made to classify questions asked by the teachers in Chapter 7.

2.6 Written Language and Science Teaching:

According to Musgrave (1965,1979), all "teachers bring to their classrooms educational ideologies, often with a high level of abstraction, which they have to apply in a general way in order to develop specific beliefs and practices for use in their day-to-day work. When they are confronted with the everyday problem of teaching they have to convert their higher-level and generalized views into detailed behaviour to meet their present situation." There is little doubt that this is how teachers function. Yet there are times when it appears that some teachers function the other way round. Such situations may be evident in classrooms where, the teacher has not planned or did not prepare his lesson before coming to the lesson. Often some remedy the situation by asking pupils to start writing 'something'. Thus all too often, teachers involve their students in quite a lot of written work.

They may be required to listen and write, read and write or just write. There is almost always some writing going on. It is not so much the ability to write out words legibly, even though it is an important first step, it is writing meaningfully, just like talking sensibly, that is important. What the teacher's responsibility must, and should always be, is to assist learners to write meaningfully. After all, writing meaningfully implies that the learner's thoughts which are organized in the language with which he thinks are being expressed freely on paper without hinderance. According to Thornton (1980) "Writing is a linguistic activity normally engaged in by an individual who is responding to a demand, and who is literate enough to switch into written mode to make that response." Even so it is acknowledged that talking is more easily accomplished than writing. But by capitalising on the benefits of meaningful writing, teachers can always help students cultivate the habit of writing leading to more meaningful writing.

Teachers set students tasks of writing usually for a purpose. Even where any one task is without an obvious purpose the students may want their works responded to by the teacher for correction or grading or both. Hence almost every time some writing is done, except in note taking situations by students, some form of grading is anticipated. To this end, the teacher must devise a positive way of dealing with students' written scripts. As Benton (1981) points out, response to written work matters; it is a main point of contact between teacher and pupil, can be crucial in shaping their relationship but its importance often underestimated. That response to students' written work by teacher can constitute a major point of contact between teacher and pupil lies in the fact that whatever comments a teacher makes on a student's written script should have the overall purpose of improving the student's future work.

2.6.1 Types of Writing:

For convenience and clarity, it may be necessary to distinguish written work by pupils into two categories. One is 'Writing for Teacher' and the other, 'Writing for Self'.

2.6.2 Writing for Teacher:

When pupils write for teacher, most often, it is teacher initiated. The teacher may have asked the pupils to write for a number of reasons or purposes such as for grading, assessment of how well pupil's are able to organize their thoughts, and show how well they are also able to pool both previous and new knowledge together, and argue a case. Many other purposes for initiating pupils' into undertaking some form of writing abounds.

The work of Carré (1977) in which some post-graduate biology student-teachers were each asked to produce a file to illustrate his awareness of the role of language in children's learning in science lessons, as well as, reinforcing his contribution as a specialist to a language across the curriculum policy revealed important issues. Among others, it became clear that teachers must help pupils while writing so that they may learn to use suitable language or terminology, (no matter how personal the reporting style may be), as a testimony that they (pupils) understood the subject-matter. Also that it will not be appropriate to tolerate writing for self when the audience is someone else.

Responsibility for the development of pupils' writing ability rests mainly, though not exclusively, with the language department. But, every teacher who asks for writing from pupils has therefore a responsibility for the development of individual pupils' writing abilities.

A piece of writing produced by a pupil should be regarded as evidence of what the pupil can do at the time it is produced. The job of the teacher, on the basis of that evidence, is to try to see that the next piece of writing is better. According to the nature of the writing, and where it comes in the programme being pursued, teachers should know what emphasis to place on the various features of the pupils' attempts to make meaning in writing.

Having argued thus, it will be rather helpful when pupils come to understand that what their teachers are doing when they draw attention to features of their writing is offering help in overcoming problems, which enables a genuine learning partnership to prevail. In this wise, the pupils will realize that their work will be judged sympathetically; that its merits will be recognized; that its shortcomings will be described, and that effective help will be forthcoming to enable them to remedy any shortcomings.

2.6.3 Writing for Self:

As has already been pointed out, there are many other occasions in a pupil's school life when a lot of what he writes is meant for his consumption or at the most, for his partner on the bench to see. In effect, such write-ups are not meant for the teacher or other members of the class. Whenever writing of the sort not meant for the teacher is done in the class, it is usually hidden from the teacher for two main reasons. The reasons are that the teacher may be dissatisfied or even displeased with the content and consequently be critical of it, and also that the organization and presentation, including spelling and grammatical structure, may be below what the teacher may expect of the pupil. In this circumstance, it may be necessary to argue that teachers should criticize pupils' works less vigorously. As teachers are generally aware of the constraints placed upon pupils by their expectations it is certainly important that teachers should afford pupils the opportunity to write for themselves, so that in the process they may be able to express their ideas in more creative forms.

Thus whether the writing done by the pupils is meant for teacher or self, the importance of writing as a way of learning and a means of consolidation, cannot be over-emphasized. Some major setbacks which usually affect writing during science lessons in schools, are the degree of precision and brevity which they require, and the fact that they are almost, always addressed to an expert/ examiner audience resulting in very formal ways of writing.

As a way of minimizing this particular difficulty, it is thought that by making use of other audiences, pupils can be encouraged to use writing which would help them to develop and communicate ideas. Barnes (1975) studied secondary school teachers' attitudes to written work done by students. These teachers of third year classes in eleven secondary schools were asked to write down 1) Why they set written work, 2) What they kept in mind when they set it, 3) What they did in marking pupils' writings and 4) What uses, if any, they made of it after marking. After categorizing and factor-analysing the answers given, it was realized that the reasons fell into a dimension which runs from a 'transmission' view of teaching and learning to an 'interpretation' view as given below:

TRANSMISSION ⟵	⟶	INTERPRETATION
Recording Aquisition of Information	(Purpose)	Cognitive Development Personal Development
Product Task	(Awareness)	Context Pupils' Attitude
Assessment No Follow-up Correction	(Response)	Replies and Comments Future Teaching Publish

The clear picture of the teachers' intentions in setting written work which emerges from the above will be particularly helpful in the preparation of teachers. The teachers who see writing from an interpretation viewpoint, see it as a means by which the writer can take an active part in his own learning. Thus as pupils write they reshape their view of the world, and extend their ability to rationalize and their thinking about it. As well pupils' writings are seen as relevant to the purpose for which it is intended thus contributing to a dialogue (interaction) in which the pupil is an important and active participant.

At the other extreme - Transmission, are teachers who think of writing as a means of measuring the pupil's performance against teacher expectations and criteria. Thus on setting a writing task these teachers' attention will be focused upon the kind of writing they expect and not what the students can produce. For such teachers, writing is valued simply as a record to which their pupils can later look back, while their responsibility in receiving pupils' writings or write-ups is to award grades.

The implication and importance of this lies in the fact that teachers have reasons for setting pupils to written tasks, though some reasons are valuable and others not. Teachers who insist on giving grades to written work fall into those on Transmission category and would not, probably, care much for the process of acquiring the writing skills. While this is thought to be obvious, it is necessary to point out that both extremes have useful and important contributions to make in the development of classroom communication skills and competences. Probably, the essence of this in teacher education terms is that the value of both should be explored in the area of skill development in teacher training.

2.7 Classroom Language - A Review of Some Works:

A lot of work has already been undertaken on the use, forms and functions of language in the classroom. Invariably most work on teacher effectiveness and classroom interaction studies is based on classroom language.

Basil Bernstein (1961) analysed the forms and functions of language as they relate to social and educational environments. From this work emerged two general forms of language codes - the Restricted and Elaborated Codes. The characteristics of the restricted code are: short and grammatically simple sentences which are also syntactically weak. There is comparatively very little use of a range of qualifiers; subordinate clauses and impersonal pronouns are also less frequent in use. There is also a considerable supposition of prior mutual understanding expressed in terms like 'you know', and 'you see' etc. Here the language is largely restricted to the function of handling social relations within situations of implicitly accepted common meanings and values.

In contrast, the characteristics of the elaborated code are: sentence structures that are grammatically complex. Syntax is accurate and frequent use of propositions which indicate logical relations, and a discriminative and broad use of adjectives and adverbs. This mode of language is designed for detailed representation of past events and future plans, and for abstract and symbolic coding of experiences.

The implicit and tacit existence of these language codes which are evident in most classroom communication cannot be in doubt. Where a teacher uses a code which pupils from relatively improvished language backgrounds have no equivalent response, a restriction is realized. Almost always, the tendency for the teacher with his social and educational experiences, and the nature of his professional material will be to employ elaborated code, while pupils will employ restricted code. When and wherever this happens, as often found in most Nigerian secondary school classrooms, the constraint placed on communication in the classroom is usually inhibiting. This leads to unsatisfactory teaching, especially for the pupils due largely to incomprehension, and to problems in class management. Further, this incomprehension results in inhibited and thus unsustained teacher-pupil verbal interaction.

The importance of knowledge of the existence of such codes lies in the ability of teachers who may already have realized the existence of this kind of language barrier to create favourable conditions which will encourage pupils not only to speak but to want to speak and learn.

It is, however, equally realized that the home is where the major transformation can be sought. At present some children come to school with the experience of having been encouraged to join in conversations, to talk, to question, to turn to books and to listen. For others, there has been little or no such encouragement to talk and question but probably only to listen. This is very much the situation in most typical Nigerian homes. In these circumstances, there may appear to be little the school can do to help develop the classroom language or communication skills of the pupils beyond what it is already doing. Yet as Marsh (1973) argues "if schools are to provide richer opportunities for children to assimilate their world, mothers and fathers will need to feel as at home in school as at present do their children ... . The experiences of conversation, and talking and listening that are so vital within the school day need, through example and imitation, to become part of the home experience of all our children."

Another study of the forms, use and function of language especially as it pertains the classroom has been that of Bellack et al (1966). The main purpose of the research was to study the teaching process through the analysis of the linguistic behaviour of teachers and students in the classroom, with a subsidiary aim to study the linguistic variables of classroom discourse in relation to subsequent pupil learning.

With 15 teachers and 345 students as subjects, tape recordings and verbatim transcriptions of four lessons of each teacher were made and subjected to the system of functional and structural analysis of discourse.

Bellack proposed a hierarchical structure for lessons with four units: game, subgame, cycle and move. Game and subgame were defined in terms of the pedagogical functions they perform in classroom discourse, while move and cycle were defined in discourse terms. The lowest unit - move, was subdivided into four major categories: structuring, soliciting, responding and reacting.

Structuring: Structuring moves serve the pedagogical function of setting the context for subsequent behaviour by either launching or halting - excluding interaction, between students and teachers.

Soliciting: Soliciting moves here are designed to elicit an active verbal response, to encourage persons addressed to attend to something or elicit physical response. All questions are solicitations, as are commands, imperatives and requests.

Responding: These moves bear a reciprocal relationship to soliciting moves and occur only in relation to them. Their pedagogical function is to fulfil the expectations of soliciting moves; thus students' answers to questions from teachers are classified as responding moves.

Reacting: The reacting moves are occasioned by a structuring, soliciting, responding or prior reacting move, but are not directly elicited by them.

Pedagogically, these moves serve to modify (by clarifying, synthesizing or expanding), and/or to rate (positively or negatively) what has been said previously. Reacting moves differ from responding moves, while responding moves are always directly elicited by a solicitation, preceding moves which serve only as the occasion for reactions.

It became known that the moves which occur in classroom discourse do so in certain cyclical patterns or combinations - TEACHING CYCLES. A teaching cycle begins with a structuring or a soliciting move, both of which are INITIATING. They serve the function of getting the cycle to start. In contrast responding and reacting moves are REFLEXIVE in nature; they are either solicited or occasioned by a preceding move. Thus a cycle usually starts with a soliciting move by the teacher in the form of a question, continues with a responding move by the student addressed, and ends with an evaluative reaction by the teacher.

By utilizing the concepts of pedagogical moves and teaching cycles, Bellack et al, described classroom discourse in terms of meanings from the viewpoint of pedagogical significance of what teachers and students communicate. From an analysis based on what teacher and students communicate, four different types of meanings functioning in teacher-pupil discourse were distinguished: 1) Substantive Meanings - referring to the subject matter, 2) Substantive Logical - the process involved in dealing with the subject matter such as explaining, interpreting and defining, 3) Instructional Meanings - those concerned with managerial aspects of instruction such as setting exercises, and 4) Instructional Logical Meanings - processes concerned with management, such as defining, directing, permitting and negative/positive rating.

From this work there emerged certain important features, e.g. that teachers are more active than pupils in the amount of verbal activity that occur in classroom discourse. Whereas pedagogical roles in the classroom are clearly defined for teachers and pupils, teachers are responsible for structuring the lesson, soliciting responses from pupils, reacting to pupils' responses and summarizing aspects of the discourse. The pupils' primary role is to respond to the teacher's solicitations and only occasionally assuming structuring, soliciting and reacting roles. This presupposes even without statistics that the teacher dominates in the classroom discourse.

It also emerged that teachers tend to be remarkably stable over class sessions in their patterns of discourse, so that one can reasonably speak of a teacher's pedagogical style as an internally consistent and temporally stable dimension of behaviour. Teachers were always found to be highly fact-stating and explaining which accounts for 50-60 per cent of total discourse. While analytic (defining and interpreting) and evaluating (opining and justifying) meanings were expressed less frequently. Yet they were found to be part of the teacher's role.

Studies of classroom language as discussed in this Chapter reveal the important role teachers should play in developing the communication skills of pupils. As one of the principal skills for a teacher in encouraging learning is the ability to manipulate language (Lawton, 1981), it will be foolhardy to expect success in this direction if the students fail to effectively communicate with their teacher owing to the factors discussed so far. If the students are to become responsible for their own learning, then they must be shown through teaching and encouragement how to use talking, writing, reading and listening as ways of achieving that responsibility.

2.8 Readability and Science Text Materials in Schools:

Readability is an attribute of texts made up of factors such as the legibility of print, the number of words per sentence, the number of syllables per sentence, illustration and colour, vocabulary, conceptual difficulty, syntax and organization. As well, readability encompasses a wide variety of features like: style of writing, size and distribution of print, the presentation of subject matter, the complexity and formality of the language, and the motivation of the reader.

It is thought that whereas the reader's characteristics such as intellectual level of development, age and experience arising from exposure are central in effective reading and comprehension, readability factors and the attributes of texts are also inextricably tied up with the reader's characteristics. According to Sansom (1965,1978) before a child can interpret symbols, he must be familiar with the sounds they represent. Before he can understand a series of written thoughts, he must be capable of following similar spoken thoughts and of expressing them himself. In effect, a child can begin to read when he has attained a particular level of ability or mastery of text factors.

On the other hand, the ability to read (pronounce) the printed words in the text, say, a chemistry text, is different from comprehending what the text is all about. In teaching, one of the main concerns of the teacher is to help the pupils develop their language by building up the necessary connections between words more precisely. Cassels & Johnstone (1983) argue that teachers may be able to help pupils to make connections between new and existing vocabulary, and by the quality of these connections it may be possible to help the pupils to move from a vague understanding of a word to a more complete understanding of its meaning, and simultaneously improve their understanding of chemistry.

Having argued thus, it may be necessary to explore what the value of textbooks is to the reader in fostering learning and understanding. The purpose of any textbook is to communicate the subject to the reader. For this to be achieved the readability characteristics listed above of that book must match approximately the intellectual level of development of the reader. Where it does not match, the result will be a clear expression of boredom, dislike and consequently, for most people abandonment of the text.

In Nigeria, there are only a few publishing houses and consequently few writers, especially of science textbooks. The textbooks in use in the schools such as: The School Certificate Chemistry by Holderness and Lambert and A New Chemistry by Godman and Bajah, etc are either foreign or simply have a joint authorship. As a result of this, it is difficult for teachers to find books which encourage use of local materials and which match the abilities of students to use them.

Apart from the issue of local material and amount of content, the readability of these textbooks is still in doubt though they are prescribed by the Ministries in conjunction with the examining bodies. This action presupposes a match but this is not frequently the case. Even in the United Kingdom from where most science textbooks used in Nigeria are published, there is evidence that the reading levels of books used in its schools both for O'level and C.S.E. are considerably higher than the intentions of both authors and publishers.

A study of 27 chemistry textbooks currently used in the teaching of 11-16 year old pupils in the United Kingdom has been undertaken by Knutton (1983). He concludes that many chemistry textbooks intended for pupils between the ages of 11 and 16 have reading levels well in excess of those that might be expected in the target population. This is particularly the case with textbooks aimed at pupils in the first two years of the secondary school.

This conclusion by Knutton should confirm the reservations expressed by most science teachers in Nigeria over both the suitability and adequacy of the reading levels of textbooks especially in chemistry, in use in Nigerian schools. As Knutton found, the 5th edition of School Certificate Chemistry by Holderness and Lambert (1978) which is also used extensively in Nigerian schools has an average reading level of 21. If so, how is it possible that a pupil who is expected to complete secondary school education in Nigeria at between 16 and 18 years of age should read, comprehend and use by application, knowledge supposedly acquired from such a book? This is probably one reason why a high proportion of chemistry candidates in the West African School Certificate examinations fail to obtain good results.

By the same token, the ability to solve problems which has come to be regarded as an important part of any science course is thought to have direct bearings on the reading-levels of the textbooks. Selvaratnam (1983) argues strongly that besides reinforcing and clarifying the principles taught in lectures (lessons), a systematic approach to problem-solving encourages good learning habits, pinpoints areas of confusion, contributes to clarity in thinking and promotes intellectual development as well as standing the student in good stead when confronted with problems. In his argument, Selvaratnam attributes students' inability to clarify a problem as the major reason for their not being able to solve problems. He uses the word 'clarification' to include the identification of all the information and data which he claims is frequently not stated explicitly in the problem statement; thus hidden in words or statements. That information and data needed to solve a problem should be so hidden in words or statements reveals the first difficulty which is that, the reading-level is high and language structure complex.

In view of the fact that the use of words both technical and non-technical increase word density and linguistic complexity, which are important factors in readability assessment, it will be arguable that failure on the part of pupils to solve problems must partly be attributed to the readability of the book.

2.8.1 Textbook Selection:

As has become evident, the suitability of a textbook is determined by the many factors which have already been listed. Yet, it is realized that the specific criteria used by many teachers can be highly personal, and to a degree, idiosyncratic. This is the reason why in Nigeria, textbooks are recommended by both the Education Ministries in the States and the Examining Bodies. Even so this measure does not eliminate the problem of reading levels and inadequacy of textbooks. Were textbooks currently in use in Nigerian schools to be subjected to readability measures using either the Fry Graph, Flesch Formula, FOG Formula, SMOG Formula or even Dale-Chall Formula (which Knutton rejected because he found it difficult to apply), the schools could end up not having any books as learning resource books. It is probably better to use books with higher reading ages/levels than none.

The difficulties which teachers face in Nigerian schools cannot be under-rated. Yet it is important to help them to make judgements about the suitability and the reading ages/levels of the books their students are made to buy, not so much for cost, but for value in terms of intellectual benefits.

Chapter 3

3. LITERATURE SURVEY OF CLASSROOM INTERACTION STUDIES AND OUTCOMES

3.1 Teaching Strategies and Styles - A Clarification:

As pointed out by Herbert (1967), the term 'teaching method' has no stable meaning, and descriptions of particular methods are too vague and inconsistent to permit an observer to distinguish them in practice. The term 'teaching method' may therefore be taken to mean a particular procedure which has implications of rote or mechanical learning resulting from its general identification with the day-to-day procedures employed by teachers in schools. This stereotype of teaching method; is what this author intends to avoid at this stage as the term 'teaching style' is introduced, even though it is appreciated that different authors also appear to have different conceptions of teaching styles.

Some conceptualize the strategy of teaching as consisting of the teacher's attempts to translate aims into practice. Others such as Strasser (1967) separate the strategic decisions about teaching which are made before the lesson begins from the minute to minute exchanges between the teacher and the pupils through which the strategies are implemented. It is these 'exchanges' that are considered as the 'teaching tactics'. Thus, the teaching strategy includes decisions reached on types of lesson, pupils' ages, ability, class size and so on, aimed at ensuring that both teacher and pupils get maximum teaching and learning opportunities. Further, the teaching strategy extends to the content to be taught to the different groups of pupils.

On the other hand, instructional strategy which includes, especially, those sets of teaching tactics that have direct bearings on the minute to minute methods of intellectual challenges, social interaction and control, have become identified as important aspects of teaching. It has also become clear that teaching tactics are those short units of sequence by which teaching is carried on in the classroom, while longer sequences with common, identifiable elements yet with a cyclical property constitute teaching strategies, (Dunkin & Biddle, 1974 p336-337).

Earlier and in a similar perspective, Flanders (1970 p400) expressed the idea that different patterns of interaction strung together could be called "teaching strategy", and went further to add that in teaching, some kind of variations in teaching behaviour is required. When the above ideas are considered together, it becomes clear that it is this necessary variation in teaching behaviour that this author considers "teaching style". All said, the term 'teaching style' is synonymous with 'method', 'technique', 'process', etc. Yet the use of 'style' is preferred as it portrays certain inherent behavioural characteristics associated with effective teaching than when 'method' or any other term is used.

This leads naturally to the issue of research on teaching which has had a respectably long, but a regrettably inglorious history, according to Gage (1972).

3.2 Early Research on Classroom (Teacher-Pupil) Interaction:

There have been a number of studies carried out using different methods to determine what was thought to be teaching styles. One of the earliest researches aimed at analysing and describing in a systematic way the spontaneous interaction between a teacher and the children in his class was made by H.H. Anderson. From as early as 1939 Anderson observed for a number of years the sort of contacts between children in nursery and elementary school classes, and related these to the behaviour of the teacher towards the children, (Wragg 1979). After this particular period there seemed to be a lull attributable to low enthusiasm and to lack of reliable observation techniques.

Earlier studies have been concerned with the task of predicting the competence of teachers and in various ways, were restricted in their range of predictors. These approaches were so restricted that instead of employing direct study of the subtleties of classroom behaviours as obtains now, indirect assessment of teachers' personalities were emphasized. As Morrison & McIntyre (1969,1973 p15) point out, the lack of carefully defined criteria appropriate to teaching situations, and of objective assessment against these, added uncertainty to those research findings. Little wonder, that Jackson (1962,1979) dismissed all those studies in these few words - "the few drops of knowledge that can be squeezed out of a half century of research on the personality characteristics of good teachers are so low in intellectual food value that it is almost embarrassing to discuss them."

However, these early investigations have certain important characteristics. They measured meaningfully and potentially important behaviour patterns or traits, and retain the objectivity and reliability of the original items on which they are based. They also helped the teacher to effect change in his behaviour should he wish to do so since the dimensions are measured in terms of specific behaviours.

The slowdown in classroom interaction research which followed the earliest studies points to need for reliable tools as reason. This is also the view shared by Sean R. St J. Neill (1983) as he writes on the essence of good observation schedule. He argues that the complexity of classrooms means that some type of selectivity is required and that this could be achieved by choosing specific behaviour for recording or by looking intensively at selected periods of time when teacher and pupil are in contact for recording. The end result would be the successful distinction of teaching styles by specific behaviours which could have important effects on classroom dynamics.

Returning to the observation instrument Neill (1983) suggests that categories of behaviour selected for observation should be based on a model of the classroom as a system in dynamic equilibrium. In effect, present observation systems must move away from teacher oriented recording system and concentrate on actual classroom dynamics. Although this point is well taken in view of current studies moving in similar direction, one finds it hard to move very far away from the teacher's actions since it is his actions, utterances, initiatives, somberness etc that determine how classroom interactions develop and ultimately affect learning on the part of pupils. Thus, it may equally be necessary to concentrate on teacher's questions, utterances and actions to achieve a measure of reliability adequate for a particular study.

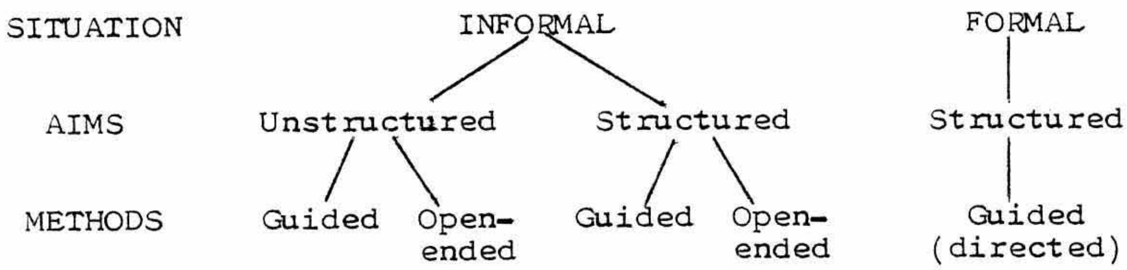
3.3 Methods used to Distinguish Teaching Styles:

Basically, there are three methods which have been used by various researchers to distinguish teaching styles in classroom interaction studies. They are by 1) Analytical Approach, 2) Observational Approach which uses (a) Category System (Flanderian) and (b) Sign System, and 3) the Questionnaire System.

3.3.1 The Analytical Approach:

As the name indicates, the analytical approach is both in design and intent, analytic. Classroom lessons (activities) are recorded either audio-visually or just by audio and transcribed. The transcriptions are then subjected to a process of analysis such as the SAID - System for Analysing Instructional Discourse (Brown & Armstrong 1978) or that by Sinclair & Coulthard (1975) which analyse the moves, episodes and cycles.

This approach was employed by Elliot (1976) and Elliot & Adelman (1974). Although they did not give names to specific teaching styles, the scheme they proposed which mapped out the conceptual basis of the teacher's classroom practice, implied styles. Thus, from this scheme:



teaching may be classified into either of the following patterns and subsequently given a 'Style' as below:

PATTERN						STYLE
Formal	-	Structured	-	Directed	-	Instructional
Informal	-	Structured	-	Guided	-	Discovery
Informal	-	Structured	-	Open-Ended	-	Discovery
Informal	-	Unstructured	-	Guided	-	Inquiry
Informal	-	Unstructured	-	Open-Ended	-	Inquiry

The patterns deduced from the above study reveal that lessons can be recorded and analysed as to their formality, structure and direction, and depending on which permutations one finds to be present, classified into a general teaching style such as discovery or inquiry etc.

The criticism levelled against this approach is that it fails to take into cognizance the teacher-pupil relationship which is essential. Also that it may not recognize a mixed style which may be essential at certain points in time during teaching. As well, the teaching styles it ultimately identifies are thought to be too broad and general, and thus lacks the specificity that is required.

3.3.2 The Observational Approach:

This is the second approach used and consists of two systems - category and sign systems.

3.3.2a The Flanderian Based Category System:

This category observation system was developed by Ned Flanders and is based on the interaction between teacher and pupils in their classrooms. This system has opened up the field by making a lot more people aware of the happenings in classrooms. As Flanders (1970) points out, his two main purposes in analyzing classroom interaction were "... to help a teacher develop and control his teaching behaviour, and ... to investigate relationships between classroom interaction and teaching acts so as to explain some of the variability in the chain of events," and certainly not to "... mention of good and bad teaching, making ratings of teaching performance or suggesting a particular way to teach," even if at the end it might be necessary.

With these concepts in mind, Flanders (1970) developed ten (10) categories of teacher and pupil verbal behaviour which an observer is given.

Flanders Interaction Analysis Category (FIAC)

TEACHER TALK	INDIRECT INFLUENCE (INTEGRATIVE)	1. Accepts feelings: Accepts and clarifies the feeling tone of the students in a non-threatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included.
		2. Praises or Encourages: Praises or encourages student action or behaviour. Jokes that release tension not at the expense of another individual, nodding head, or say 'uh huh' or 'go on' are included.

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3. Accepts or Uses ideas of Students: Clarifying, building or developing ideas or suggestions by a student. As teacher brings more of his own ideas into play, shift to category five.

4. Asks questions: Asking a question about content or procedure with the intent that a student answer.

5. Lectures: Giving facts or opinions about content or procedure; expressing his own idea; asking rhetorical questions.

DIRECT
INFLUENCE
(DOMINATIVE)

6. Gives directions: Directions, commands, or orders with which a student is expected to comply.

7. Criticizes or Justifies Authority: Statements, intended to change student behaviour from non-acceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing, extreme self-reference.

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8. Student talk-response: Talk by students in response to teacher. Teacher initiates the contact or solicits student statement.

9. Student talk-initiation: Talk by students which they initiate. If 'calling on' student is only to indicate who may talk next, the observer must decide whether student wanted to talk. If he did, use this category.

10. Silence or Confusion: Pauses, short periods of silence, and periods of confusion in which communication cannot be understood by the observer.

Although the skills involved are considerable as the categories need to be learned or memorized, their use practiced, tabulation and the clerical duties involved given sufficient attention, and the analysis procedure learned, more will be required of the observer. The observer will be required to be able to set aside how he/she feels about what is going on in the class. The observer, who is given the ten categories of teacher and pupil verbal behaviour will in every three-second period of a total observation episode, decide which category best represents the behaviour observed in that period that is subsequently recorded as it occurs. Every episode will initially be represented by a sequence of category numbers which can be transferred later to a matrix.

The matrix produced by entering tallies obtained from a single episode or a combination of episodes makes it possible to derive several particular or more general scores of such aspects of the verbal behaviour in a classroom as a total amount of teacher or student talk, the extent to which the teacher employs direct influence or the amount of sustained communication between students themselves. The scores can most obviously be used to construct classroom profiles as well as combine scores from several categories as Flanders does when he combines categories 1 and 3, and 5 to 7, to calculate a ratio of indirect/direct teacher influence.

However, the major feature of this category system lies in the analysis of initiatives and response which is a characteristic of interaction between two or more individuals. On the whole, Flanders' scheme, according to Morrison & McIntyre (1969,1973) has proved effective when viewed from a number of perspectives. It preserves a considerable amount of behaviour, and to some extent the sequence of events. Observer agreement on categorizing behaviours is also high, while observers can readily be trained in reliable use of the categories and the extensive data obtained are straight forward to analyse.

Outcome of Flanders' Work:

The outcome of Flanders' interaction analysis was that there exists a distinct positive correlation between pupil performance or achievement in school as measured through test results, and teaching style. The positive relationship between indirectness and pupil achievement is supported by experimental results, Flanders (1970 p418) maintains. Thus pupils taught by teachers whose styles represented "indirect methods" - by talking less, giving few directions and criticisms, showed superior achievements, and better attitudes to learning, whereas those pupils under teachers whose styles reflected "direct methods (Didactic)" by talking a lot, giving too many directions and criticisms of pupils' ideas, utterances and works, and attitudes, showed inferior achievements, and less favourable attitudes towards learning.

Although, Flanders suggests that there are times when teachers need to be direct as when presenting new content and giving directives to pupils for particular work, there is little doubt that large doses of directives and criticisms fail to achieve desired results. Nonetheless, a level of flexibility should be encouraged.

The significance of this work for teachers and teacher educators is sufficiently clear. It enables teachers to improve on their styles of interaction. This is to say that by learning to use interaction analysis teachers could become more "indirect" or responsive and thus be able to balance the initiation and response pattern between teacher and pupils in the classroom. In practice, there is a complementary relationship between teacher initiation and response, and pupil response and initiation. In effect, teacher initiation stimulates or elicits pupil response and teacher response elicits pupil initiation. It is thought that the ratio is too high on the part of the teacher. By exposure to interaction analysis, it is suggested that teachers could become more indirect or responsive thereby achieving a preferred balance in ratio of interaction. An "indirect" or responsive teaching style is associated with effective behaviours such as accepting feeling, praising and acknowledgement of pupils' ideas (categories 1, 2 and 3), and encourage pupils to increase initiation and response, as against mainly responding to teacher initiations associated with direct style. The teacher will be using a 'direct' style of teaching if he initiates all or most of the verbal exchanges in the classes. Whereas it is not being suggested the "direct" style of teaching is necessarily poor teaching it is thought that it contrasts with "indirect" style which requires the use of categories 5,6, and 7 to be able to meet the teachers' expectations which agrees with category 8.

The importance of Flanders Interaction Analysis Category System (FIAC) can be traced in the work of Houston & Pilliner (1974). Working on the effects of verbal teaching style on the attainment of educational objectives in physics in Scotland, Houston & Pilliner employed the Flanders Interaction Analysis Categories. After the observation, they analysed the variance and covariance of the effects of different teaching styles as identified by the FIAC technique on the cognitive and affective domains of 14-16 year olds following the O - grade course for the Scottish Certificate of Education.

From their findings, the "open-ended" teaching styles achieved more complex cognitive educational objectives than did the "Intermediate" or "Expository" styles. On the whole, the "Open-ended" procedures was the most successful as well in developing favourable attitudes towards physics.

3.3.2b The Sign Based System with Particular Reference to The Work of Eggleston et al:

This is the second method within the observational approach. This particular method which resembles the category system, provides the observer with a list of specific events, so that as and when a particular event occurs within a specified time period, the observer enters a tally in the appropriate section of the list. The observation Schedule and Records (OSCAR) developed by Medley & Mitzel (1958) is a typical example of this system.

A card is provided for checking off particular activities as they occur within each five-minute observation session, for example, teacher works with individual pupil, teacher questions - pupil answers etc.

This method is thought to improve the reliability of observation by reducing the difficulty of the judgements required and does not require very highly trained observers as such, while it separates the more or less objective process of recording from that of scoring. Most of these observation instruments have long been modified and new and more comprehensive and probably more reliable forms have emerged over the years.

The Science Teaching Observation Schedule (S.T.O.S.) Approach:

This is a comparatively new instrument which has its roots down in the earlier models of Flanders (1963), Medley & Mitzel (1958) etc. It is credited to Eggleston et al (1975).

Preparatory to the development of the S.T.O.S., a number of reasons for embarking on its development were advanced. Most prominent of all was the reason derived from a "dissatisfaction with comparative pre-test/post-test evaluation strategies based upon true experiments which attempted to control for the differential responses of teachers to the curriculum package ..." Eggleston et al (1976 p75). To embark on such a systematic study of actual classroom interaction processes, they further thought that it would help to minimize the problems and improve the practice of science teaching. Other thoughts derive from convictions that "... acts of teaching are observable and may be judged against some criteria whereas learning itself cannot be seen but only inferred as a result of observing behaviour " Nicholls & Nicholls (1972,1978).

The reason for embarking on each classroom interaction research varies a great deal with each researcher/investigator. For Eggleston et al, it was to further determine and categorize teaching styles employed by teachers of science particularly through investigating the patterns of interaction which normally occur between teachers and pupils. In the words of Eggleston (1980) "the behaviour of teachers and pupils in science lessons on which our interest will be focussed is a subset of interactions which facilitated matching and which will function as independent variables in investigating conditions for effective learning of presumably, the substantive knowledge of science."

Having set themselves this task, the Science Teaching Observation Schedule (STOS), was developed (Eggleston, Galton & Jones, 1975) after a cross-sectional study or survey of various identical and isomeric works by others. The STOS as an observational instrument "provides a wealth of information about those intellectual transactions which occur in science lessons " (Hacker et al 1979). As it cannot span all areas, the STOS is limited to cognitive behaviours which might be expected to occur in science lessons. It is thus not concerned with the affective nor managerial aspects of science classroom behaviours.

This sign system used in recording data is used with a time - sampling unit of three-minutes when each category is checked once no matter the number of times it occurs during each three-minute period. It is not checked if it did not occur. The two main categories are concerned with those events 1) initiated by the teacher and 2) those initiated and maintained by the pupils. Teacher talk is further subdivided into three major categories: 1) Teacher's questions, 2) Statements and 3) Directives. While pupil activity is divided into two major categories: 1) Pupils seek information or consult and 2) Pupils refer to teacher. Further, each of these five main categories is subdivided into minor categories; the basic pattern being interactions associated with 1) Recall of facts or principles, 2) Problem-solving, 3) Hypothesizing and 4) Experimental procedures. (See Appendix 1).

Results:

The data collected from 94 science classrooms constitutes one of the most comprehensive information about science classroom interactions which is currently available. When this was subjected to cluster analysis, the team were able to isolate three main styles of science teaching. These were labelled Styles I, II and III.

Style I:

This was characterized by teacher initiated transactions which challenged pupils over a wide range of demands. The lessons were based on inquiry but with all the major initiatives coming from the teachers. This style was favoured most frequently by teachers of physics and chemistry. This style is further associated with problem-solving and speculation in both practical and theoretical contexts.

Style II:

This style is characterized by its relatively infrequent use of teachers questions excepting possibly those demanding recall and application of facts and principles to problem-solving, with little emphasis on inquiry. From this style also emerged a relatively high incidence of teachers' directions to sources for facts finding and there is a non-practical bias in this style.

Style III:

From Style III emerged more uniquely distinctive features than either Styles I or II. Commenting further on Style III, Eggleston et al (1976) say "there is clearly a much higher level of pupil participation, both consultation and referral to teacher. Pupil initiated and maintained behaviour is directed to experimental procedures, to inferring, to formulating and testing hypotheses as well as to acquiring and confirming facts." In effect, this style is more pupil-centred; initiatives by pupils occur most frequently and it is practical, with a high level of intellectual engagement.

Implication of Findings for Science Teaching:

A more general look at the result of the analysis shows that Style I is very readily associated with problem-solvers. This is due to the relatively high frequency of teachers questions and statements. In so far as this style is concerned, the initiative was found to be held by the teacher who, nonetheless, challenges his pupils with a comprehensive array of questions, which are observational, problem-solving and speculative, in both practical and theoretical contexts. Reference to the work of Flanders

(1970) should enable Style I teachers of Eggleston et al's (1976) to be thought of as teacher-directive or the dominative pattern, with a high incidence of teacher talk and statements engendering a low proportion of pupil initiated and maintained activities. Even though Flanders did not come out with distinctive classifications of styles, his work which revealed a teacher dominative group and the STOS analysis for Style I, are virtually identical.

The Style II may be related to convergent-thinking; the teachers inevitably dubbed "Informers". This appears to be directed towards meeting some specific ends such as examinations. However, there was still a highly frequent incidence of teachers' statements of facts, and pupils' referring to teacher for the purpose of acquiring and confirming facts. The STOS analysis shows Style II as distinctly didactic but less theoretical than Style I.

Teachers who most consistently employed what has been typified by Style III, were in turn dubbed the "Enquirers". The fact is that pupils initiated and maintained behaviour which was directed towards designing experimental procedures, inferring, formulating and hypotheses-testing earned this style a look of 'divergence'. Writing on 'Some Characteristics of Effective Science Teaching' Galton & Eggleston (1979) emphasize that "the description of 'pupil-centred enquiry' might not be an inaccurate reflection of the characteristics of this teaching." Thus Style III and Style I share common heuristic characteristics.

The Final Stage of the STOS analysis which examined the correlation between process data, as represented by the three teaching Styles isolated, and the products as represented by pupils' learning is even more relevant. It has shown that the teacher-directed, didactic approach of the 'Informing-Style' - Style II, was the least effective of the three styles. Yet, it was most popular among the biology teachers. It must have emerged as popular among these teachers probably as a result of what the teachers considered to be the need to inform and bombard pupils with biological facts, terminologies and principles inherent in this subject and demands of examinations.

It was also shown that chemistry and physics teachers favoured Style I (Problem-solving). The reason for this inclination stems in the nature of demands made by the O-level examinations. Another explanation being that the structure of biological science-substantive and syntactic, is different from that of physical science, and that these differences have become reflected in the commonly used teaching styles.

This work must be particularly significant for teachers especially as it emphasizes that neither the discovery-didactic, nor the Flanderian teacher-directed/indirect axis, is in itself an absolute typology for the teacher to copy. Rather, it would appear that the teacher's approach should be varied to match the skills it is desired to develop within pupils. This suggestion has become necessary in view of the fact that each of the styles isolated appears to be significant in the development of particular skills at certain cognitive levels. The suggestion is further necessary as the process part of the research revealed that the tendency for teachers is for them, whatever style they fall into, to be consistent no matter what form of activity takes place. Didactic teachers teach practical work didactically and teachers favouring investigatory methods of learning do so to the exclusion of any other style. Worse still, science teachers who claim to vary their styles according to the needs of the pupils were more often referring to the different ability levels between their sets rather than the variety of objectives subsumed within particular activity. Even then, altering a style was usually equivalent to changing the pace of delivery rather than to altering the overall lesson strategy.

Nonetheless, the findings of Flanders (1970) and Eggleston, Galton and Jones (1976) have some common characteristics from which teachers and researchers alike should benefit.

3.3.3 The Questionnaire System With Reference to the Work of Neville Bennett:

The questionnaire method is another process that has been employed by some researchers to distinguish teaching styles. Prominent among them is Neville Bennett (1976) whose work in the United Kingdom changed the thinking of many teachers and educators.

Although, the questionnaire survey approach to determining teaching styles appears significant, literature on this approach is scanty. As pointed out by Bennett (1976), only three other such works or studies had been available. Of these, one is British - Simon (1972) and two American - Adams (1970) and Walberg & Thomas (1971).

The Adams' questionnaire was developed to enable him survey teaching styles which he perceived in four countries Australia, New Zealand, the United Kingdom and the United States. Interestingly, Adams (1970) isolated seven variable classes of teaching styles which gave varying degrees of emphasis. The questionnaire used covered the following aspects which affect teaching: Content orientation, cognitive emphasis, interaction mode, organizational differentiation, control source, control mode, and motivational mode. The results of this survey compared teachers in the four countries on each variable and did no more as it found little or no difference in them that should be of much value.

Walberg and Thomas (1971) isolated eight themes and built a fifty-item teacher questionnaire and a rating scale around them. The eight themes and item representation are: Provision of Learning, Humaneness, Diagnosis of Learning Events, Instruction, Evaluation of Diagnostic Information, Seeking Opportunities for Professional Growth, Self Perception of Teacher, and Assumptions about Children and Learning Process.

The degree of conceptual overlap between the works and findings of Adams (1970) and Walberg & Thomas (1971) is quite high.

The Neville Bennett:

For Bennett (1976), the questionnaire system was employed following a realization that it is what one achieves and not the way it is achieved that matters. Preparatory to the questionnaire development Bennett (1976) first analysed the terms 'Progressive' and 'Traditional' as then applied to teaching before translating them into questionnaire items. This theoretical analysis was complemented with interviews with primary school teachers. The interviews were carried out to ascertain what teaching behaviours these teachers consider to differentiate progressive and traditional styles of teaching.

From that interview emerged eleven (11) characteristics of progressive and traditional teachers as given here:

PROGRESSIVE	TRADITIONAL
1. Integrated subject matter.	1. Separate subject matter.
2. Teacher as guide to educational experiences.	2. Teacher as distributor of knowledge.
3. Active pupil role.	3. Passive pupil role.
4. Pupils participate in curriculum planning.	4. Pupils have no say in curriculum planning.
5. Learning predominantly by discovery techniques.	5. Accent on memory, practice and rote.

6. External rewards and punishments not necessary i.e. intrinsic motivation.	6. External rewards used, e.g. grades, i.e. extrinsic motivation.
7. Not too concerned with conventional academic standards.	7. Concerned with academic standards.
8. Little testing.	8. Regular testing.
9. Accent on co-operative group work.	9. Accent on competition.
10. Teaching not confined to classroom base.	10. Teaching confined to classroom base.
11. Accent on creative expression.	11. Little emphasis on creative expression.

'Bennett 1976 page 38.'

The basic features of the questionnaire method used appears to be the translation of the differentiating elements into classroom behaviours and then into questionnaire items. The items cover six areas which are:

1. Classroom management and organization - extent of freedom of movement and talk in the classroom, seating arrangements adopted.

2. Teacher control and sanctions - degree of disciplinary rather than physical control.

3. Curriculum content and planning - allocation of teaching time, extent of timetabling and home work, degree of pupil choice.

4. Instructional strategies - types of teaching approach.

5. Motivational techniques - whether intrinsic or extrinsic motivation is stressed, and

6. Assessment procedures - type and quantity of evaluation of pupil work.

The questionnaire was posted to teachers for completion. Then the data obtained was cluster analysed - a technique which can be used to group together people who have similar characteristics. Finding: From this analysis Bennett (1976) isolated twelve (12) teaching styles or teacher types. The large number of teacher types isolated is not at all surprising especially as this work was centred on primary school teachers. At primary school level, it is possible to find teachers who are ready, and infact, go all out, to help children learn and grow, and thus employ all possible behavioural patterns (teaching styles) they considered helpful to achieve this common goal. On the other hand, if it had been extended or rather carried out at the secondary school level, the result in terms of number of teacher types would probably have been fewer.

Implications:

Eventually Bennett (1976 p79) groups all twelve types into three major characterisable groups representing the extreme formal, informal and the moderate or mixed groups of teaching styles. Thus teacher types 1 and 2 were found and grouped to typically represent "Informal styles of teaching", types 3, 4 and 7 representing "Mixed styles", and types 11 and 12 representing the "Formal styles of teaching".

On the question of which type is most effective, Bennett (1976, p158) argues that pupils taught by teachers using an 'informal approach' for the most part on individualized teaching and learning made the least progress in basic skills of mathematics and English. He went on to suggest that the supperior performance of pupils taught by 'formal teachers' was due to the fact that pupils in these classes "... engaged in work related activity more frequently," while pupils in 'informal classes' of similar initial achievement, engaged in the lowest amounts of such activity, "preferring to talk about their work or indulging in purely social interaction," Bennett maintains. In Bennett's eye-view, it is the organization of the classroom and careful structing of the curriculum activities which is important. This is understood to mean that in this closely controlled environment there is less scope for children to take part in time-wasting activities. The above points are quite understandable but is fairly hard to accept the idea that for teaching effectiveness, "... it is what you do not the way that you do it" that counts in the words of Bennett (1976 p160). From experience and from research evidence, the way the teaching is done, that is, the style, counts as much as what the teacher does. Hence the way it is done is equally important and cannot be separated from pupil achievement.

However, a subsequent re-analysis of his data (Aitkin, Bennett & Hesketh, 1981) came to rather different conclusions. Though three new clusters or styles of teachers were identified with all the teachers in either one or the other clusters, Bennett's assumptions remained fundamentally unchanged. In their words "The teaching style differences in achievement which were found in 'Teaching Styles and Pupil Progress' are modified by the re-analysis." The re-analysis results show that the style ascribed the term 'informal approach' which previously made the least progress in basic skills in mathematics and English, at least, has now been shown to make more progress in both subject areas than the mixed style. Even so the changes have been rather small with Bennett's assumptions remaining fundamentally unchanged.

By and large, what in Bennett's (1976) work that is of interest for this remains the methodology employed which is the questionnaire approach.

3.4 The Importance of Specific Teaching Behaviour in Process Variable Research:

Many researchers have indicated that a person's beliefs determine his/her behaviour, and invariably affect educational practices. But these ideas are not necessarily conclusive, (Dunkin & Biddle, 1974). However, Wheling & Charters (1969) have suggested that there are common dimensions of behaviour and belief about educational practices. Also, Power (1977) has reported studies which centre on the relationships between measures of the educational values and preferred practices of teachers and their behaviour in Australian Science Educational project classrooms. It was found that teachers foster activities in science lessons which are congruent with their beliefs about teaching. For example, in those classes taught by teachers who valued an inquiry approach to science, both pupils and teachers were more actively and intimately involved in lessons, and they appeared to be more involved in the process of inquiry than in the mechanics.

If so, it may be argued that the beliefs of teachers which determine their behaviours equally control or determine or influence teaching styles. The reasons underlying this assumption centre on the fact that teaching styles which are behaviourally controlled are determined by beliefs. Presumably, this is the position taken by Bennett (1976) as discussed earlier.

<u>The Work by W.J. Horak and V.N. Lunetta (1979)</u>:

In a study on science teacher types, Horak & Lunetta (1979) studied the beliefs of teachers about the importance of specific teaching behaviours. In this study, three distinct factors or science teachers' groups were identified with the following basic features representing their findings.

Science Teacher Group I:

This group consists of 35 teachers and accounted for 52 per cent of the common factor variance. The following five items received the highest degree of acceptance by these teachers: Be good listener; allow children to think for themselves; let students discover ideas and situations to problems; let pupils be active in their own education; and provide more guidance than answers. While the next five distinguish this group's beliefs from those of all other teachers: Let pupils work under their own initiatives; let students express their own ideas much of the time; allow children freedom in the execution of learning activities; let pupils be active in their own education; and fit the curriculum to the child and not the child to the curriculum.

From the above, Group I science teachers appear to tend to stress the importance of indirectness in the classroom. And are vividly differentiated from Groups II and III science teacher groups by their views about the need for individualizing activities.

Science Teacher Group II:

For this group of science teachers which number 20 and account for 30 per cent of the common factor variance, the following five items received their highest acceptance: Let students discover ideas and solutions to problems; use a lot of positive reinforcements in the classroom; ask questions that require original thinking to answer; present well planned lessons, and let discipline be governed by well established standards.

This group's beliefs from those of all other teachers are distinguished best by the following items: Be strict in order to maintain good discipline in the classroom; insist that a pupil obey the teacher; have the curriculum consist of subject-matter to be learned and skills to be acquired; assume various roles such as classroom authority, classroom discussion leader, and classroom guide ; and give students more control over the planning of learning activities.

In fact, this group of science teachers could be generally identified by their views pertaining to the broad category of communication, and by the fact that they ranked statements about order and discipline higher than did other groups.

Science Teacher Group III:

For this group of science teachers which included only 12 teachers and account for 18 per cent of the common factor variance, the five statements which received their highest degree of acceptance are: Have many interesting ways of explaining materials; be directive at times and non-directive at other times when working with students; focus upon the structure of the field of knowledge when teaching science; break lessons down into small compact segments and let discipline be governed by well established standards. While the five other statements that distinguish this group's beliefs from Groups I and II are: Focus upon the structure of the field of knowledge when teaching science; break lessons down into small compact segments; never be in doubt about what the student means; ignore minor misbehaviours and have many interesting ways of explaining materials.

On the whole, Group III science teachers considered flexibility the most important aspect of science teacher behaviour in the classroom.

From this work by Horak and Lunetta (1979) it becomes evident that teachers' beliefs influence their behaviour and invariably, their styles. Although this work does not concretely ascertain the effects of teachers' beliefs on pupils' achievements it still provides room for speculation to the affirmative that teachers' beliefs affect pupils attainment as measured by examination outcomes or results.

Implication:

The significance of this study lies in its similarity in outcome to the work of Eggleston et al (1976). More precisely, Horak and Lunetta's Group I teachers approximate to Eggleston's Style III teachers. The features which most vividly distinguish Horak and Lunetta's Group I teachers coincide with those which were featured most consistently by Eggleston's Style III teachers in practice as 'Enquirers'. Group II of Horak and Lunetta approximates to Style I of Eggleston et al's. This is the dominative teacher group who see their role as basically the challenging and leading of their pupils. While Group III of Horak and Lunetta correspond, though not perfectly, with Style II of Eggleston et al's (1976).

What should be said here is that a prominent difference lies in the conduct of the studies. While Eggleston et al's work was based on pure classroom observation; the study by Horak and Lunetta was conducted on the basis of opinion samplings which took little or no account of the classroom realities or practicalities. This difference should prompt one to look at Horak and Lunetta's work with some scepticism. This is because teachers have been known to believe in one way of doing a thing, and yet do it differently under practical circumstances. In effect, teachers under observation are known to exhibit atypical behaviour patterns when an outsider is nearby watching resulting in behaviours which may appear to be artificial.

This question of doubt could be minimized if teachers observed as in Eggleston et al (1976) had opinion sampling questionnaires administered to them as by Horak and Lunetta (1979) and vice versa. This is isomeric to the point made by Galton and Simon (1980 b) that "unless therefore, teaching tactics, as measured by direct observation of classroom behaviour, and organizational and curriculum strategies, of the type reported by Bennett's survey, are both considered within the same study, it is not possible to determine which of these factors plays the major part in determining pupil progress."

3.4.1 Some Other Valuable Studies:

Apart from the studies of classroom interactions discussed thus far, many more important studies have been undertaken as follows:

3.4.1a The Work of Dreyfus and Eggleston:

As if to drive home the fact that the sign system is a powerful means of determining the type of class interaction existing between pupils and teachers, Dreyfus & Eggleston (1977) studied the teaching behaviour of student-teachers of science disciplines during their one term teaching practice.

The behaviours observed were those described as intellectual transactions and the instrument used was the Science Teaching Observation Schedule (STOS) developed by Eggleston, Galton & Jones (1975), and first used to describe the behaviour of experienced teachers. Forty-four science teachers were involved. After the observation had been made, comparisons were made between students early and late in their teaching practice with the behaviour of experienced teachers. Comparisons were also made between students teaching different disciplines and between student groups; the composition of which were determined by the ever popular cluster analysis.

When student-teachers in general were compared with experienced teachers, it was found that both achieved a close match on questions and statements of facts, directions to pupils to find facts and in problem-solving questions. For transactions involving more complex cognitive operations such as speculating, inferring and interpreting observations, student-teachers used them less frequently. Still, there were indications that student-teachers behaved less like experienced teachers as their training proceeded.

Among the interesting conclusions made by Dreyfus & Eggleston (1977) was the fact that students come to their teaching practice with a tradition - a set of assumptions about the nature of the process of science teaching, acquired possibly from their experience as pupils and students, and this consists of three main elements; the transmission of facts and principles directly by statements, and indirectly by questioning and reference to sources; problem-solving which in STOS's terms is a convergent activity and discussion about experimental procedures, and doing practical work, largely under teacher direction.

However, towards the end of the practice the student-teachers' behaviours began to change away from the experienced teachers. These changes which became even more conspicuous when comparisons was made discipline by discipline, is now thought to be due to these reasons: a) The immediate feedback of pupils responses, b) the observation of tutors, and c) the interpretation by the student-teachers of the messages they receive. Equally important among the finds is that student-teachers when threatened by a possible loss of control, regress to fact stating (b1), and note giving. Also, that initially student-teachers approximated to the pattern of transactions of experienced teachers but failures to engage successfully in those activities requiring higher cognitive thinking and reluctance to risk losing initiatives to pupils results in their taking up a 'fall-back' position with teacher domination and 'fact-stating' categories being dominant.

These findings are important for teacher trainers, and add flesh to the reasons why a study of interaction analysis of teacher-pupil in classrooms is essential in teacher training programmes. For, if the student-teachers studied, had the opportunity of studying or training on the STOS, they would have probably, not regressed so easily inspite of the pressures on them.

3.4.1b The Work of Galton and Simon:

As if to move some steps away from what they had done with Eggleston and other colleagues, Galton and Simon (1980b p15) undertook further studies of classroom interaction. This time, however, it has been directed towards the primary schools.

In this work an attempt was made to bridge the gap that existed between the methods of Flanders (1970) and Bennett (1976). Flanders (1976) insists that the way teachers teach does matter, while Bennett (1976 p160) feels it is what the teacher does and not the way he does it that matters. This thinking is reflected vividly in the instruments they both have used. While no teachers were systematically observed teaching in Bennett's study, others using Flanders Interaction Analysis Category system (FIAC) took little or no account of either classroom management or curriculum planning. They both systematically excluded the basic variable which the other thought to be the important determinant of teacher effectiveness.

All the same, the idea of narrowing the gap permits the use of more than one observation instrument in any one classroom. Thus the ORACLE employed by Galton & Simon (1980b) consisted of the 'Teachers Record' and 'Pupil Record' which were designed to reflect the complexity of the on-going interactional process within primary school classroom, and also to differentiate effectively between patterns of interaction within these classrooms.

Pupil Record:

The 'Pupil Record' is divided into three areas which reflect pupil behaviour: Pupil-adult interaction, Pupil-pupil interaction and Pupil activity. While they are further made up of sub-categories. Coding is done on all occasions in case of pupil activity, and only when pupil is actually interacting with the teacher or pupil in the case of the first two interaction categories.

Teacher Record:

The 'Teacher Record' consists of categories embracing all questions and statements teacher makes and which is divided into those concerning pupil-tasks, task supervision and management issues. It also differentiates between higher - and lower-order questions and statements. The second and third 'Teacher Record' categories include forms of 'silent interaction' and 'teacher activity' when no interaction is taking place. The teachers' audience, whether an individual, a group of pupils or the class as a whole, is also coded, as is the curricular area on which the pupils are engaged at the point of interaction. The instrument also covers such areas as praise, providing feedback on work or effort and 'critical control' as well as silent marking of pupils' work as well as reading and story telling. Codings are made on this instrument every twenty-five seconds.

Findings:

This study by Galton & Simon (1980b) has added further understanding to what obtains in the typical primary school classroom. Among other things it found that a typical pupil spent well over half (58 per cent) of the teaching time involved and co-operating on task, in addition to another 12 per cent spent co-operating on routine activities for maintaining task and a further 4.3 per cent spent waiting for the teacher for some form of attention. This gives a total of nearly 75 per cent of a typical pupil's time in the

United Kingdom that is spent fully involved and co-operating on task and on routine activities necessary for maintaining the task. This high percentage of involvement time by pupils reflects the existence of good learning atmosphere with few distractions.

Another finding is that the typical pupil in the primary school spends over 20 per cent of his time on writings involving practice and formal exercises. This data goes to support partly a claim in an earlier section (2.6) that pupils do a lot of writing in school. If the percentage in the primary school is as given, then it must be much higher at the secondary level where the pupils have become more capable of writing both for teacher and for themselves, and see the advantages of writing down ideas or points during each lesson.

One other finding which has very important implications for teaching in Nigerian Schools is that conclusion with class size. The classes Galton & Simon (1980b p32) studied averaged 29.9 pupils per class. It was found that the larger the class, the less interaction with the teacher is experienced by the typical pupil, who in turn spends more time waiting for the teacher. It is probably in response to such decline in teacher-pupil interaction owed to large class sizes that teachers in Nigerian Schools generally resort to teaching whole classes which in the opinion of many affected teachers should be the easiest strategy but certainly not suitable for all abilities (Theobald, 1980).

On questioning, they confirm 23 per cent total questioning time of which a higher proportion of all questions consists of task supervision questions (32 per cent), routine matters (15 per cent), and 29 per cent based on fact-related questions. On the other hand, on the analysis of 'Teacher Record' data by cluster analysis, four main teacher types operating four teaching styles were isolated as below:

Style 1 (Individual Monitors):

This group of teachers accounts for 22.4 per cent of the sample and has the highest level of individualized one-to-one interaction with pupils. This makes them the group with least interest in group or whole class teaching. In spite of this, their teaching is still didactic and concerned with telling pupils what to do while their questions are mainly factual rather than probing or open-ended.

Style 2 (Class Enquirers):

This group of teachers constitute 15.5 per cent of the sample, and of all the groups devote the highest proportion of time to class teaching. They combine this approach with individualized interactions. Thus they spend very little time interacting with pupils in groups. They are known to use questioning much more than any other group; especially questions relating to task work. More statements of ideas and problems is also a characteristic of this group. It is thought that emphasis on problem-solving and ideas, together with teacher control through class teaching gives them their title - Class Enquirers.

Style 3 (Group Instructors):

This group consists of the next 12.1 per cent of the sample. Members of this group are known to maximize interaction with pupils as members of a group. Even though these teachers spend less than a fifth of lesson time in this way, it is, on average, three times as great as the rest of the sample. Their teaching appears largely didactic. Though there is a high level of feedback, the main emphasis is placed on giving of information.

Style 4 (Style Changers):

This group constitute 50 per cent of the sample. These teachers have the second highest levels of individual, group and class interaction, and have certain features of their teaching style closely associated with one or other of the remaining groups. Closer examination of data and material from descriptive accounts suggests that members of this group tend to change their teaching style, and to adopt the characteristics of a specific style when they change to its pattern of organization. Thus three main styles of changers emerge from this:

<u>Style 4a (Infrequent Changers)</u>:

This sub-group constitute 10.3 per cent of the sample and are thought to have made a deliberate change in style due to behaviour of pupils. This sub-group is known to have reached the highest over-all level of questioning of all types including higher-cognitive order questioning and statements of ideas. In effect, they reached the highest level of interactions of all the styles.

<u>Style 4b (Rotating Changers)</u>:

This sub-group consists of 15.5 per cent of the sample and use grouping of pupils based on different curricular areas to distinguish itself. The groups rotate from one curricular area to the next by moving bodily to the relevant table in each case. This results in the whole class shifting position at given points during the day. Questioning is also high but on task supervision and critical control (management of class through activity).

<u>Style 4c (Habitual Changers)</u>:

The composition of this sub-group is almost half of the whole of Style 4 - 24.2 per cent of the sample. As their descriptive title - habitual changers - shows, they are thought to change a lot between class and individualized instruction. The changes are seen to be unplanned, thus due to reaction to pupils whose behaviour cause difficulties. While the time spent in interacting with pupils in the class was the lowest of the sample, use of questioning was relatively very little.

Implications of This Study in Teaching:

The significance of this ORACLE research study centre on the fact that apart from the initial analysis of the process variables which have to do with the daily drama which is played out in the classroom, and consisting of observable behaviours of both teachers and pupils, the products which have to do with pupil learning in relation to the styles was also determined, if only by test outcomes. As the particular unique observable characteristics of any teacher groups constitute their teaching style, Galton & Simon (1980b p70-71) establish a link of pupil progress with each of the styles isolated. Thus, while pupils taught by teachers of the group, 'Class Enquirers' were most successful in mathematics and language skills, it is the pupils of the 'Infrequent Changers' who made the greatest gains in reading skills. However, in language skills the 'Class Enquirers' enjoyed no over-all superiority from either the 'Group Instructors' or the 'Infrequent Changers'. In Mathematics, the progress of pupils taught by 'Infrequent Changers' did not differ significantly from that achieved by the group taught by 'Class Enquirers'.

The least successful style, from the data and analysis, would seem to be that of the 'Rotating Changers' as no considerable improvement in terms of achievement gains in the basic skills of pupils taught by them are reported.

The 'Class Enquirers' success is attributed to the fact that teachers of this group spent up to a third of their time on class-based instructions. With 'Infrequent Changers' who made the second highest use of class instruction coming next to 'Class Enquirers'. Then Group Instructors.

3.4.1c The Work of Hacker et al - A Cross-Cultural Study of Science Classroom Interaction:

This study involves the replication of the British Observational Study of science classroom interactions undertaken by Eggleston et al (1976) in Atlantic Canada by Hacker, Hawkes and Heffernan (1979).

For this study, the main aim was to see if the advanced stage of development of the STOS device as an observational instrument could be replicated in a Canadian setting. To achieve this Hacker et al (1979) matched schools, teachers and pupils across those variables which might be expected to influence class interactions.

In the sample, 21 schools which passed the screening process were selected, while those with resources for science which were considered to be so poor as to preclude certain teaching strategies were excluded. Then a pilot study was carried out with video taped lessons taught by local science teachers to find whether the STOS instrument could be used in its standard form, or whether some modifications for use in Canadian Schools would be necessary. Accepting the limitations of the instrument, the five observer team felt that the system provided an accurate profile of intellectual transactions as they occurred and that valid distinctions could be made between teaching styles.

Eventually, the observation process went on with each teacher being observed between three and four hours. Data collected was then calculated for percentage use for all 23 STOS categories. Also, the percentage-use data was cluster-analyzed in order to group the 33 teachers on the 23 STOS behaviours in such a way as to minimize within-group variations and maximize between-group variations.

On the whole, two teaching styles emerged from the cluster analysis as follows: STYLE A (N=21) teachers were characterized by frequent use of a relatively small number of the STOS categories especially a1, b1, c1, d1 and e1. The very high incidence of teachers' statements of fact or principle, and directions to sources of information to confirm facts or principles is mirrored by pupils' frequent referral to the teacher to confirm facts and principles. The paucity of other categories except a1 confirms the fact acquiring emphasis of this group. Thus, this style is described as didactic, teacher-directed and theoretical. While STYLE B (N=12) is distinguished by the relatively high frequency of teacher's questions which are answered by applying facts or principles to problem-solving (a2) and by direct observation (A5). Higher levels of pupil initiated and maintained behaviour concerned with problem-solving (categories d2 and e2) indicate a shift in emphasis from acquisition of facts towards problem-solving. This, even so, occurred both in theoretical and practical context. Lower usages of categories a3, a4, b3, c3, d3 and e3 emphasize the convergent nature of these problem solving activities.

On the whole, the biology teachers showed an overwhelming preference for Style A, whilst Style B was more popular with teachers of chemistry and physics.

Cross-Cultural Comparison:

Based on the above findings, Hacker et al (1979) made a comparison of the typologies from the two studies (Hacker et al's (1979) with Eggleston et al's (1976)). The comparison revealed that Style A and Style II have similar profiles of use of the STOS categories as both are basically non-practical and teacher-directed styles. Emphasis, for both, was on informational aspects of science. In contrast, however, Style A was preferred by about two-thirds of the Canadian sample while it is preferred by about one-third of the British sample. For Style B, it is with Style I that it shares common characteristics. They commonly used problem-solving categories. This is in so far as there is a de-emphasis of knowledge of facts and principles in favour of problem-solving activities.

On the whole, it is along the heuristic-didactic continuum that substantial differences in teaching patterns are apparent. Categories b1, c1, d1, and e1 which are associated with didactic teaching were more frequently used by the Canadian sample against the corresponding categories associated with heuristic teaching strategies (categories a3, a4, b2, b3, c2, c3, d3 and e3) which were lower in the Canadian sample than British sample. Also, all the categories related to practical work (b4, c4, d4 and e4) were used less frequently in the Canadian lessons than in British lessons. Thus practical work, including demonstrations and class experiments, accounted for between 10 per cent and 20 per cent of class time in the Canadian Schools and somewhere between 30 per cent and 50 per cent of class time in the British Schools. This is clearly a significant difference which may be accounted for by the level of emphasis and dependence on centralised and decentralized syllabus in Canada and British Schools respectively.

Even so, Hacker et al (1979) attribute this to the wide geographical dispersion of the Canadian science teaching population, and coupled with substantial provincial autonomy in educational decision making which is not the case in England and Wales.

3.4.1d Other Studies:

In an earlier study however, Hacker (1976) set out to investigate the preferences for curriculum materials and teaching styles of 40 chemistry and 30 physics teachers by some specially designed attitude scales.

The outcomes of this study indicated that chemistry teachers showed preference for pupil-based materials used in individual or small group experiments, while the physics teachers showed a strong preference for teacher-based materials used in demonstration. On the styles (Behaviour) of teaching, Hacker (1976) found that both groups of science teachers showed preference for teacher-directed behaviours (or styles).

In the same year Johnson (1976) undertook a study of discourse events in chemistry lessons in two British comprehensive schools with six teachers who taught the Nuffield Science Schemes. The lessons were audio-recorded simultaneously as they were being coded continuously with the Science Teaching Observation Schedule (STOS).

On analysis, eight types of transactions were identified and classified into Initiating, Median and Terminating phases. The teachers were found to show remarkable similarity in the form and sequence of exchange types within recall transactions and were differentiated only by their overall frequency of usage. In this same study, an additional investigation using an observation record schedule, questionnaire and interview were employed.

From this second means, Johnson, (1976) found that there was a dichotomy between teachers' verbal actions and their views on the aims of chemistry teaching and the functions of language in science teaching among other findings.

This study, thus, went further to elucidate the concern expressed earlier that teachers' displayed strategies and tactics (or styles) of teaching which differ or are at variance with what they profess to do in practice, on paper.

In another investigation, Heaney (1971) in co-operation with 12 teachers from schools in Staffordshire in the United Kingdom examined the effects of three teaching methods on children's learning from a curricular unit in Biology. The three teaching methods examined were:

1) Heuristic - guided discovery.
2) "Cook-Book" - children worked as if following a Cookery recipe.

and

3) "Didactic-with-Demonstration" - pupils listened to and watched there teacher.

The investigation was designed to examine the hypothetical link between teaching style (the single independent variable) and learning (the dependent variable). To achieve this all other dependent variables were controlled as pupils differences were taken into consideration mainly through measurement of which the Thurstone Primary Mental Abilities Test was used to determine the pupils' verbal, spatial, reasoning, perceptual and numerical abilities. Also, pre-course tests were given to assess the pupils' initial knowledge of biology and their initial stage of development in problem-solving and intellectual skills.

The outcome of this investigation showed that the heuristic method was more successful than the "Cook-Book" and the didactic-with-demonstration methods for the a) development of problem-solving skills when pupils were tested as an integral part of their learning from the curriculum unit (Curricular Learning); b) improvement made by pupils as measured on pre - and post - course tests in problem-solving skills, reasoning and recall of biological knowledge and practical laboratory skills (Improvement); and c) recall and application of problem-solving skills and knowledge to problems in biology that the pupils had not previously experienced (Attainment).

In view of the above it may be suggested that young pupils may be taught science more by the heuristic method involving guided discovery to enable them learn by doing and at first hand.

Even so, a number of criticisms have been levelled against research studies which have tended to identify a preferred method of teaching on the basis of a research study such as the above. Prominent in such criticism is Theobald (1980) whose work will now be discussed.

In a study designed to explore the relationships between student attributes, styles of teaching and outcomes, in a BSCS - based secondary school biology course, Theobald (1980) investigated two teaching styles (individual or small group teaching, and whole-class teaching) in relation to student attributes or characteristics. The characteristics are personality and cognitive preferences which were in turn related to achievement and attitudes.

In criticizing various studies on teaching methods and curricula which he says have been designed to compare the effects of an alternative treatment as measured on some criterion usually an achievement test to conclude that one method is better or that no significant difference in outcome has been established, Theobald argues that they have suffered from various faults in design and analysis. His main criticism is that the study of the main effects alone tends to obscure the probability that many students will perform worse under a treatment or 'regime' that is found to be the 'better method in general'.

Thus using the concept of teaching Style, in a more restricted sense than that used by Eggleston, Galton & Jones (1976) and Bennett (1976), Theobald (1980) selected eight teachers who were teaching the Australian 'Web of Life' biology course committed to teaching strategies which emphasize the nature of scientific enquiry by deliberately selecting and organizing teaching methods that are designed to lead to specified student behaviours explicit in the students' manuals of the 'Web of Life' course. The classroom behaviour of these teachers was systematically observed and recorded over a year with audiotapes made, and annotated transcripts were analysed using the category system for the Analysis of Teaching Styles (CATS) (Theobald, 1971). From this analysis emerged two clusters of teachers. Teachers in group one were found to differ characteristically from those of group two as they carried out most of their teaching with individual students or small groups, and asked more questions of memory and open questions. Whereas group two teachers did most of their teaching by talking to the class as a whole.

Data was also collected about the students (numbering 146) on seven attribute variable as follows: general ability, four personality factors and two cognitive preferences. The results from this study showed that the style of teaching which was individual-centred is superior for pupils with a cognitive preference for principles rather than rote-learning, but that the class-centred style of teaching is counter productive for these students. For students with a strong preference for rote-learning, the class-centred style becomes the more effective. On the other hand, Theobald suggests that for the highly intellectual pupils the individual-centred style is of the advantage.

The essence of this study is that different teaching styles have been shown to be superior for different intellectual groups of pupils.

3.4.2 Tamir's (1981) Israeli Study:

Another significant classroom interaction analysis of school biology which had been undertaken was by Pinchas Tamir (1981). This study involved 22 (18 female and 4 male) teachers who were teaching in 22 High Schools spread over the middle and southern parts of Israel. The aim was to obtain a comprehensive data on what happens in Israeli High School biology classes especially in the attempt to try and describe and then compare transactions in recitation and laboratory lessons, and to study the effects of subject matter on classroom transactions with a view to demonstrating how a synthesis of different interaction analysis schemes can enrich the findings of classroom observation studies.

As a matter of deliberate policy to control the subject matter to be taught, only topics dealing with photosynthesis (plants) and digestion (animals) were observed. On the average each teacher was observed in three theoretical lessons lasting 150 minutes and two laboratory lessons lasting between 100 and 150 minutes each. Whereas data was obtained from two sources, 1) Direct Observation - of what went on in the classrooms during the lessons especially who talks in class, place and position of teacher, and organization, the second 2) was Tape-recordings. The direct observation, according to Tamir (1981) served only as a complement to the tape recordings made.

On the analysis of data so obtained, Tamir (1981) employed a combination of different instruments taken mainly from classroom interaction studies of science lessons. The various instruments allowed for classroom interaction studies to be focussed on: 1) Nature of Teaching, 2) Number and kinds of Questions asked in Lessons, 3) Instructional techniques and 4) Modes of Teaching Employed by the Teachers. The advantages of employing different instruments for analysing classroom interaction in any one study is immense. This is so as there are important and positive advantages even though there are some obvious difficulties.

On the nature of teaching, instructional situations were placed on a continuum: the poles of which represent extreme positions. As a result, the nature of teaching is dealt with on concrete-abstract continuum, practical-theoretical continuum and directed-nondirected continuum. For each continuum, the lesson was characterized on a 5-point scale. On the number and kinds of questions asked by the teachers, eight categories derived from Wilson (1969) who used five of Bloom's (1956) behaviours in the cognitive domain as his question categories, and all of Fischler and Zimmer's (1967-68) five categories specific to the natural sciences.

In effect, 3 of Wilson's categories, and all 5 categories of Fischler & Zimmer, in addition to the category of Evaluation and Judgement were used. Hence the number and kinds of questions asked by the teachers were analysed on the bases of: 1) Knowledge and Recall, 2) Skill, 3) Observation, 4) Comprehension, 5) Understanding Relations, 6) Formulating

Hypotheses, 7) Testing Hypotheses, 8) Evaluation and 9) Judgement.

Instructional Techniques or Styles were analysed on a minute to minute basis using the following:

1) Teacher Talk - giving of instructions, lecturing, explaining and clarifying, and summarizing.

2) Teacher and Student Talk - teacher asks questions, students initiate and ask questions, and discussion usually directed by teacher.

3) Teacher Activities - demonstrating, using audio-visual aids and helping students individually, and

4) Student Activities - demonstrating to class by reading, solve problems, individual or groups work and laboratory work.

Analysis of laboratory lessons followed this pattern except that Teacher Activities were modified to 'Performance of Work for the Students and Guides a group of Students.'

The mode of teaching was analysed also, but its analysis was based on another instrument - that of Gallagher (1967). The recorded lesson was divided into unit topics which ranged between 15 and 26 per lesson. Each unit was then categorized according to two criteria: Purpose - which is either to deliver specific content or to develop a skill, and Level and Style - which are represented by six categories. The categories are:

1) Description of data, facts, and concepts;

2) Explanations, comparisons, and generalizations;

3) Formulating a problem and examining its significance;

4) Predicting, hypothesizing and planning research;

5) Reporting, interpreting and analysing the processes and findings of a research study;

6) Evaluating and judging the weaknesses and strengths of a research study.

Findings:

1) Nature of Teaching:

On this, Tamir (1981) concludes that the teaching of biology is highly theoretical and almost entirely directed by the teachers. Also, a balance between concrete and abstract presentation was found to exist in laboratory and recitation lessons even though that might have been expected. But Tamir argues that there is no reason why the laboratory lessons should be more practical than the recitaation lessons except for the reason that the practical nature of laboratories enables students to engage with activities which bear relevance to their every day life experiences.

2) Number and Kinds of Questions:

On this variable, Tamir (1981) concludes that since the average number of questions in recitation lessons was 0.7 per minute and 0.3 per minute for laboratory lessons, then it must follow that high level questions and high level inquiry are the common characteristics. Hence if the suggestion by Ladd & Andersen (1970) that students whose teachers ask more inquiry questions achieve better than students whose teachers ask few inquiry questions is anything to go by, then it goes to affirm that thought-provoking questions lead to high achievements even in terms of recall. Also, Tamir found that there were five higher level questions to every three recall questions, even though most of the Israeli biology classes observed used the traditional curriculum.

3) Instructional Techniques:

On the techniques of instruction, Tamir (1981) concludes that there are strong effects of subject-matter which explains why there are differences in the instructional techniques between laboratory and recitation lessons. Tamir argues, as a result, that the difference between digestion and photosynthesis lessons is the reason why there is less talk by teachers in photosynthesis lessons (64.7%) than in digestion lesson (68.1%) as more independent students' work occurred.

4) Modes of Teaching:

While acknowledging that laboratory lessons are quite distinct from recitation lessons in that they cover fewer topics and deal considerably more with the development of skills, Tamir (1981) concludes that: a) the same teachers teach different topics in different ways. b) the inquiry level in biology classes in Israel does not fall behind that of teachers who follow the new science curricula in the United States. In certain aspects, inquiry level in Israel is even higher than in the United States. c) Israeli students' verbal initiative and involvement is even greater than in the United States. d) in Israel, there is a greater emphasis on theoretical aspects and less on practical applications of the learned materials, and lastly e) that the teaching of biology in Israel is, by and large, highly teacher-directed and only rarely are students getting opportunities to plan and follow their own plan of study.

<u>Implications</u>:

The importance of Tamir's (1981) findings in Israel is that, the nature of teachers' questioning, the subject matter to be taught, the mode of the teaching itself have clearly become highly sensitive indicators of the nature of teaching and learning. Thus, if teachers have the opportunity of being encouraged through training to constantly reflect on these and other issues, it is thought that teaching and its attendant image, learning, will make significant advances.

Further, Tamir's (1981) findings reflect on the prevailing situation in Nigerian secondary schools as will be realised later.

In a similar study, Johnson (1982) explored how verbal teaching style might change under cetain circumstances. The circumstances are when: 1) a teacher teaches the same topic to different class groups, 2) a teacher teaches different topics to the same class group, 3) teachers in the same school teach similar topics and 4) teachers in different schools teach similar topics.

To be able to carry out this study Johnson (1982) built up a data base consisting of 192 lessons collected over a two year period from 9 science teachers in three schools. The lessons recorded and transcribed included the teaching events during pupils' practical work, all of which were considered to be typical chemistry topics taught during the first four years of the secondary school.

To minimize the rate of data reduction, Johnson (1982) developed an alternative sequential mode of analysis which enabled a reflection on aspects of the hierarchical development of the subject. The results of this study suggest that teaching style is not an invariant process and hence needs to be considered within a contextual framework. Johnson (1982) attributed the varying nature of teaching styles to five factors ranging from a consideration of teacher as classroom manager, how teachers extend and develop pupils' knowledge base, sequence of lessons within a topic and use of aids, the size of the class and ability of pupils, and the modes of explanation employed by the teachers.

All these factors have been discussed in Chapters 1 and 2, and constitute some major sections of this study which is primarily attempting to determine the levels of effectiveness of the limited styles of teaching commonly employed by teachers in Nigerian Schools.

3.5 Studies in Science Teaching: The Nigerian Experience

The known reported studies on science teaching undertaken in Nigeria date back to 1967. This does not preclude the possibility that some others may have been undertaken but not reported.

Grant (1967) carried out a survey of the opinions of 10 expatriate workers who were connected with education in Nigeria either as advisers or administrators under the auspices of some United Nations organizations. On the basis of such opinion sampling, Grant concluded that science teachers in Nigeria were employing the Lecture-method of teaching, while emphasizing acquisition of facts largely through rote-memory.

Seven years later, Thollairathil (1973) undertook a similar study, the basic difference being that Thollairathil's survey was about the status of teachers of science in secondary schools in Nigeria. The sample was much larger and involved heads of science departments from 294 secondary schools. The questionnaire survey was responded to by post and entailed the heads of departments reporting both how science was taught and what science teachers' status was.

On the basis of that questionnaire survey, Thollairathil reported that the main emphasis of science teaching was on the giving of information on the part of the teachers and its acquisition and learning by the students.

Some other studies have arrived at similar conclusions. Even so, a questionnaire survey can no longer be considered fully adequate and appropriate in a study of science teaching strategies and tactics or processes. Recent studies require the observer to be physically present in the classroom to observe and record or code what is thought to be actually happening. This approach is often described as 'acting as a fly on the wall', as the observer is not expected to participate in the lesson unless so designed. The observer positions himself appropriately and concentrates on categorizing either the pupils', the teacher's or both pupils' and teacher's behaviours, in terms of talk, or acts, or both, yet remaining as inconspicuous as possible in order to ensure that normal classroom interactions, relationships and behaviours are not disturbed and upset. Though some may insist that no matter how inconspicuous the observer, his/her presence remains and consequently affects or interfers with the status quo, Adams & Biddle (1970) have reported that equipment, including television/video cameras did not appear to have distracted the attention of either teachers or pupils unduly in the classroom. The said cameras were mounted in the classrooms during many earlier lessons to enable members of the class to become used to their presence.

One further study of science teaching in Nigeria was by Ogunyemi (1972) who employed a factorial experimental design that tested for several combinations of approaches to science teaching. He found that teacher-supplied information about a science-oriented task situation improved the performance of the female students of secondary school level, but not the male students at the criterion task.

Ogunyemi pointed out that there is some evidence from the same study that when objectives like the level of cognition (application, analysis, synthesis, and evaluation) and transfer of learning are considered the discovery approach produces better results in terms of student achievement, while the expository method can be efficient in communicating information to students though it is not to be preferred pedagogically to the student-centred methods if student learning is to be measured by criteria that include other objectives in addition to that of acquisition and recall of knowledge.

To back up the above findings, Ogunyemi (1972) further argues that biology teaching in particular lends itself to the student-centred instructional methods since topics like anatomy, morphology, physiology, reproduction, embryology, mendelian genetics and ecology lend themselves very well to an inquiry laboratory in which investigatory field or laboratory practical work can precede and lead to classroom discussions rather than rely on exposition.

One other study carried out in Nigeria concerning science teaching was by Ipaye (1975). Based on already existing knowledge about two teaching styles commonly referred to as the 'Dominative Style and the Integrative Style', Ipaye went on to relate the above to the psychological terms 'extraversion' and 'introversion' respectively.

45 N.C.E. student-teachers were observed by Ipaye and two of his associates using two research instruments. The one was the Eysenck Personality Inventry (EPI) consisting of three measures: Extraversion-Introversion, Neuroticism-Stability, and a Response Distortion (Lie) Scale. The second and third measures were not used in the study. The second instrument used was the Flanders Interaction Analysis Category (FIAC) consisting of ten behavioural categories. Ipaye used the first eight to observe the student-teachers by coding statements and sentences which they made during lessons lasting just about 20 minutes, while each student-teacher was observed about five times over a period of six weeks.

On the analysis of the data thus obtained Ipaye (1975) reported that Extraverts and Introverts differed significantly on three of the four behavioural components listed for the Integrative Style of teaching, while they differed on two of the four listed for Dominative Style of teaching. The Introvert was significantly better than the Extravert on items 1 to 3 but there were no differences in item 4. Extraverts had significantly higher means on items 5 and 8 than the Introverts, while there were no differences in items 6 and 7. The items with the serial numbers 1, 2, 3, 4, 5, 6, 7 and 8 are the F.I.A.C. categories as given in the section 3.3.2a.

While clearly enumerating the limitations of the study, Ipaye went on and concluded that since the student-teachers with high E-scores were classified as Extraverts, they should be the Dominative ones as they were authoritarian, lectured, gave directions, or orders, justified position or authority and criticized pupils' behaviours. On the other hand, the student-teachers with low E-scores were the Integrative teachers as they accepted, clarified and supported pupils' ideas and feelings, praised and encouraged pupils and asked stimulating questions aimed at orientating pupils to school work.

Shuaibu (1979) investigated the relationship between science teachers' methodology and science teaching objectives in Kaduna State of Nigeria. An instrument for observation was developed and this contains broad categories of expository method, teacher demonstration method, discussion method, student demonstration method, inquiry/discovery method, and an unclassified category. Seven observers took part in the observation exercise involving 59 teachers in 14 secondary schools. Each teacher was observed twice consecutively. A questionnaire circulated to pupils for use in the assessment of their teachers was also employed. In effect, the study was two-pronged.

The analysis of data so obtained and compared with teachers objectives in science teaching culled from existing science education literature enabled Shuaibu to conclude that teachers' methods of instruction were not consistent with the methods implied in the science curriculum or syllabus, and that the teachers' behaviour patterns are mainly expository, that is, descriptive and explanatory. The findings of this study confirm observations already made by many researchers in this direction.

Another study which indirectly focuses on the strategies and tactics of science teaching was reported by Okeke & Wood-Robinson (1980). It was aimed to shed light, among other things, on whether there are any significant differences between the performances of pupils in urban schools compared with those in rural schools in relation to their levels of understanding of a range of biological concepts derived from: growth, reproduction and transport mechanisms within living organisms.

This study was based on personalized interviews carried out on the basis of an interview schedule consisting of a series of short questions to probe pupils' understanding of each of the concepts within the broad biological areas listed above. 120 secondary schools biology pupils in Nigeria aged between 16-18 were involved.

From this study, the authors concluded that "the differences due to the location of the schools reached the significance level of 0.05 in the case of 12 out of the 27 concepts. In each case, the level of understanding of the pupils from urban schools was higher than that of the pupils from the rural schools."

On the basis of their conclusions, it may be deduced that with all other factors under control, the strategies and tactics of teaching employed by teachers in the rural and urban areas in Nigeria must differ significantly, probably reflecting the concentration of the better trained and experienced teachers in the urban areas at the expense of rural schools. This has been reported by Ugwu (1980). Okeke & Wood-Robinson (1980) equally emphasized what may be referred to as environmental-cultural influences on pupils which teachers apparently realized exist. Thus, for the 'experienced' teacher in some rural schools to be aware of the areas of pupils' conceptual difficulties as the authors pointed out, without resorting to analysing such data using the Piagetian Model which the authors employed, and for the pupils to yet continue to display such difficulties, suggests in very strong terms that the strategies and tactics of the teachers have been clearly unsatisfactory. This is further so, as the teachers failed continuously to help the pupils by capitalizing on whatever concepts (correct or incorrect) which they already knew that pupils had about the topics.

This leads to the next study reported in the same year by Ugwu (1980). Ugwu employed the Science Teaching Observation Schedule (STOS) developed by Eggleston, Galton & Jones (1975) and a teacher questionnaire. With the STOS, 56 biology teachers from 42 secondary schools in Anambra State of Nigeria were observed. The objective was to study the teaching styles employed by the sample teachers in their lessons.

From this study, Ugwu (1980) identified three (3) groups of teachers which he termed clusters. For Cluster I teachers, there was a high incidence of teachers' questions answered by direct observation (a5). Also, there was active participation in class activity by the pupils. This approach enabled pupils to seek and acquire information (facts and principles) on their own. Broadly, Cluster I teachers were associated with the discovery method of teaching which enabled pupils to inquire and discover answers/information. It also enabled them to become motivated in contrast with the expository teaching styles. He likened this Cluster I to Hacker et al's (1979) Style B, and Eggleston et al's (1976) Styles I and III. Cluster II teachers exhibited a high incidence of teachers' statements of fact and principle (b1), while practical activities were non-existent in their lessons. And this Cluster is likened to Style A (Hacker et al 1979) and Style II of Eggleston et al, as they emphasized knowledge, ability to recall facts and principles.

Ugwu's Cluster III teachers varied their teaching styles as they flexibly combined discovery (Cluster I) and didactic (Cluster II) methods depending on need. Thus there was a high incidence of identifying and solving problems (d2) on the part of pupils and statements of fact and principle on the part of the teachers (b1). On the whole, Ugwu (1980) concluded that teachers tended to be consistent in their use of the discovery or a didactic method of teaching during separate observations. But when the separate observations are pooled together, a small number of inconsistent teachers emerged to form the third Cluster above.

One thing that emerges from this study is the fact that even with biology teachers alone, variations in behaviour and in strategies and tactics, which ultimately determine styles of teaching abound.

A similar study, in terms of the design and instrument used was reported by Ajeyalemi (1981); the major differences being that Ajeyalemi studied not just the styles, but the cognitive interactions going on in the O'level chemistry classes by employing both the STOS and another instrument - the System For Discourse Analysis of Sinclair & Coulthard (1975).

The purpose and objective of the study was primarily to study, analyze and describe the teacher-learner cognitive interaction patterns, and the way this is prompted through classroom discourse. Other objectives included the identification and description of whatever teaching styles might emerge. These would then be compared with results of studies carried out in other cultures. In the study a total of 69 chemistry lessons taught by 9 teachers were observed in Lagos Metropolis with the help of STOS. Of this number, 25 lessons were audio-recorded and transcribed for analysis by the system of Discourse Analysis.

From this study, there emerged results which support Ugwu's (1980) earlier findings. More precisely, the STOS data was cluster analysed resulting in two teaching styles which Ajeyalemi labelled Clusters 'F' and 'G'. According to Ajeyalemi (1981), of the nine (9) teachers whose lessons were observed 5 came into the 'F' group while 4 in group 'G'. For style 'F' teachers, teaching was highly teacher-directed. Questions which were dominantly and aggressively asked by these teachers were answered by recalling facts and principles (a1) and by applying facts and principles to problem-solving (a2). There was a very high incidence of teachers' statements of problems (b2) and directions to sources of information for the purpose of identifying or solving problems (c2). This group also allowed quite a frequent occurrence of pupils' categories d2 and e2.

Teaching, therefore, is believed to be slightly oriented toward problem-solving activity, but still theoretical, teacher dominated and didactic, while intellectual process fostered in pupils is rote-memorization.

In contrast with Style 'F', Style 'G' teachers' questions were very infrequent except those answered by (a1) recalling facts and principles. Initiative was held by teacher who emphasized informational aspects of chemistry. Ajeyalemi reports that about 50 per cent of all transactions were of teacher makes statements while 78 per cent of these were statements of fact and principle (b1). Pupils seeking information for the purpose of acquiring or confirming facts or principles (d1) was also of common occurrence. Relative absence of teacher-directed problem-solving activities, that is, low occurrence of a2, b2 and c2 resulted in this group being different from Group 'F' teachers.

Also, there was a total absence of experimental and problem-solving activities which resulted in this group being extremely theoretical, factual, teacher-directed and didactic with the level of intellectual engagement being extremely low.

A second instrument was used in this study and it involved an analysis of classroom discourse using the Sinclair & Coulthard (1975) instrument. From this discourse analysis there emerged the fact that Nigerian teachers talk more in their classrooms than their counterparts in the U.K., U.S.A., New Zealand, Canada and Australia. Although teachers and pupils play different and complementary roles, the teachers' main roles were to initiate most interactions and provide feedback to pupils' responses and initiations. The pupils' primary role was to respond to teacher's initiations. On the whole, the cognitive or intellectual transactions in the classrooms were informing, eliciting, evaluating, checking, answering and directing for the teacher, and answering, informing and eliciting for the pupils in that order.

A study aimed at examining the oral questioning pattern of 4 physics and 4 chemistry teachers randomly selected from secondary schools in Plateau State of Nigeria was undertaken by Gyuse (1982). In total, 32 lessons representing four separate lessons from each teacher were audio-recorded and transcripts of only the questions asked by the teachers were listed and categorized. The categories were adapted from the Bloom's (1956) Taxonomy of Educational Objectives.

From this study, Gyuse (1982) classified the questions asked by the teachers into five categories: 1) Classroom Routine Questions, 2) Memory Knowledge Questions, 3) Comprehension Questions, 4) Application Questions and 5) Evaluation Questions. On the basis of these categories, she found that on average the 8 teachers identified as A-H asked 17, 21, 21, 27, 23, 20, 22 and 29 questions respectively during an average teaching period of 35 minutes.

Also, it was found that two types of questions labelled Memory and Routine, were most employed by both the chemistry and physics teachers. Memory questions constituted 55 per cent and 34 per cent for chemistry and physics teachers respectively. The table below shows the various percentage occurrence of the categories of questions as given in the publication and with total percentages exceeding 100 per cent probably in error.

<u>Table 3.1</u>

Comparison of Types of Questions used by Chemistry and Physics Teachers:

TYPES OF QUESTIONS (%)

TEACHERS	Classroom Routine	Memory	Comprehension	Application	Evaluation
A,B,C,D (Physics)	36 %	34 %	21 %	6 %	4 %
E,F,G,H (Chemistry)	30 %	55 %	16 %	4 %	2.5 %

On wait-time, that is, the length of time the teachers or groups of teachers waited for their questions to be answered, it was found that the chemistry teachers generally had longer wait-time (approximately 2.7 seconds) than the physics teachers (approximately 2.0 seconds) with none having a wait-time of less than one second.

Two main concerns about Gyuse's study centre on the methodology of obtaining the questions for classification. It would have been more appropriate to have transcribed all the lessons to ensure that no questions were left out. To write out only the obvious questions can result in questions answered by non-verbal responses and the rhetorical questions to be left out. Besides, complete lessons transcriptions enable researchers to appreciate the trend of the lessons which subsequently affect the types of questions and the levels of thinking which the questions demand of the pupils.

In another study Shuaibu & Ogunsola (1983) studied the cognitive styles of chemistry students of the School of Basic Studies (SBS) of Ahmadu Bello University, Zaria, Nigeria, which is basically a school for remedial programmes for O'level and A'level candidates. The aim was to provide answers to the following questions: 1) What cognitive styles are most prevalent among the chemistry students of the S.B.S? 2) Are there differences in the cognitive styles between male and female students? 3) Are there measurable differences in the cognitive styles between students who were schooled in educationally disadvantaged areas as against those who were schooled in educationally advantaged areas of Nigeria?

The result of this study showed that: (i) Nigerian students have a preferential cognitive style for recall (R) followed by principle (P), unlike for example Israeli children who showed a stronger preference for critical questioning (Q) as reported by Tamir (1981a). (ii) Cognitive styles appear to be unrelated to sex and location of previous schools attended by students along the continuum of advantaged and disadvantaged areas. This particular finding runs counter to the finding of Okeke & Wood-Robinson (1980) in which performance of pupils from urban and rural schools were compared in regard to their understanding of a range of biological concepts cited above.

The strong preference for recall (R) and principle (P) by Nigerian students as reported by this study is the more important outcome which is inevitably tied up with the teachers' styles, or strategies and tactics of teaching, and their preferred emphasis during teaching.

The one other study which has attempted to determine the desirability (preferences) of selected statements of objectives and methodology as a guide for science teaching in Nigerian Schools was by Abdullahi (1983). This study involved 280 indigenous teachers comprising 120 biology teachers, 90 chemistry and 70 physics teachers. Again, it involved sampling of the opinions of teachers by a postal questionnaire consisting of 32 statements of objective and methodology formed into an instrument which provides respondents with three responses to each statement such as: Highly desirable, desirable and undesirable. According to Abdullahi (1983), the instrument was factor analysed into eight subscales - three for objectives and five for methods of science teaching. The subscales are represented as follows: OBJECTIVES - 1) Scientific Literacy, 2) Vocational Preparation and 3) Liberal Education. FOR METHODOLOGY - 1) Inquiry Method, 2) Lecture Method, 3) Project Method, 4) Discovery Method and 5) Laboratory Method.

Information collected from the questionnaires was grouped under the factors to which it belonged and then analysed. The results of this study as pertains to the objectives of science teaching did not differ significantly between the three subject teachers' groups. The mean value ratings on items under vocational preparation were highest. On methodology, however, the ratings on items relating to Lecture Method and Project Method differred significantly among the three groups of science teachers. Whereas the biology teachers rejected the Lecture Method and embraced the Project Method as a highly desirable method of science teaching more than the chemistry or physics teachers, the three teachers' groups value-ratings of items on Inquiry Method, Discovery Method and Laboratory Method did not differ significantly. On the whole, however, they all rated the Laboratory and Inquiry Methods as a more desirable methodology for science teaching.

A major criticism of these questionnaire based studies was earlier highlighted. Even so, it may well be reiterated that it centres on the degree of falsehood with regard to the information given by the subjects, in this case science teachers. Whereas teachers could easily tick or enter any ratings for the questionnaire items they consider desirable, there may be no means of verifying what they do in practice. It is known that science teachers, especially in Nigerian Schools, hardly function or practice as their preferences or desirabilities show. Thus, systematic interaction studies only may be the more valid and reliable process of determining teachers' most practical strategies and tactics of teaching.

Another study recently reported was by Ogunniyi (1984). He states its purpose as that of identifying and describing the nature of teacher's verbal behaviours exhibited during science teaching and instruction.

The instrument employed in this study was a slightly modified version of Flanders' (1970) Interaction Analysis Categories. The main modification was with teacher questions (Category 4) which was subdivided into additional subcategories for the purpose of distinguishing questions of memory, those that are informational, rhetorical, leading and probing.

Three trained observers were involved in the observation of 24 randomly selected secondary school science teachers from the Ibadan Local Government area of Oyo State in Nigeria. Each teacher was observed for an entire class period two or more times within a one-month period.

From this study once more there emerged evidence that verbal behaviours in science lessons are dominated by the teacher, with the students mostly remaining passive to listen and absorb or record information verbatim. More than four-fifths of the lesson period is devoted to verbal instruction with the students' verbal expressions limited mainly to responding to teachers' questions, while the teachers were found to ask a lot more questions than their students could answer. Ogunniyi (1984) relates this to the existing status quo in a traditional society where the elder (in this case, the teacher) has all the knowledge and usually remains unchallenged, even by way of questioning.

In addition to the above findings on verbal interaction, Ogunniyi reports the percentage proportion of the types of questions used by the teachers observed which is as in Table 3.2 reproduced below.

<u>Table 3.2</u>

Comparison of Percentage Proportion of Types of Questions used by Teachers in Science Lessons Within Three Subject Areas:

GROUP	Memory	Informational	Rhetoric	Leading	Probing
Biology (N=16)	4.58	72.29	14.46	1.45	7.22
Physics (N=16)	0.79	53.67	35.43	4.20	5.91
Chemistry (N=16)	1.54	57.69	35.38	2.31	3.08
This author's Average percentage of all Science Teachers, culled from Ogunniyi's	2.30	61.21	28.42	2.65	5.40

It could be interpreted to mean that on the average the science teachers (Biology, Physics and Chemistry inclusive) observed employed in decreasing order 61.21 per cent of informational questions, 28.42 per cent of rhetorical questions, 5.40 per cent of probing questions, 2.65 per cent of leading questions and 2.30 per cent of memory based questions. More specifically, biology teachers asked most of the informational questions (72.39%) as well as most of the memory questions (4.58%), and probing questions (7.22%). While physics teachers asked most of the rhetorical questions (35.43%) and leading questions (4.20%). The chemistry teachers closely follow the biology teachers in informational questions (57.69%) and following the physics teachers with (35.38%) of rhetorical questions.

3.5.1 Conclusion:

Suffice it to say that not many studies in the area of science teaching in Nigerian Schools have been reported compared to the developed nations. But from the findings of the few studies so far undertaken and reported, and discussed here a number of features and characteristics about interactional, cognitive and behavioural patterns of both teachers and pupils can be inferred. Some of these include the dominant nature of lesson and classroom interactions by teachers, the high incidence of statements of facts leading to didactic teaching. On questions, teachers ask far more questions which are answered by recalling facts and principles, than of any other kind.

Of the studies so far reviewed, those of Ajeyalemi (1981), Shuaibu & Ogunsola (1983) and Ogunniyi (1984) have certain elements which are of interest to this author. Although Ajeyalemi (1981) proposed as one of his objectives, a detailed descriptive analysis of classroom language or discourse in Nigerian chemistry classrooms, some of the essential aspects of any classroom discourse such as the strategies and tactics of explaining employed by the teachers remained unexplored. Ajeyalemi & Maskill (1982) attribute low intellectual engagement in Nigerian classrooms to the questions asked by the teachers, and the pupils' answers to them. Yet there was no direct evidence of these in Ajeyalemi's (1981) work on the basis of which they conclude that "... from teachers' questions and pupils answers ... the level of intellectual engagement in these Nigerian classrooms was extremely low."

The finding by Shuaibu & Ogunsola (1983) that Nigerian students have a preferential cognitive style for recall and principles, does not alarm this author over much. Failure to relate this to the strategies and tactics of the teachers casts some doubts on the finding. In the same way, the conceptual and cognitive levels of questions asked by both teachers and pupils, and their respective responses to the questions remain under explored inspite of the attempts by Gyuse (1982) and Ogunniyi (1984) to categorize teachers' questions on the bases of adaptions of Bloom's (1956) Taxonomy of Educational Objectives, and Flanders' Interaction Analysis Categories, respectively.

This author believes that a knowledge of of the quality of questions, the thinking levels that they demand of the pupils and vice versa, and the strategies and tactics adopted by the science teachers in their bid to achieve effective exposition will be particularly important in the effort to improve and increase the quality of science teaching in particular and the Nigerian Educational provision, in general.

Chapter 4

4. SYSTEMATIC OBSERVATION OF THE TEACHING OF SCIENCE IN NIGERIAN SECONDARY SCHOOLS: THE METHODOLOGY

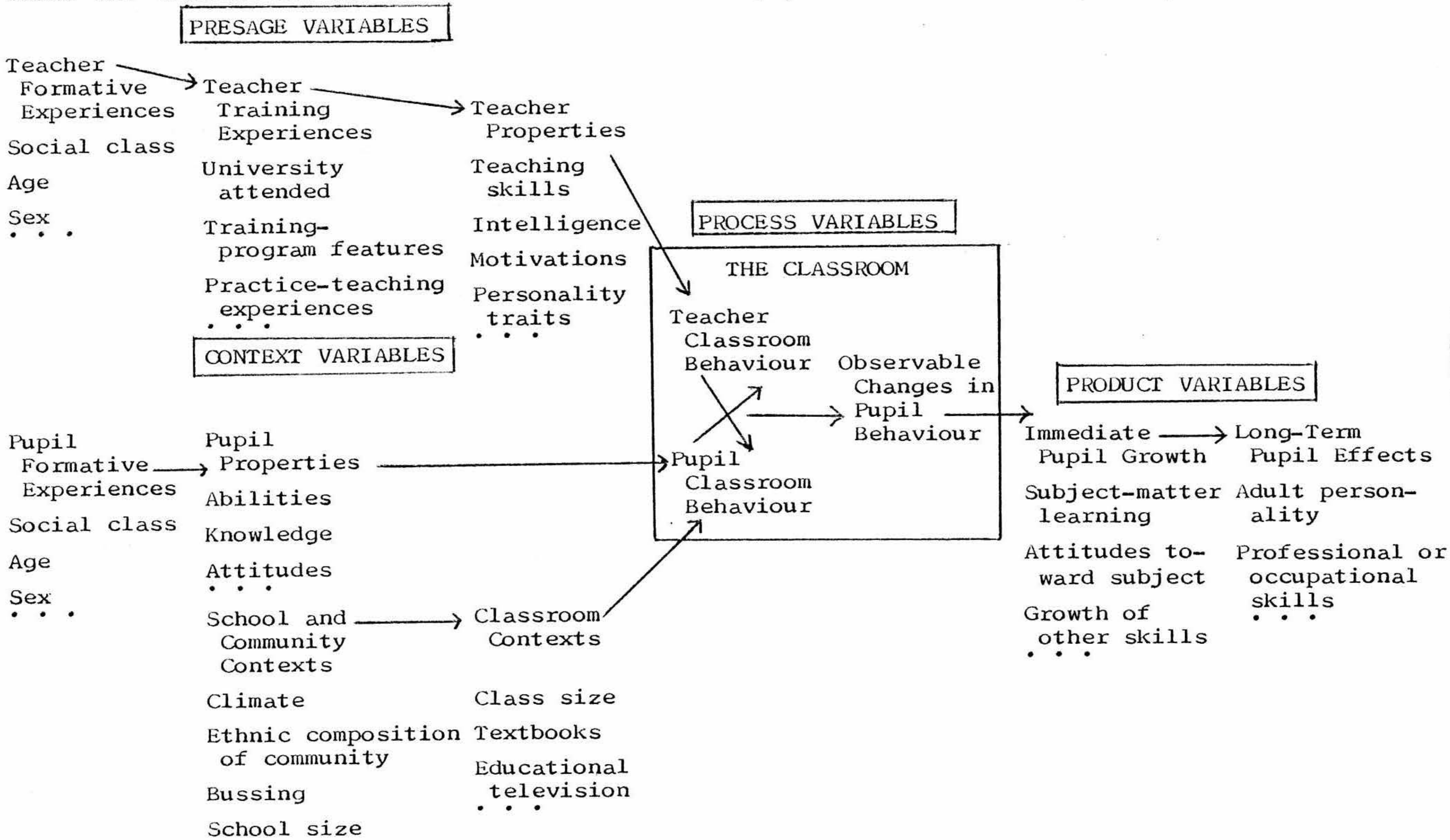
4.1 Introduction:

In Chapter 1, some factors affecting teaching and learning effectiveness have been explored. In Chapter 2, the role and effects of the formal forms of communication employed in the classroom have been discussed. Finally, in Chapter 3, a number of ways by which classroom interactions were, and should be studied have been considered.

All these chapters point to further studies of a number of possible variables which are thought to have brought about the current unsatisfactory practices in schools round the world, especially in Nigerian schools. However, it is not enough to assert a wish to study teaching. What is crucial is what aspects of teaching this study should involve?

For the purpose of organizing the findings of research on teaching, Dunkin & Biddle (1974 p36) constructed a model that concerns itself with the properties of teachers and pupils, the characteristics of the classroom, together with those the school and community. It also concerns itself with those changes in pupils for whom we are presumably conducting the enterprise of education, and the process of teaching itself, with the actual behaviour of teachers and pupils as they play out the complex drama of classroom teaching. All these are summed up in the terms: presage-, context-, process-, and product-variables and expressed schematically as follows:

Chart 4.1 A Model for the Study of Classroom Teaching (From Dunkin & Biddle, 1974)



As about 50 pupils on the average are enrolled in a typical Nigerian secondary school class, it would only be theoretically possible to attempt to observe all pupils and teachers who are involved in speaking, asking questions, giving answers, exhibiting facial expressions, stand, move, gesture, touch themselves and others, write on the chalkboard and so on. On practical grounds, however, no one can study all aspects of teaching as shown by the model because of the cost involved. Apart from cost, it may be unrealistic and indeed, questionable for a single study to attempt to answer most of the questions that researchers would like answered concerning teaching. As a result, this study will be attempting to be involved in an aspect of the process variables which should lead to better teaching in schools.

4.2 The Process Variables:

As Dunkin & Biddle (1974, p44) have pointed out, process variables concern the actual activities of classroom teaching; what teachers and pupils do in the classroom including all the observable behaviours of teachers and pupils. Some teachers may appear incapable of keeping order in the classroom, some pupils engage in horseplay or whisper to others; as long as these events are observable they may be judged as components of teaching-process variables. This is similar to Green's (1971, p215) contention that "to understand the idea of teaching we need to grasp the nature of knowing, believing, thinking, learning, explaining, judging, wondering, defining and demonstrating, and so forth. Each of these activities has a place in teaching. Still, not even collectively do they constitute all that we mean by teaching ...".

Nonetheless, some activities of teaching from the point of view of teacher-pupil interaction will be the centrepiece of this study.

4.2.1 Commitment:

There is now sufficient evidence that teachers who employ teaching styles which encourage pupils to ask questions and participate fully in lessons achieve better results (Flanders, 1970; Dunkin & Biddle, 1974; Eggleston et al, 1976; Hacker et al, 1979 and Theobald 1980). Also, it has become evident that teachers whose approach is less didactic and exert indirect influence by undertaking more constructive rather than destructive criticisms of pupils' works and responses, achieve better results. The use of pupils' ideas, moderation of the amount of talk, and use of precise words ensure effective teaching and learning. During lessons based on expository teaching involving descriptions and explanations, clarity and fluency, adequate emphasis, adequate use of examples and analogies, effective organization and feedback, have been identified as means of achieving effectiveness (Brown & Hatton, 1982; Brown & Armstrong, 1984; Perrott, 1982; Simons, 1984). Also, there is sufficient evidence that asking intelligible questions results in the achievement of better school learning and results (Brown & Edmondson, 1984; Kerry, 1982; Perrott, 1982; and Wilson, 1969).

If the above evidence is to be regarded as conclusive and hold good in an educational system and situation such as obtains in Nigeria; then one may want to investigate and obtain answers to the following questions:

1 a) What is the nature of teaching in Nigerian science classrooms? What styles of teaching do Nigerian teachers adopt? Is science teaching more didactic and expository (Recitation type) than discovery (experimentation or heuristic type).

b) On the part of the pupils: What response do pupils give to a teacher's particular style of teaching? Do they understand and consequently benefit from such style(s) of teaching? Do they get involved in lessons?

2 a) What is the nature of explanation during lessons? Do teachers explain ideas, concepts, rules, principles etc and if so, how effectively? Is the amount of explaining

done largely responsible for the amount of teacher talk during lesson?

b) On the part of the pupils: Do teachers' explanations help pupils to think and find relationships, and/or simply add to information known? How do pupils respond to teachers' explanations? Does engagement or confusion leading to boredom and disengagement result from the teachers' styles?

3 a) What is the nature of questioning in the science classrooms during lessons? Do teachers regard questioning as an essential part of teaching? What levels and types of questions do teachers employ? Do teachers encourage pupils to ask questions?

b) On the pupils' part, do pupils appear to enjoy being asked questions during lesson? Do pupils view teachers' questions as threatening? Do pupils regard questions and answers as an essential part of teaching and learning?

The model of teaching behaviour implicit in this study is that teaching styles and teacher behaviour are a function or mirror of the quality of the teachers and the activities of teaching. Further, it is suggested that, from the behaviour exhibited and the styles derived therefrom, the quality of the teaching acts can be evaluated. This is because the evaluation is based on internal criteria which are evident in the two instruments to be employed in this study.

4.2.2 The Observational Instruments to be Used: (Units of Analysis)

The choice of the observational instrument to be used in this study depends on the aspect of teaching that this study involves. The aspect of teaching to be studied is essentially in the area of process variables with particular concern for teachers' strategies and tactics, and their modes of explaining and questioning.

Most systems for studying teaching have concentrated on teacher behaviour, assuming that much of the success of teaching is in the hands of teachers. This idea has been mooted earlier in Chapter 3. But teacher's behaviour is also a function of pupils' behaviour, and the success of the teaching enterprise rests with pupils as much as with the teachers. Some researchers have thus confined their studies to the target pupil who is addressed by the teacher, ignoring the other audience pupils. Others (Eggleston et al, 1976; Hacker et al, 1979; Tamir, 1981) have studied the reaction of pupils as a mass audience, making judgements about the collective or average state of pupils' behaviour for a given unit of time. Yet others like Galton & Simon (1980 a&b) have studied the reaction of randomly selected pupils for a given unit of time.

Those researchers whose interests centre on classroom communication patterns have used instruments relevant to their studies (Sinclair & Coulthard, 1975; and Bellack et al, 1966). Others on classroom cognitive interaction (Eggleston et al, 1976; Hacker et al, 1979), have used instruments such as the S.T.O.S. which has become an important instrument for such studies. Yet, others have used a combination of instruments (Tamir, 1981) to effectively analyse different aspects of the study, (see 3.4.2).

Instruments differ in their units of analysis as well as the events of teaching they choose for study. Some instruments further concern themselves with 'acts', some with 'questions' and 'answers', some with gestures, facial expressions, some with teaching cycles or episodes, and yet others with arbitrary units of time (Dunkin & Biddle, 1974). For a result, and for the purpose of validity, this study must employ such instruments that may be considered, after due evaluation, to be relevant and appropriate to the aspect of teaching that this study entails.

In 1970, some 200 observational instruments of which most were American and only two British were available according to Simon and Boyer (1970). Eight years afterwards, Galton (1978) published a more complete descriptive matrix of 41 British classroom observation schedules. Of these, those of Alexander (1974), Eggleston et al (1975) and McIntyre & Brown (n.d) "Analysis of Teaching Behaviour", focus directly on science teaching. Others focus on subjects across the curriculum. Yet others are limited to social science and language subjects.

For this study, the main selection criteria are that: the instrument to be used should provide for a wide range of cognitive behaviours. Second, the instrument should, where possible, be specifically developed for the study of science lessons. The latter criterion is intentionally imposed as systems for across curriculum studies as classified by Galton (1978), have often failed to cope adequately with the unique aspects of science lessons in a laboratory context (Hacker et al, 1979 p4). In view of this, it was decided that the STOS (see Chapter 3) be employed in this study in Nigeria. The second instrument which is designed to help in the analysis of the nature and cognitive levels of teachers' explanations and questioning strategies and tactics will be discussed in the next Chapter.

4.3 Defining The Population:

Having decided to observe science teachers in action in their classrooms, it became necessary to define the target population of teachers from which the sample of teachers was going to be drawn.

It might have been possible to observe more teachers than this author ended up with but for the presence of expatriate teachers and the few unqualified teachers who were intentionally excluded. For the expatriate teachers, it was realized that they did not train in Nigeria and have contract appointments which may terminate anytime, and as a result could not be held accountable as such for the current practices in the schools. The few underqualified teachers found teaching integrated science course were also excluded because they are temporary teachers who could leave without being questioned.

In effect, my sample of teachers was selected randomly and all are holders of qualifications from the N.C.E. up to the first degree in either pure science or a degree in science education and teaching in the Rivers State of Nigeria.

4.3.1 Preliminary Arrangements:

Initial contact with some teachers and schools was made in the 1982/83 session during which time a 3-hour long video recording of 8 single period science lessons were made in a few Rivers State schools. These lessons have been used in the preliminary studies leading to this main study. Although no direct contact was made from the United Kingdom so as not to create unnecessary anxieties on the part of the teachers, direct and immediate contacts were begun directly this author returned to the Rivers State, in Nigeria for the main study in September 1984. The trip lasted a whole school term and this author returned to the U.K. in December 1984.

The main reasons why no contact was made with schools from the United Kingdom prior to the main study are two fold. First, most heads of secondary schools (principals) attach little or no importance to such contacts. Rather, they prefer to meet the researcher as and when the researcher is ready to commence observation. It must be pointed out here that the principals were most co-operative. A meeting with the principal of a school, for instance, resulted in either the vice-principal or heads of science departments being invited. They would then take the trouble of taking this author round to meet the chemistry, biology and integrated science teachers. The second reason why no direct contact was made from the U.K. is because the heads of schools as well as the teachers are liable to transfer to other schools. Thus, any earlier arrangements might not have been fruitful as either the head or the teachers could have gone on transfer.

4.3.2 Meeting the Teachers in the Schools:

On arrival, visits were quickly made to a few schools where the principals of the schools were met. Following such meetings, the Head would invite either the head of the science department or the vice-principal who would conduct this author round to meet the teachers at which time the purpose of my visit was explained to the teacher(s). The method used to explain my purpose in undertaking the observation was brief but to the point. First I informed them of my background as a science teacher and then of my current studies. Then I briefed them on the ultimate purpose of my studies which is aimed at tapping their wide and varied experience in order to formulate a better basis on which to train future teachers of science. A letter produced and given to each teacher so met and consequently observed is given in Appendix 2.

In addition to the few teachers who turned down my request to observe their lessons, a few others opted to be observed but failed to hold their classes. The reasons adduced each time lessons were not held were flimsy and usually unacceptable to me, but then, I had to bear with them and sympathise with the reasons.

This process of meetings continued as this author progressed from school to school. In total, 12 secondary schools were visited from which 54 lessons were observed using the Science Teaching Observation Schedule (STOS) including the 12 coded from transcripts rather than insitu.

In general, all the teachers observed have qualifications which the employers consider to be adequate for teaching. Thus of the 42 science teachers, 17 hold the Nigerian Certificate of Education (N.C.E.) and 25 are graduates. Of the 25, 8 hold the Bachelor of Education degree and the rest hold single honours degrees in either Chemistry, Biology or some other biological science related areas.

However, more interest centres on the teachers whose lessons were audio-recorded and transcribed for use with the Explanation Appraisal Schedule (E.A.S.). As the table below shows, there are 12 teachers whose lessons are used for the E.A.S. analysis and their profiles are summarized in the table on the basis of their association with the two clusters distinguished (see Table 5.2).

Table 4.1a

The Science Teachers' Profile:

Characteristics		Cluster X	Cluster Y
sex	M	0	1
	F	7	4
Highest Qualification:	N.C.E.	4	3
	B.Sc.	3	2
	B.Ed.	-	-
Teaching Experience in years:	- 1	2	0
	1+ - 3	0	1
	3+ - 5	0	4
	5+ - 8	4	0
	8 - 12	-	-
	12+	1	0
Number of Schools Taught in:	1	1	0
	2	3	2
	3	1	3
	4	1	0
	5+	0	0
In-Service Opportunities:	0	6	5
	1	1	0
	1+	0	0
Average Class Size Range (21 - 54)		40	30
Grade of pupils Taught:	Form 1	1	-
	2	-	-
	3	2	-
	4	2	2
	5	2	3

4.3.3 Data Collection In the Schools:

After agreeing with a teacher to have lesson observed, the teacher's timetable was taken and the convenient lessons would then be agreed. This procedure was followed for all the lessons so observed. Initially, a minimum of three lessons per teacher was planned. But owing to unforeseen difficulties, this became impossible to achieve within the available time and resources. This was partly because the audio-recording of some selected lessons was also undertaken.

In total, 27 lessons comprising 10 biology, 15 chemistry and 2 Integrated science lessons were audio-recorded. On the basis of clarity, audibility and suitability for use in further analysis, 12 lessons comprising 5 biology, 6 chemistry and 1 Integrated science lessons were subsequently transcribed.

<u>Table 4.1b</u>

Summary Table of Lessons Observed:

<table>
<tr><th>Number of Schools Visited</th><th>Total Number of Lessons</th><th>Biology</th><th>Chemistry</th><th>Integrated Science</th><th>Total</th></tr>
<tr><td>12</td><td>54</td><td>19</td><td>23</td><td>12</td><td>54</td></tr>
<tr><td colspan="2">Number of Lessons Audio-Recorded</td><td>10</td><td>15</td><td>2</td><td>27</td></tr>
<tr><td colspan="2">Number Transcribed</td><td>5</td><td>6</td><td>1</td><td>12</td></tr>
</table>

Later, the 12 lessons transcribed were analysed using the Explanation Appraisal Schedule (E.A.S.), an instrument developed for this purpose and described fully in the next Chapter.

4.3.4 Using The S.T.O.S.:

The fact that the STOS was originally developed for use in British schools and thus took account of the nature of classroom settings, the general structure of the curriculum of schools and the pupils' developmental patterns under British circumstances cannot be ignored. The structure of the curriculum of the schools along with the built-in instructional patterns appear to run counter to the pattern existing in Nigeria.

In addition, classrooms in Nigerian schools are much more congested than in Britain as between 48 and 55 pupils are enrolled in each single arm of a class and this affects the way classroom interactions and activities are conducted. This affects the way intellectual activities are organized. Teachers do not encourage pupil-pupil dialogues, and even teacher-pupil dialogues is limited to question and answer situations.

These differences are exaggerated by the general lack of adequate teaching resources to back-up teaching and the apparent lack of enthusiasm of the teachers resulting in low out-put. Even so, the following results were obtained using the Science Teaching Observation Schedule (S.T.O.S.) and subsequently analysed.

For comparative purposes, lessons 43 - 54 were coded from the transcripts of the audio-recorded lessons, the audio-tapes being used to check the 3-minute intervals required for analysis.

Table 4.2

SCIENCE TEACHING OBSERVATION SCHEDULE (STOS) DATA

STOS / TEACHER	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	Lesson
01	00	00	00	00	00	00	00	11	00	00	03	00	00	00	00	00	00	00	00	01	00	00	00	C
02	03	00	00	00	00	00	01	11	00	00	00	07	00	00	00	00	00	00	00	01	00	00	00	B
03	05	01	01	00	01	00	02	11	00	00	00	00	00	00	00	00	00	00	00	01	00	00	00	S
04	04	03	00	00	01	00	00	11	00	00	03	00	00	00	00	00	00	00	00	02	00	00	00	B
05	07	02	00	00	00	00	02	10	00	02	00	00	00	00	00	00	00	00	00	02	00	00	00	B
06	04	04	00	02	02	02	03	11	00	00	03	01	00	00	00	00	00	00	00	00	00	00	00	C
07	06	05	00	00	00	00	00	11	00	00	00	00	00	00	00	00	000	00	00	04	00	00	00	C
08	08	04	00	01	00	03	00	11	00	00	05	01	00	00	00	00	00	00	00	00	00	00	00	C
09	06	02	00	00	00	00	01	11	01	01	07	00	00	00	00	00	00	00	00	02	00	00	02	C
10	02	00	00	00	00	00	00	10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	C
11	08	02	00	00	00	00	00	11	00	00	00	00	00	00	00	00	00	00	00	02	00	00	00	B
12	03	02	00	01	01	01	00	11	00	00	06	00	00	00	00	00	00	00	00	02	00	00	00	S
13	02	01	00	00	00	00	00	10	00	01	02	00	00	00	00	00	00	00	00	02	01	00	00	B
14	05	01	00	00	02	02	00	11	00	01	01	00	00	00	00	00	00	00	00	02	00	00	00	B
15	09	02	00	00	03	00	00	11	00	03	05	00	00	00	00	03	00	00	00	02	02	00	00	S
16	02	00	00	00	00	00	00	11	00	00	02	00	00	00	00	00	00	00	00	01	00	00	00	C
17	08	05	00	00	01	03	01	11	03	01	02	01	00	00	00	00	00	00	00	00	00	00	00	S
18	04	05	00	00	00	00	00	11	00	00	03	00	00	00	00	00	00	00	00	04	00	00	00	B
19	07	05	00	01	00	00	01	11	00	00	04	02	00	00	00	00	00	00	00	00	00	00	00	C
20	00	00	00	00	00	00	00	11	00	00	02	00	00	00	00	00	00	00	00	00	00	00	00	S
21	03	02	00	00	00	00	00	11	00	00	05	02	00	00	00	00	00	00	00	01	00	00	00	B
22	06	00	00	00	00	00	00	11	00	00	03	02	00	00	00	00	00	00	00	01	00	00	00	C
23	10	02	00	00	01	00	00	11	00	00	03	00	00	00	00	00	00	00	00	00	00	00	00	B
24	08	00	00	00	00	00	00	11	00	01	00	00	00	00	00	00	00	00	00	04	00	00	01	B
25	08	04	00	00	02	00	00	11	00	00	03	00	00	00	00	00	00	00	00	02	00	00	00	B
26	09	02	00	00	01	00	00	11	00	00	04	01	00	00	00	00	00	00	00	02	00	00	00	C
27	07	04	00	00	00	00	00	11	00	00	06	02	00	00	00	00	00	00	00	02	00	00	00	C
28	07	03	00	00	00	00	00	11	00	00	01	01	00	00	00	00	00	00	00	00	00	00	00	S
29	07	01	00	00	00	00	00	11	00	00	05	00	00	00	00	00	00	00	00	00	00	00	00	C
30	09	04	00	00	02	00	00	11	03	01	01	01	00	00	00	00	00	00	00	00	00	00	00	S
31	07	07	00	01	00	01	01	11	02	02	06	01	00	00	00	00	00	00	00	01	00	00	00	B
32	05	01	00	00	00	00	00	11	01	02	04	01	00	00	00	00	00	00	00	02	00	00	00	C
33	07	04	00	00	00	03	00	11	02	02	00	01	00	00	00	00	00	00	00	04	00	00	00	S
34	09	05	00	00	00	00	00	11	05	00	02	00	00	00	00	00	00	00	00	00	00	00	00	S
35	09	01	00	00	05	00	00	11	01	06	04	02	00	00	00	00	00	00	00	02	00	00	00	S
36	06	05	00	00	01	02	00	11	03	07	00	02	00	00	00	00	00	00	00	02	00	00	00	B
37	05	01	00	00	00	00	00	11	03	03	07	00	00	00	00	00	00	00	00	00	00	00	00	C
38	06	02	00	00	00	00	01	11	01	02	04	00	00	00	00	00	00	00	00	02	00	00	00	C
39	06	04	00	00	02	00	02	11	03	04	08	02	00	00	00	00	00	00	00	00	00	00	00	C
40	06	02	00	00	02	00	00	11	02	03	07	00	00	00	00	00	00	00	00	03	00	00	00	C
41	01	00	00	00	00	00	00	11	00	03	09	01	01	00	01	00	00	00	00	03	00	01	00	B
42	07	05	00	00	00	00	00	11	03	01	05	00	00	00	00	00	00	00	00	04	00	00	00	S
43	06	00	01	00	00	00	00	11	05	10	01	03	01	00	00	00	00	00	00	01	00	00	00	B

Cont'd

STDS / TEACHER	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	Lesson
44	10	05	00	00	00	01	02	11	07	10	05	06	04	00	00	01	00	02	00	05	02	00	00	B
45	05	04	00	02	03	06	01	10	02	02	05	01	00	00	00	00	00	00	00	00	00	00	00	C
46	05	04	00	00	00	00	01	11	00	03	10	02	01	00	01	00	00	00	00	01	00	00	00	C
47	00	03	01	00	03	00	00	09	05	09	08	05	01	00	01	00	00	00	00	00	00	00	00	C
48	05	02	01	03	01	03	00	10	05	06	04	08	00	00	00	00	00	00	00	03	03	00	02	B
49	04	03	00	00	02	01	00	11	07	06	06	05	04	00	00	00	00	00	00	02	00	00	00	B
50	03	02	00	00	00	00	00	11	07	08	06	05	00	00	00	00	00	00	00	01	00	01	00	C
51	05	07	00	00	00	00	00	11	08	02	10	05	02	00	00	01	00	00	00	01	02	00	00	C
52	08	01	00	00	02	02	03	08	05	02	03	05	03	00	00	00	00	00	00	01	01	00	00	S
53	08	07	00	00	00	00	00	11	06	05	01	03	00	00	00	00	00	00	00	00	00	00	00	B
54	08	06	00	00	00	00	00	11	05	07	06	05	01	00	00	00	00	00	00	00	01	00	00	C
TOTAL	308	147	04	11	38	33	19	584	95	116	200	84	18	00	03	05	00	02	00	76	12	02	05	
mean	5·7	2·7	·07	·20	·70	·61	·35	108	1·76	2·15	3·70	1·56	0·33	00	·06	·09	00	·04	00	1·41	·22	·04	·09	

4.4 Analytical Discussion of Findings From the S.T.O.S. Data:

Generally, all the biology, chemistry and integrated science teachers observed using the S.T.O.S., taught in closely similar ways. That is to say, the science teachers concerned did most of their teaching with the pupils sitting passively, listening and watching their teachers, only occasionally responding to questions. In very few instances only did pupils ask questions.

The STOS data was fed into the computer and was programmed to analyse the data in terms of the following:

- Frequencies of Distribution - the distribution of the codes or scores recorded by means of the S.T.O.S.

- Correlation Coefficients - the degrees of linear relationship between any two variables that comprise the STOS. The PEARSON CORRELATION COEFFICIENT was used.

- Analysis of Variance - the determination of whether there are statistically significant differences between the means of several different groups of teachers (lessons). The STUDENT NEWMAN-KEULS procedure was used as the post-hoc method of establishing differences between individual means after an ANOVA proved statistically significant.

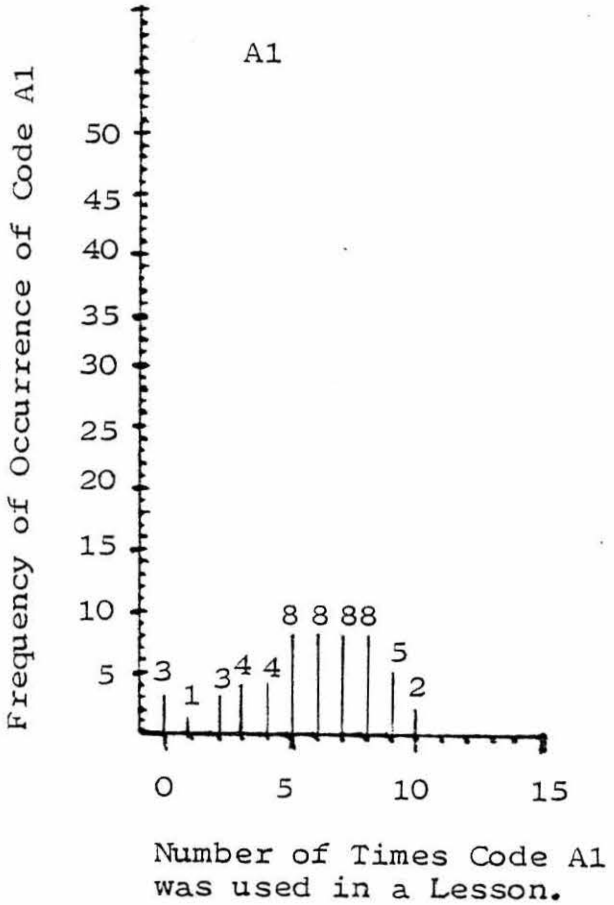
- And lastly, Cluster Analysis - which attempts to establish groupings of lessons with similar profiles. The method used was the RELOCATION CLUSTER ANALYSIS.

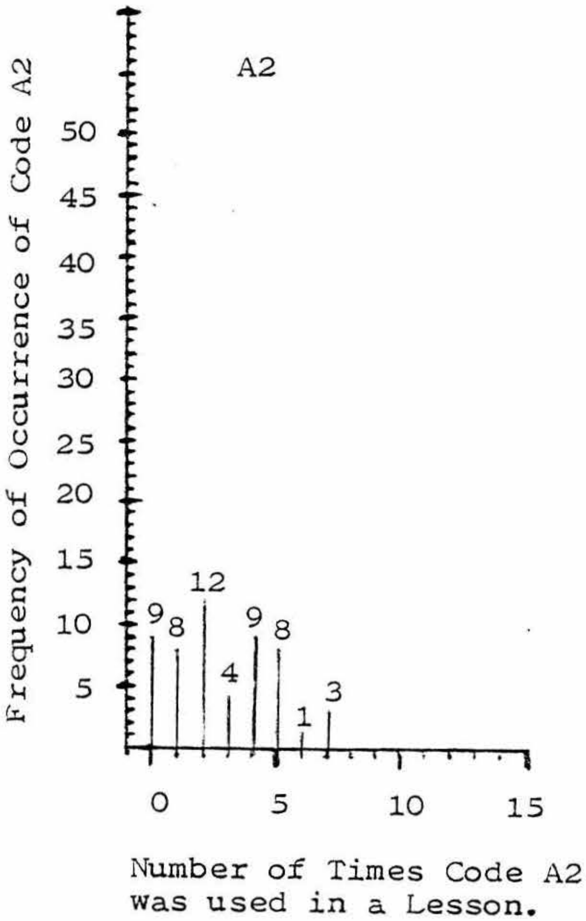
4.4.1 Frequencies of Distribution of Codes:

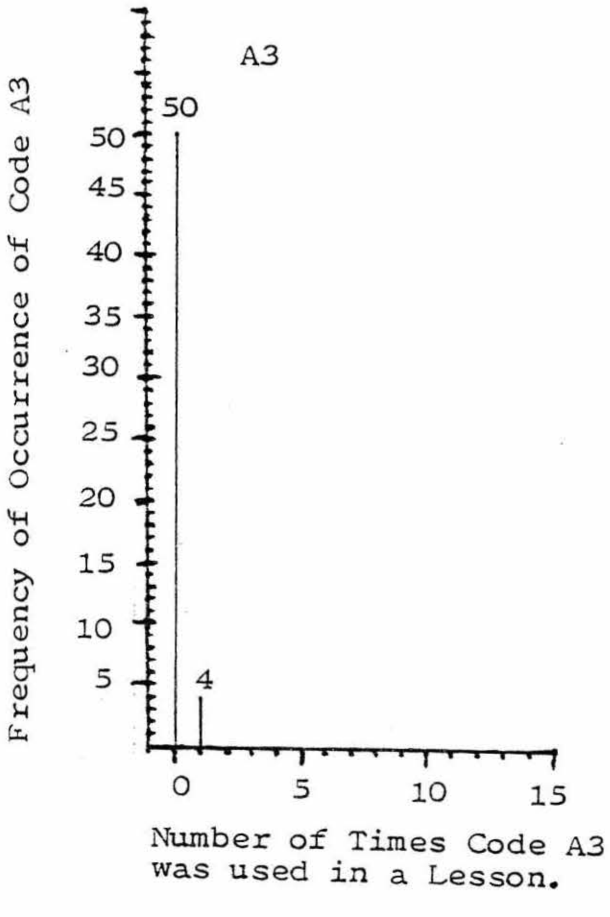
As the term suggests, Frequency Distribution is the organization of statistical data produced by dividing the range of values of the variables into classes and showing the frequency of occurrence of each class. On this basis therefore the frequencies of distribution of the 23 S.T.O.S.

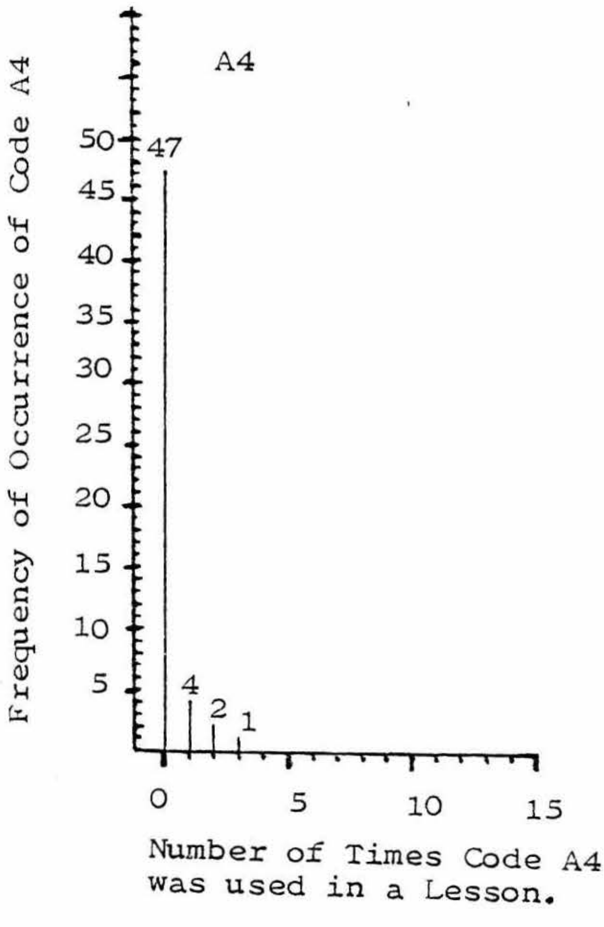
categories were determined.

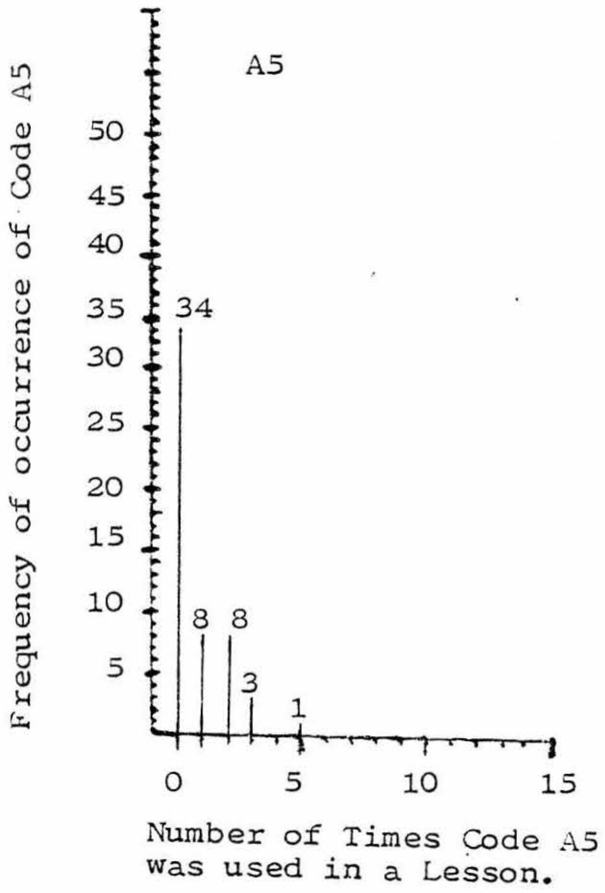
Although the frequencies of distribution will eventually be considered in 3 groups on the basis of occurrence, the summary charts below provide the basis of the groupings. This is based on the mean values of each of the S.T.O.S. categories. Further, the histograms - the graphical representation of frequency distribution are given to provide the necessary picture of the use of each category by a defined number of teachers.

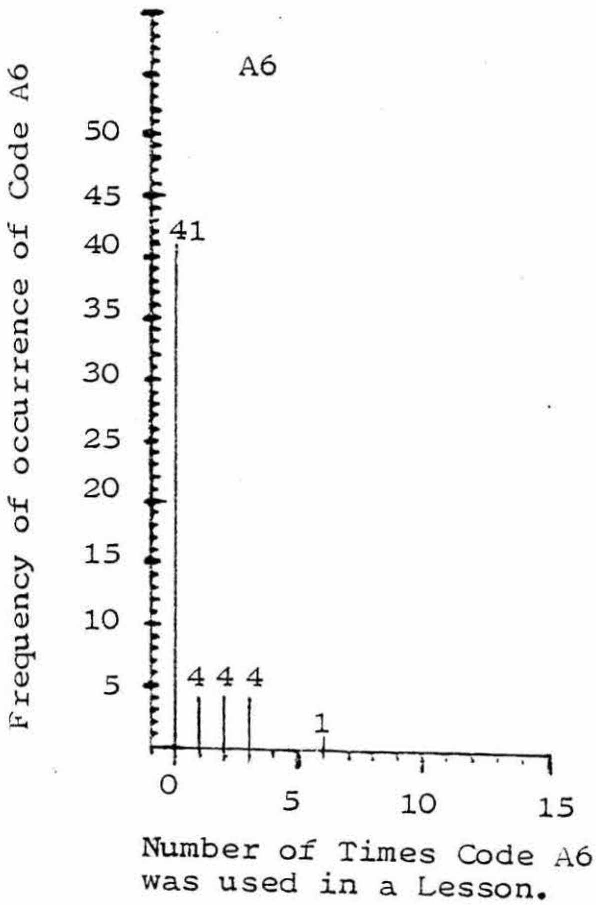

A1
Frequency of Occurrence of Code A1
Number of Times Code A1 was used in a Lesson.

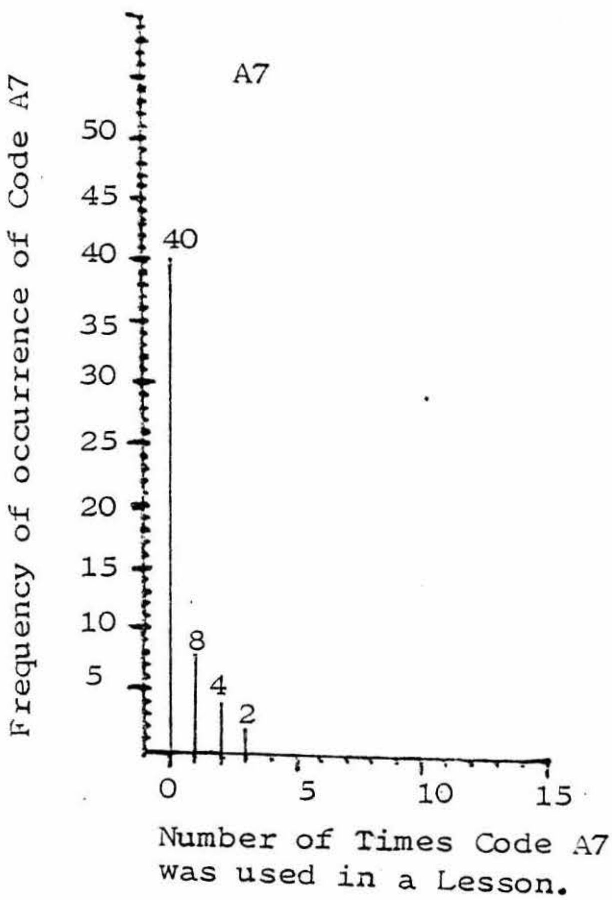

A2
Frequency of Occurrence of Code A2
Number of Times Code A2 was used in a Lesson.

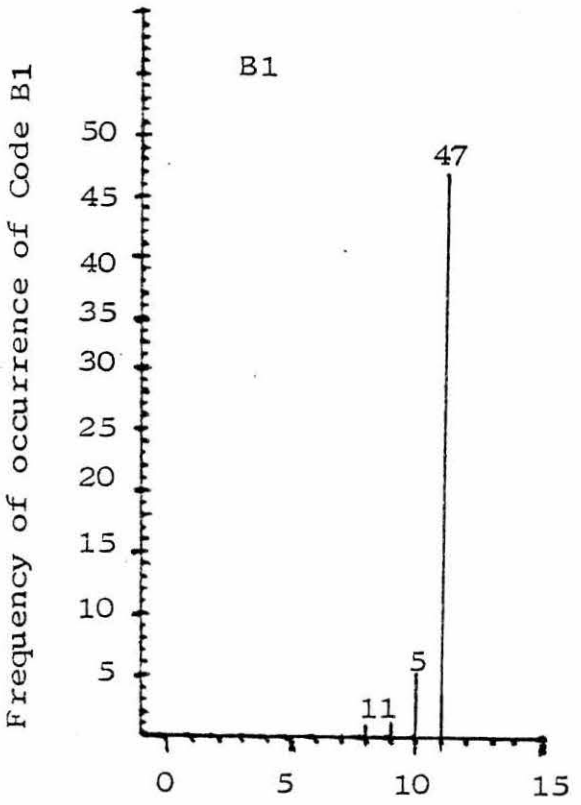

A3
Frequency of Occurrence of Code A3
Number of Times Code A3 was used in a Lesson.


A4
Frequency of Occurrence of Code A4
Number of Times Code A4 was used in a Lesson.

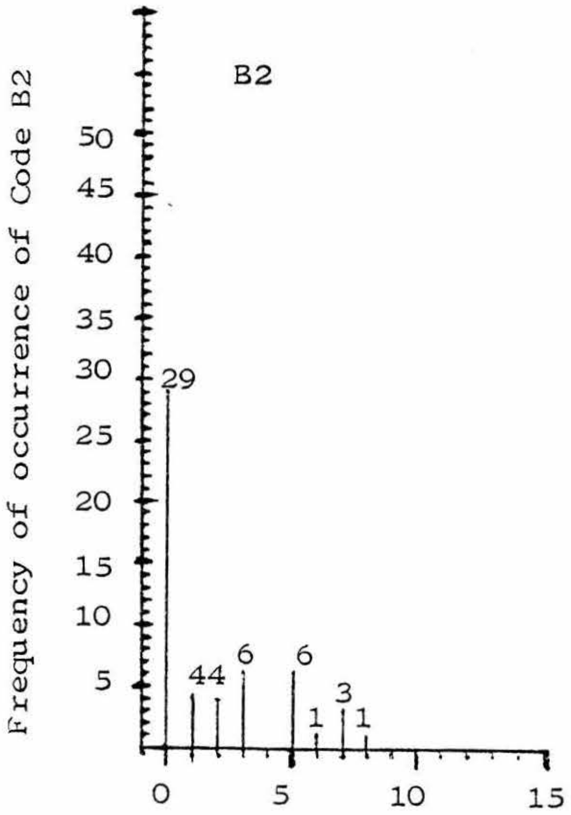

A5
Frequency of occurrence of Code A5
50
45
40
35
30
25
20
15
10
5
34
8
8
3
1
0
5
10
15
Number of Times Code A5
was used in a Lesson.


A6
Frequency of occurrence of Code A6
50
45
40
35
30
25
20
15
10
5
41
4
4
4
1
0
5
10
15
Number of Times Code A6
was used in a Lesson.

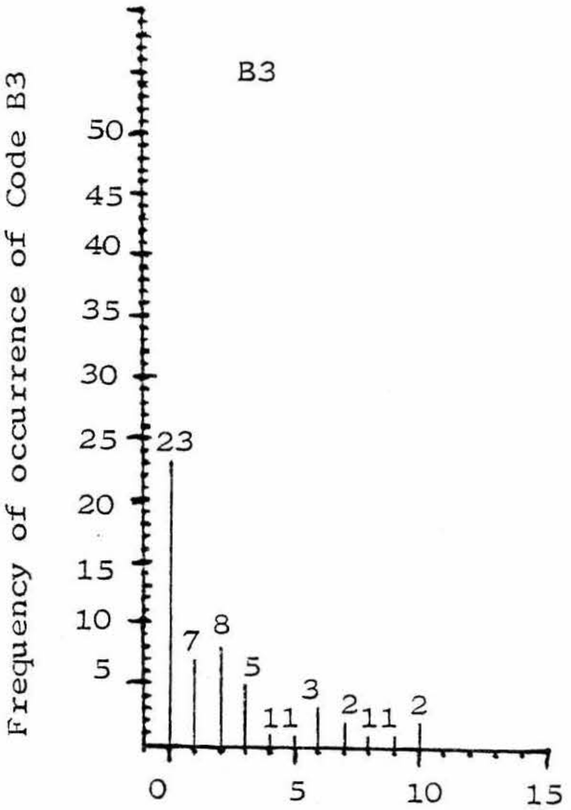

A7
Frequency of occurrence of Code A7
50
45
40
35
30
25
20
15
10
5
40
8
4
2
0
5
10
15
Number of Times Code A7
was used in a Lesson.



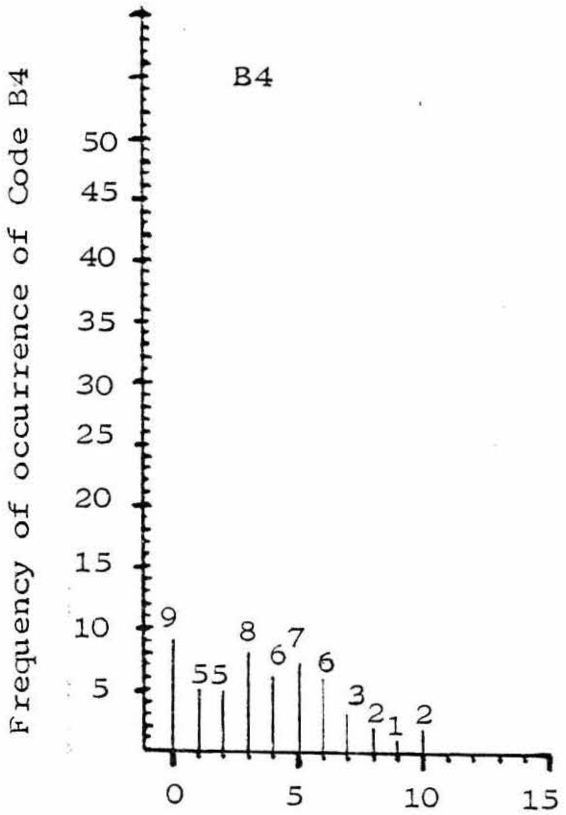
Number of Times Code B1 was used in a Lesson.



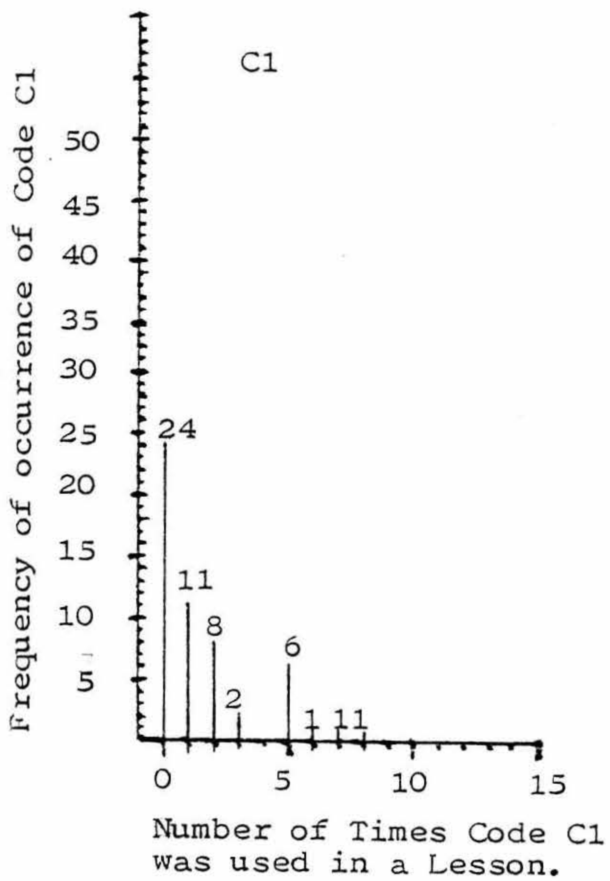
Number of Times Code B2 was used in a Lesson.

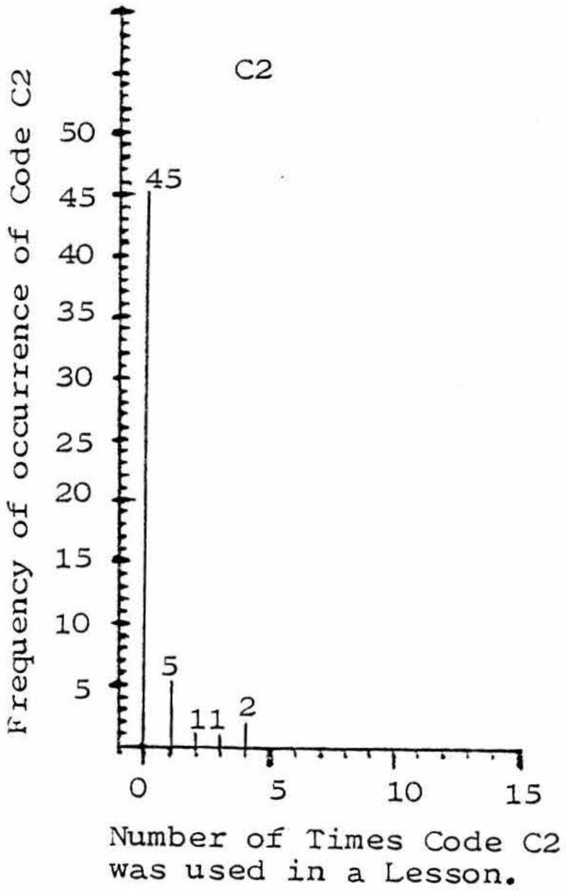


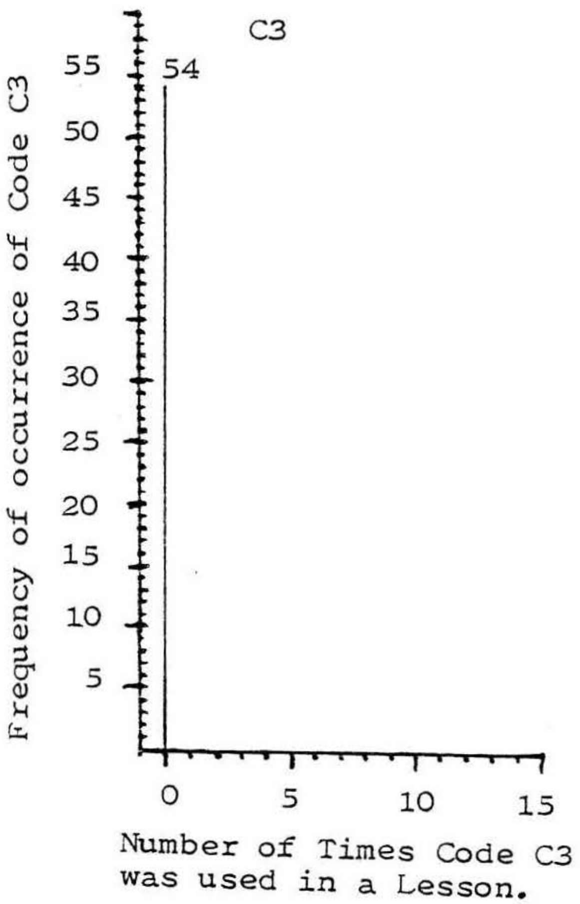
Number of Times Code B3 was used in a Lesson.

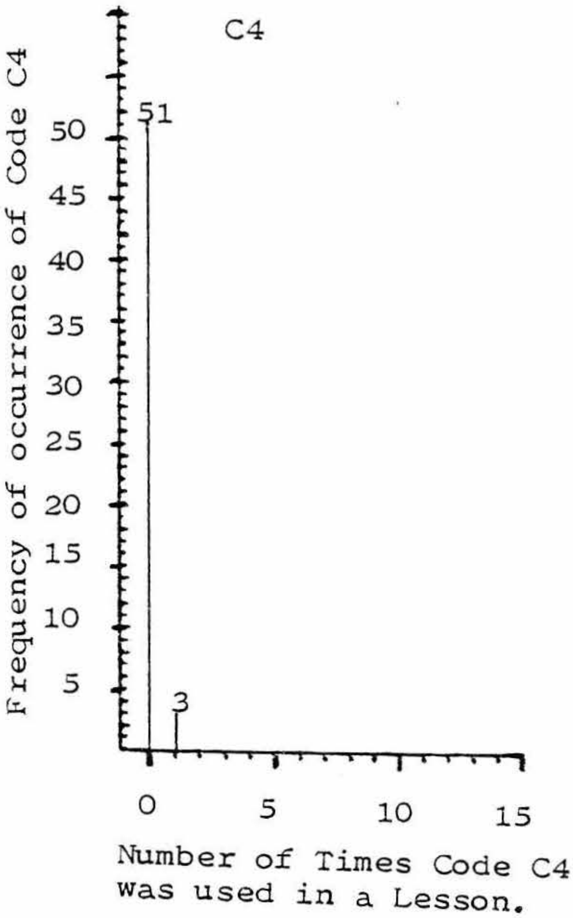


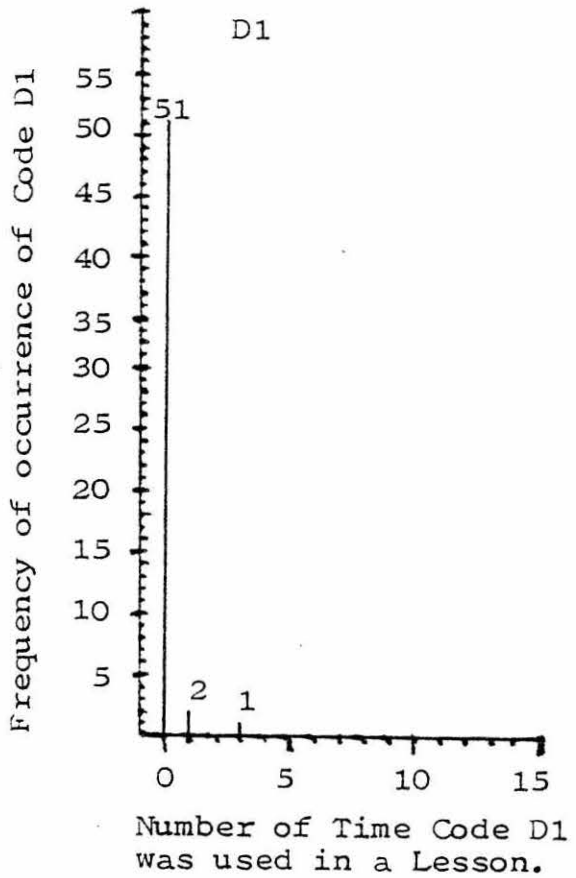
Number of Times Code B4 was used in a Lesson.

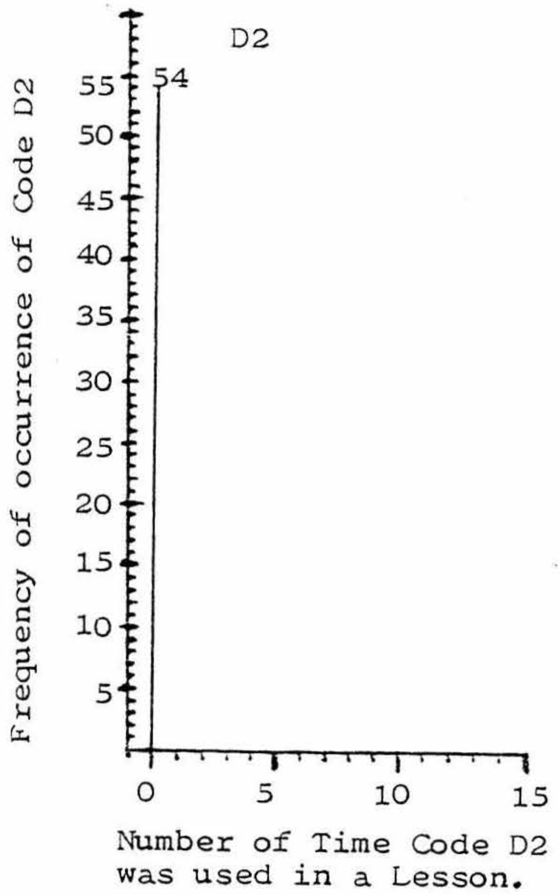

C1
Frequency of occurrence of Code C1
50
45
40
35
30
25
20
15
10
5
24
11
8
2
6
1
1
1
0
5
10
15
Number of Times Code C1
was used in a Lesson.

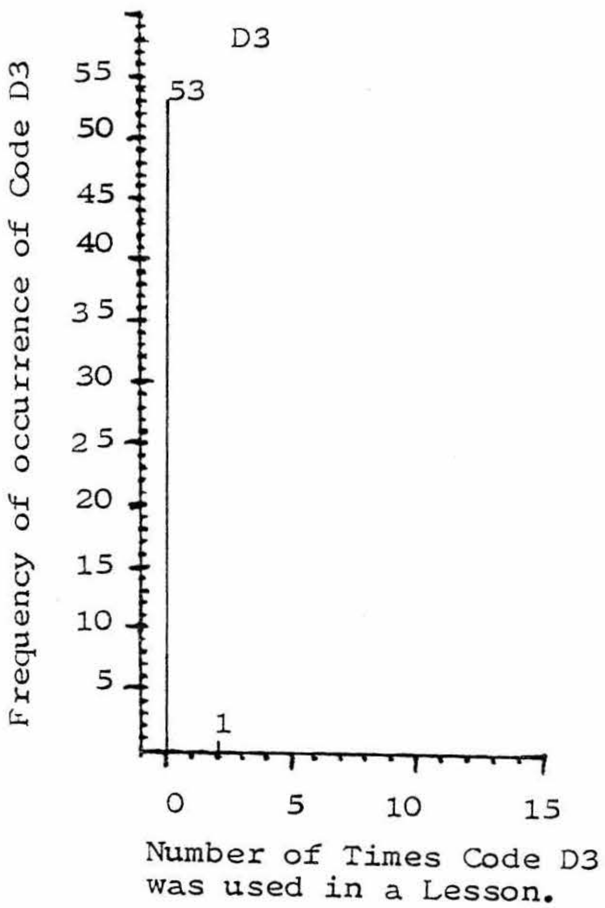

C2
Frequency of occurrence of Code C2
50
45
40
35
30
25
20
15
10
5
45
5
1
1
2
0
5
10
15
Number of Times Code C2
was used in a Lesson.

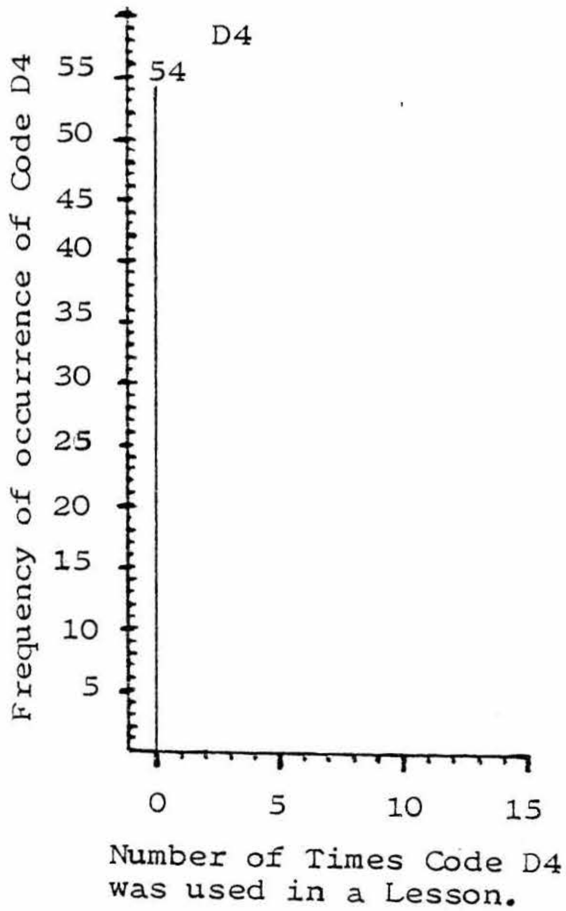

C3
Frequency of occurrence of Code C3
55
50
45
40
35
30
25
20
15
10
5
54
0
5
10
15
Number of Times Code C3
was used in a Lesson.

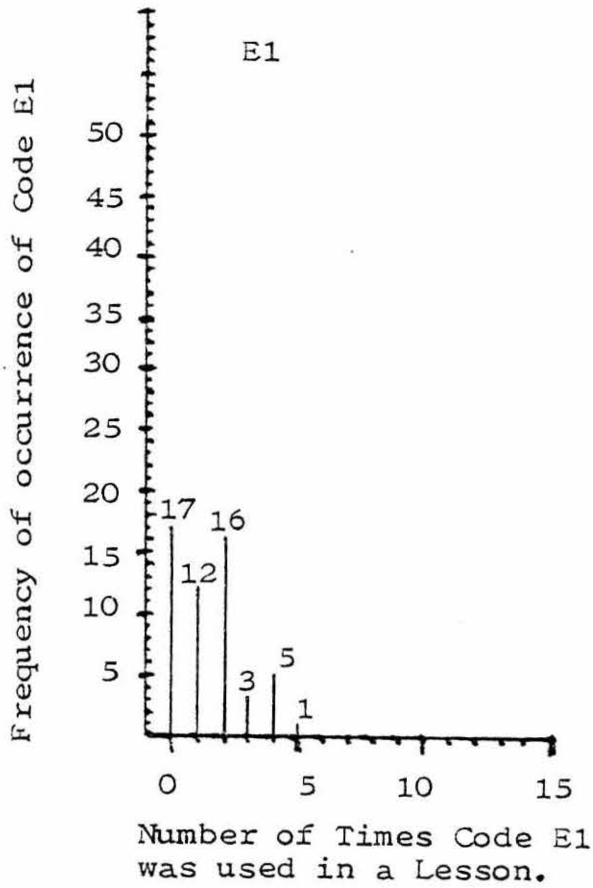

C4
Frequency of occurrence of Code C4
50
45
40
35
30
25
20
15
10
5
51
3
0
5
10
15
Number of Times Code C4
was used in a Lesson.

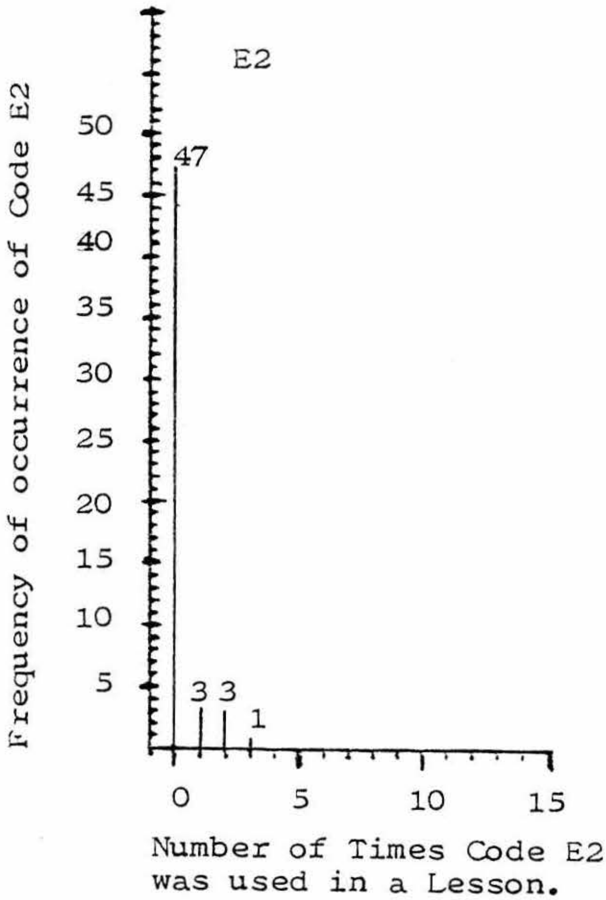

D1
Frequency of occurrence of Code D1
55
50
45
40
35
30
25
20
15
10
5
51
2
1
0
5
10
15
Number of Time Code D1 was used in a Lesson.

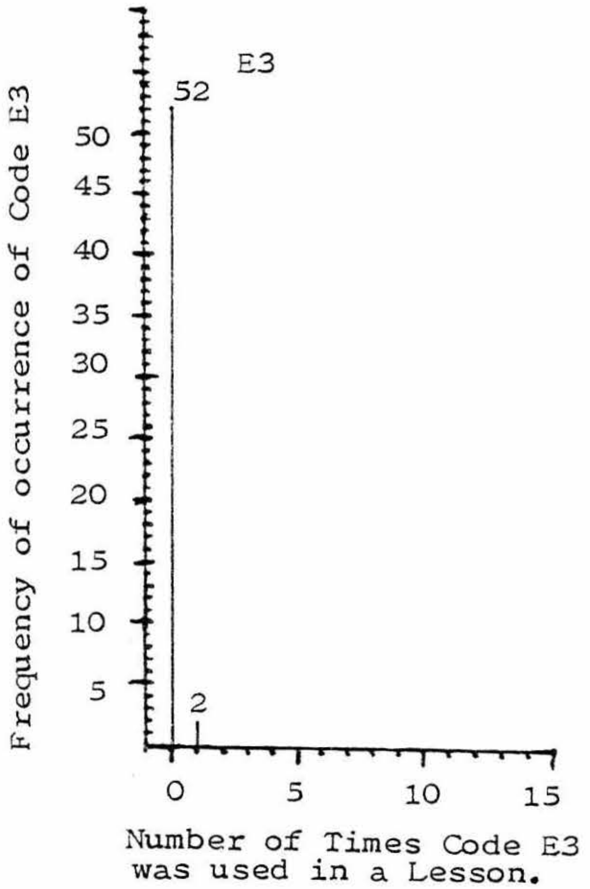

D2
Frequency of occurrence of Code D2
55
50
45
40
35
30
25
20
15
10
5
54
0
5
10
15
Number of Time Code D2 was used in a Lesson.


D3
Frequency of occurrence of Code D3
55
50
45
40
35
30
25
20
15
10
5
53
1
0
5
10
15
Number of Times Code D3 was used in a Lesson.


D4
Frequency of occurrence of Code D4
55
50
45
40
35
30
25
20
15
10
5
54
0
5
10
15
Number of Times Code D4 was used in a Lesson.


E1
Frequency of occurrence of Code E1
50
45
40
35
30
25
20
15
10
5
17
12
16
3
5
1
0
5
10
15
Number of Times Code E1
was used in a Lesson.


E2
Frequency of occurrence of Code E2
50
45
40
35
30
25
20
15
10
5
47
3
3
1
0
5
10
15
Number of Times Code E2
was used in a Lesson.


E3
Frequency of occurrence of Code E3
50
45
40
35
30
25
20
15
10
5
52
2
0
5
10
15
Number of Times Code E3
was used in a Lesson.

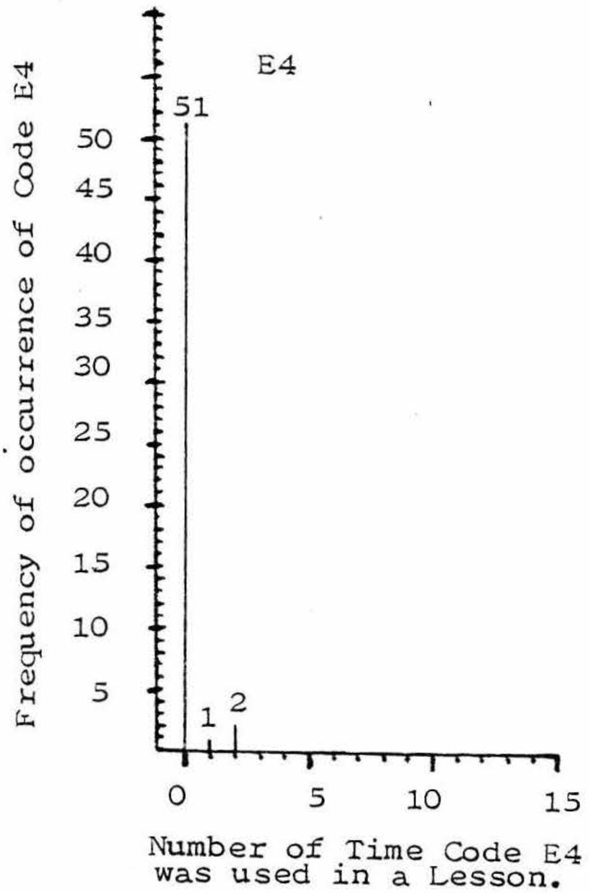

E4
Frequency of occurrence of Code E4
50
45
40
35
30
25
20
15
10
5
51
1
2
0
5
10
15
Number of Time Code E4
was used in a Lesson.

Table 4.3

Summary Table of Frequencies of Distribution of Variables:

STOS	NO. OF OCCURRENCES IN 3-MINUTE TIME SAMPLING INTERVAL											
VARIABLE	0	1	2	3	4	5	6	7	8	9	10	11
a1	3	1	3	4	4	8	8	8	8	5	2	-
a2	9	8	12	4	9	8	1	3	-	-	-	-
a3	50	4	-	-	-	-	-	-	-	-	-	-
a4	47	4	2	1	-	-	-	-	-	-	-	-
a5	34	8	8	3	-	1	-	-	-	-	-	-
a6	41	4	4	4	-	-	1	-	-	-	-	-
a7	40	8	4	2	-	-	-	-	-	-	-	-
b1	-	-	-	-	-	-	-	-	1	1	5	47
b2	29	4	4	6	-	6	1	3	1	-	-	-
b3	23	7	8	5	1	1	3	2	1	1	2	-
b4	9	5	5	8	6	7	6	3	2	1	2	-
c1	24	11	8	2	-	6	1	1	1	-	-	-
c2	45	5	1	1	2	-	-	-	-	-	-	-
c3	54	-	-	-	-	-	-	-	-	-	-	-
c4	51	3	-	-	-	-	-	-	-	-	-	-
d1	51	2	-	1	-	-	-	-	-	-	-	-
d2	54	-	-	-	-	-	-	-	-	-	-	-
d3	53	1	-	-	-	-	-	-	-	-	-	-
d4	54	-	-	-	-	-	-	-	-	-	-	-
e1	17	12	16	3	5	1	-	-	-	-	-	-
e2	47	3	3	1	-	-	-	-	-	-	-	-
e3	52	2	-	-	-	-	-	-	-	-	-	-
e4	51	1	2	-	-	-	-	-	-	-	-	-

Number of cases = 54.

The means given in the following summary chart are based on eleven 3-minute time sampling intervals (in which the STOS is analysed). Lessons being generally of 35 minutes duration.

Table 4.4

Summary Table of the Mean and Standard Deviation of each of the STOS Variables:

VARIABLE	MEAN	STANDARD DEVIATION
a1	5.70	2.58
a2	2.72	2.03
a3	0.07	0.26
a4	0.20	0.60
a5	0.70	1.12
a6	0.56	1.19
a7	0.41	0.79
b1	10.82	0.55
b2	1.76	2.40
b3	2.15	2.84
b4	3.70	2.75
c1	1.56	2.08
c2	0.33	0.91
c3	0.00	0.00
c4	0.06	0.23
d1	0.09	0.45
d2	0.00	0.00
d3	0.04	0.27
d4	0.00	0.00
e1	1.44	1.34
e2	0.22	0.63
e3	0.04	0.19
e4	0.09	0.40

4.4.1a Categories with the Highest Frequencies of Occurrence - a1, b1:

From the summary charts in Table 4.3 and 4.4, and the histograms, it can be seen that categories a1 (recalling facts and principles), and b1 (statements of fact and principle), have the highest occurring frequencies.

Even so, the a1 did not occur as frequently as the b1. This implies that the teachers' questions and statements centred mainly on facts and principles, and maintained teaching strategies and tactics which are largely expository.

The mean frequency of occurrence of a1, is 5.7 out of 11 possible occurrences showing that teachers asked questions of a1 kind (recalling of facts and principles) on average in one half of the time sampling intervals. This however conceals a considerable diversity of practice. All but 3 teachers in the sample asked questions in the a1 category. In effect, category a1 occurred once in one lesson, twice in each of 3 lessons, and four times in each of 4 lessons. The a1 category further occurred five, six, seven and eight times in each of 8 lessons respectively. Also, it occurred nine and ten times in each of 5 and 2 lessons respectively.

For the b1 category (Teacher Makes Statements of Fact and Principle), it was used 11 times in 47 out of 54 lessons, which is the maximum possible extent in each of the time sampling intervals. This represents 87.04 per cent of all the lessons observed, and of the remaining seven teachers, five made such statements in ten of the time sampling intervals, and one each in eight and nine times of sampling intervals.

This is the only category which all teachers used in all 54 lessons, and frequently too. The mean occurrence consequently came out as the highest with 10.81 with a standard deviation of 0.55. This very high occurrence is believed to be a fair reflection of science teaching in Nigerian schools, even though it is only strictly typical of the constituent sample of teachers.

4.4.1b Categories within Middle Frequencies of Occurrence a2, b2, b3, b4, c1, and e1:

Data from the summary charts in Tables 4.3 and 4.4, and the histograms show that the categories a2, b2, b3, b4, c1, and e1 have moderate occurrences compared to the a1 and b1 categories, and the remainder of the categories. Questions of type a2 (applying facts and principles to problem solving) occurred in 45 lessons out of 54. This represents 83.3 per cent of the lessons, with a mean of 2.72 occurrences in the eleven 3-minute time sampling intervals. Category a2 occurred less frequently than the a1 but nevertheless occurred moderately frequently compared to many other categories of questions. The relationship of a1 and a2 questions in the traditional expository type of lesson is clearly established, and demonstrates the existence of a level of teaching above the mere rote level. In contrast, questions involving hypothesis formation, a3, are almost completely absent.

For the b2, b3 and b4 categories, occurrences have been quite moderate. The b2 (statement of problems) category has a mean of 1.76 and a standard deviation of 2.40. While it occurred in 25 out of 54 lessons. However, the b2 did not occur in 29 lessons representing 53.70 per cent. Thus b2 category occurs less frequently than the b1. B3 (of hypothesis) also has a moderate occurrence with a mean of 2.15 and a standard deviation of 2.84. Even so, it did not occur in 23 out of 54 lessons. This represents 42.6 per cent. For b4, it did not occur in 9 out of 54 lessons. Even so, its occurrence has a mean of 3.70 and a standard deviation of 2.75.

In terms of occurrence, b4 comes next to b1 following the use of statements of experimental procedures, without actually being physically involved in practical activities. In effect, the b4 category has been used largely descriptively in the lessons. It is likely that, according to the STOS ground rules, such statements should be classified as b1 - statements of fact referring to practical procedures - but in the context of traditional theoretical science teaching it was considered worth identifying teachers who, at least, paid lip service to practical matters. Very few demonstrations were carried out by a handful of the sample teachers.

The level of occurrence of b2 suggests that most of the teachers do not state the topics they teach their pupils in problem form. The possible reason for this trend is to minimize the chances of being drawn into practical activities. Higher use of b2, b3 and b4 categories would involve their being drawn more into experimentation and uncertainty which these teachers may prefer to avoid. This leads teachers to directing pupils to their textbooks, if only moderately, as the c1 category of acquiring or confirming facts or principles shows with its occurrence mean at 1.56 with a standard deviation of 2.08. It did not occur in 24 lessons representing 44.4 per cent.

E1 category of pupils referral to teacher for the purpose of acquiring or confirming facts or principles has a comparatively moderate occurrence with a mean of 1.44 and a standard deviation of 1.34. Even so, it did not occur in 17 lessons.

The encouraging sign worthy of note is the moderate occurrence of a2. It suggests that in nearly a quarter of the sampling interval time was devoted to asking questions which enabled pupils to apply facts and principles to problem-solving thereby going above rote-memorization. Further, the moderate occurrence of e1 category, suggests that whereas some teachers allowed pupils to ask questions, they did not expect pupils to discuss amongst themselves and hence the low occurrence of the d1 category of pupils seek information or consult for the purpose of acquiring or confirming facts or principles.

4.4.1c Categories with Low Frequencies of Occurrence - a3, a4, a5, a6, a7, c2, c4, d1, d3, e2, e3 and e4 and those with Zero Frequencies - c3, d2 and d4:

From the summary charts on Tables 4.3 and 4.4, and the histograms, the categories a3, a4, a5, a6, a7, c2, c4, d1, d3, e2, e3 and e4 have very low occurrence frequencies with c3, d2 and d4 not occurring at all. This low occurrence stems from the fact that respectively they failed to occur in 50, 47, 34, 41, 40, 45, 51, 51, 53, 47, 52 and 51 lessons out of each of 54 lessons. The very low occurrence of the above categories relates to the fact that they especially the a3, a4, a5, a6 and a7, are the experimentation-oriented categories. In effect, teachers questions leading to pupils giving responses based on those categories can only be asked while involved in experimentation or demonstration lessons, which was not frequently the case.

The generally low occurrence of the 2d and 2e categories based on pupil initiated transactions further suggests that, owing to the very high emphasis on statements of facts and principles by the teachers, and the asking of largely recall based questions, the teachers failed to give pupils the necessary opportunities to contribute to the lessons. Also, the teachers' dominance of the lessons results in failure to encourage pupils to discuss among themselves.

Table 4.5

Summary of Range of Occurrence of Categories:

Occurrence	Categories	Number of Teachers Not Using Categories	Percentage
Absent (0)	c3,d2,d4,	54 out of 54	100
Low (1-4)	a3,c4,d1, d3,e3,e4.	About 50 out of 54	92.6
(5-20)	a4,a5,a6, a7,c2,e2.	About 34 out of 54	62.9
Moderate (25-46)	a2,b2,b3, b4,c1,e1. (45,25,31, 46,30,37)		
High (51-54)	a1,b2, (51,54)		

Categories c3, d2, and d4 did not occur even once in any of the 54 lessons. The most noticeable feature of these categories is their complete absence from the lessons of the teachers observed as the table above shows. For c3, it is highly likely that failure by the teachers to undertake experimentation resulted in their failure to direct pupils to sources of information for the purpose of making inferences, formulating or testing hypotheses.

For d2 and d3, it is equally certain that in the absence of experimentation, pupils would have little or no cause to seek information for the purpose of identifying or solving problems. The same holds for d4 category of seeking quidance on experimental procedure. In effect, pupils never had the opportunity to undertake practical activities which would warrant seeking guidance on experimental procedure.

D1 category has a much lower occurrence than the e1 category in view of the fact that the traditional outlook of the teachers debars them from encouraging pupil-pupil talks especially when lesson is going on. Rather, they would tolerate a few questions aimed at acquiring or confirming facts or principles (e1).

4.4.2 Correlation Coefficients of The STOS Data:

As one of the pieces of information necessary to determine the patterns of intellectual transactions between teachers and taught, the degree of overlap or linear relationship between the variables which in this case are the STOS categories was determined. This was based on the determination of how each category correlates with every other category. The correlation exists on a scale between 0 and 1. Hence a1, for instance, correlates positively with 13 variables and negatively with 5 as the complete table of Pearson Correlation Coefficients (see Appendix 3) shows. However, on the basis of N=54, a correlation between any two categories must be equal or above $\pm$ 0.26 and up to $\pm$ 0.34 to be significant at the 5% level. To reach the 1% level of significance, a correlation must be above or equal to $\pm$ 0.34 and up to $\pm$ 1.0.

Correlation below $\pm$ 0.26 may be considered to be of no statistical significance, that is, no relationship between any two categories may be surmised. On the other hand, correlations above $\pm$ 0.4 and up to $\pm$ 1.0 show a more marked and hence substantial relationship as the Table below shows with the relationship and their exact values (Pearson Correlation) of significance.

Table 4.6 PEARSON CORRELATION COEFFICIENTS:

VARIABLES SHOWING RELATIONSHIP AND EXACT SIGNIFICANCE VALUES

	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4
A1		+1% P= .003													-1% P= .009							-5% P= .037	
A2	+1% P= .003								+1% P= .002														
A3				+5% P= .055				-5% P= .032		+1% P= .002		+5% P= .013											+5% P= .034
A4			+5% P= .055			+1% P= .000															+5% P= .016		+1% P= .003
A5						+5% P= .038		-5% P= .043															
A6				+1% P= .000	+5% P= .038			-5% P= .048															
A7								-5% P= .011					+5% P= .040					+5% P= .041					
B1			-5% P= .032		-5% P= .043	-5% P= .048	-5% P= .011					-5% P= .025	-5% P= .035								-5% P= .060		
B2		+1% P= .002								+1% P= .000	+5% P= .041	+1% P= .000	+1% P= .000					+5% P= .026			+1% P= .002		
B3			+1% P= .002						+1% P= .000		+5% P= .053	+1% P= .000	+1% P= .000					+1% P= .004			+5% P= .013		
B4									+5% P= .041	+5% P= .053			+5% P= .025		+1% P= .000							+5% P= .045	
C1			+5% P= .013					-5% P= .026	+1% P= .000	+1% P= .000			+1% P= .000					+5% P= .030			+1% P= .000		
C2							+5% P= .040	-5% P= .035	+1% P= .000	+1% P= .000	+5% P= .025	+1% P= .000						+1% P= .000			+1% P= .003		
C3																							
C4	-1% P= .009										+1% P= .000											+1% P= .005	
D1																		+5% P= .039			+1% P= .000		
D2																							
D3							+5% P= .041		+5% P= .026	+1% P= .004		+5% P= .030	+1% P= .000			+5% P= .039				+1% P= .006	+1% P= .004		
D4																							
E1																		+1% P= .006					
E2				+5% P= .016				-5% P= .060	+1% P= .002	+5% P= .013		+1% P= .000	+1% P= .003			+1% P= .000		+1% P= .004					+1% P= .007
E3	-5% P= .037										+5% P= .045				+1% P= .005								
E4			+5% P= .034	+1% P= .003																	+1% P= .007		

Given that there are 253 possible correlation in this matrix (23 x 22 ÷ 2), 12 or 13 chance correlations at the 5% level might be expected to occur, and 2 or 3 at the 1% level. In practice, 23 correlations at the 1% level were established and a further 23 at the 5% level. The chance element however cautions against the unquestioning acceptance of all the correlations established and any attempts to vigorously interprete each case.

Correlation Coefficients as with Each S.T.O.S. Category:

1a: Teacher Asks Questions (or Invites Comments) Which Are Answered By:

A1 - Recalling Facts and Principles

From the table of correlation coefficients (see Appendix 3) it will be observed that a1 correlates positively with 13 variables and negatively with 6. While the other 3 are non-occurring. But on the 5% to 1% significance level based on the coefficients of between $\pm$ 0.26 and $\pm$ 0.34 and up to $\pm$ 1.0, it was realized that there is a definite though small relationship between the a1 category and a2, - c4, and - e3. In effect, teachers who used a1 tended to use a2 as well. But tended not to use the c4 and e3 categories hence the negative signs.

The reason for their use of a2 relates clearly to the close similarity between a1 and a2. Prior to applying facts and principles to problem solving, knowledge in form of facts and principles is recalled.

The negative correlation of a1 with c4 is in keeping with the teacher-dominated a1 and a2 categories though why c4 alone emerges of all the c - categories is difficult to interprete as is also the case with e3 with which a1 has a negative correlation.

A2 - Applying Facts and Principles to Problem-Solving

Category a2 correlates positively with 13 variables and negatively with 6. But on the 5% and 1% significance level, a2 has a definite but small relationship with b2 in addition to that already discussed with a1.

The use of b2 appears to be a preamble to asking questions which are answered by the use of either a1 or a2 in some instances.

A3 - Making Hypothesis or Speculation

From the correlation coefficients (see Appendix 3), a3 correlates positively with 11 variable and negatively with 8. At the level of significance, there is a definite but small relationship between the use of a3 and a4, - b1, b3, c1 and e4.

The use of a3 and a4 suggest that teachers were inclined towards some practical activities during lessons. This is further supported by the use of the b3 in which case teacher makes statements of hypothesis or speculation resulting from one made by pupil incorrectly.

The negative correlation of b1, that is, a slightly lower use of statements of facts and principle goes further to support the above suggestion. From these, it is possible that the teachers who used the a3, a4, b3, c1 and e4 categories are more experimentation inclined teachers and even though the few practical activities are limited to teacher demonstrations during lessons this appears to have moderated slightly the unrelieved pressure of factual statements.

A4 - Designing of Experimental Procedure

The a4 category correlates positively with 11 variables and negatively with 8 variables. At the level of significance, a relationship exists between a4 and variables a6, d3, e2, and e4. In effect, teachers who used a4 tended to use a6, d3, e2 and e4.

The explanation here also is probably that a4, d3 and e4 are experimentation based variables. While the e2 category of pupil referring to teacher for the purpose of seeking guidance when identifying or solving problems, also has a practical bias even though it is a pupil initiated and/or maintained category.

A5 - Direct Observation

A5 correlates positively with 13 STOS variables and negatively with 6. At the level of significance, a5 has a definite but small relationship with a6 and - b1.

In effect, whereas teachers who used a5 tended to use the a6, they moderated their use of the b1 (teacher makes statements of fact and principle). The possible explanation to this, is that the two categories, a5 and b1, have different requirements in terms of use. Whereas the a5 is a more practical oriented category, the b1 category is essentially an expository variable.

A6 - Interpretation of Observed or Recorded Data

The a6 category correlates positively with 13 variables and negatively with 6 variables. At the level of significance, a6 has a definite but small relationship with a4, a5, and - b1.

The interpretation of these correlations is presumably similar to that advanced in the preceding paragraph. When observation (a5) is completed, it is then interpreted and/or recorded (a6) hence the noted simultaneous use of these two categories.

A7 - Making Inferences from Observations or Data

The a7 category correlates positively with 13 variables and negatively with 6. A7 has a definite but small relationship with variables - b1, c2, and d3, at the levels of significance.

The teachers who used a7 directed pupils to sources of information for the purpose of identifying or solving problems (c2), and at the same time encouraging pupils to make inferences, formulating or testing hypothesis (d3). The use of these two categories tend to portray these teachers as being more practical or experimentation oriented. This is supported by the relatively lower use of the b1 category by these teachers.

1b: Teacher Makes Statements:

B1 - Of Fact and Principle

This variable has a positive correlation with 7 variables and correlates negatively with 12. The b1 category has a small but definite relationship with seven variables: - a3, - a5, - a6, - a7, - c1, - c2, and - e2 at the 5% and 1% levels of significance.

The explanation of the negative correlation of b1 with the experimentally oriented categories, a3, a5, a6, a7 has already been discussed. It must be recalled that we are correlating low occurrence categories with small variations from 100 per cent usage of the dominant b1 category, but the existence of these correlations is a hopeful sign.

The negative correlation of b1 with c1, c2 and e2 indicate that, once again, the mere appearance of other categories is accompanied by some reduction in the unrelieved pressure of factual statements.

B2 - Of Problems

B2 correlates positively with 16 variables and negatively with 3. While the other 3 are non-occurring categories. At the level of significance, there is a definite relationship between b2 and a2, b3, b4, c1, c2, d3, and e2.

The possible explanation to this, is that the tendency is towards expository strategies and tactics of teaching since all the affected variables are theory based. A2 is more related to expository strategies and tactics, and the use of b4 is achieved equally during lessons based on explanation and description even though it is more activity based.

The use of the d3 and e2 - pupil based categories suggests that teachers allowed pupils to occasionally make their contributions, although these have very low occurrences.

B3 - Of Hypothesis or Speculation

The b3 category correlates positively with 18 variables and negatively with one which is the b1. At the level of significance, b3 has a small but definite relationship with a3, b2, b4, c1, c2, d3, and e2.

The use of b4, d3, and e2 come close to the situation with b2 above. But the association with a3 tends to draw the orientation towards experimentation from exposition.

In itself the b3 is a more practical activity based category which may necessarily be used along with others which are also activity based. As said earlier, the b4 is an activity based category which could also be used to achieve expository strategies and tactics. In effect, b4 has been used more descriptively by many teachers rather than experimentally.

B4 - Of Experimental Procedure

This category correlates positively with 15 variables, and negatively with 4 variables. While the other 3 are non-occurring categories.

Yet, on the 5% to 1% significance level based on the co-efficients of between ± 0.26 and ± 0.34 and above, the b4 shows a definite though small relationship with five variables, b2, b3, c2, c4 and e3.

As already observed, the b2, b3, and b4 categories are the more practical activity oriented of the 1b categories. Hence the use of b4 along with b2 and b3 is indicative of the nature of teaching strategies and tactics employed by the affected teachers. The use of c2 which is also activity based lends credence to its practical orientation inspite of its low occurrence.

1C: Teacher Directs Pupils To Sources of Information for The Purpose of:

C1 - Acquiring or Confirming Facts or Principles

The c1 category correlates positively with 16 variables and negatively with 3 variables. At the level of significance, c1 appears to have definite but small relationship with a3, - b1, b2, b3, c2, d3 and e2. The relationship with b1 is negatively correlated.

In effect, teachers who used the c1 category tended to reduce the use of the b1. Even so, the use of c1 and the reduced use of b1 suggests that the teachers employed some other strategies and tactics of teaching which may imply a middle path between the more experimentation oriented and the more expository strategies and tactics oriented teaching and intellectual transactions.

By the same token the use of a3 and d3 suggest that pupils were involved in the lessons to a limited extent.

C2 - Identifying or Solving Problems

The c2 category correlates positively with 16 variables and negatively with 3. At the level of significance, c2 appears to show a definite though small relationship with three variables: a7, - b1, and b4 and substantially with b2, b3, c1, d3 and e2.

The possible explanation for this will be that a7 and b4 are activity based categories, their use of which will suggest that the strategies and tactics have more practical inclination. This suggestion is supported by the tendency of these teachers to reduce their use of the b1 category. Equally, the use of e2 suggests a pupil oriented teaching which enables pupils to make some contributions during lessons.

C3 - Not Included in Analysis on Account of its Non-Occurrence

C4 - Seeking Guidance on Experimental Procedure

This category correlates positively with 7 variables and negatively with 12 variables. However, at the 5% to 1% significance levels, c4 shows a definite though small relationship with - a1, b4 and e3.

Over and above what has already been said, there appears to be little more that one can say about these relationships.

2d: Pupils Seek Information or Consult For The Purpose Of:

D1 - Acquiring or Confirming Facts or Principles

The d1 category correlates positively with 12 variables and negatively with 7 others, and 3 variables are non-occurring. However, at the level of significance the d1 category shows a definite though small relationship only with d3 and e2. These are pupil based categories suggesting some pupil involvement.

D2 - Not Included in Analysis Owing to its Non-Occurrence

D3 - Making Inferences, Formulating or Testing Hypotheses

This category correlates positively with 13 variables and negatively with 6 others. While the other 3 are non-occurring. At the level of significance, d3 shows a definite though small relationship with a7, b2, b3, c1, c2, d1, e1 and e2.

Although these lessons are largely descriptive and explanatory, the additional variables these teachers tend to use hinge on the activity oriented ones. The use of a7, b2, and b3 provided the basis for this inference, while the combined use of d1, d3, e1, and e2 seems to support the suggestion that pupils were allowed but not necessarily encouraged to make a few contributions during lessons.

D4 - Not Included in Analysis Owing to its Non-Occurrence

2e: Pupils Refer to Teacher For The Purpose of:

E1 - Acquiring or Confirming Facts or Principles

The e1 category correlates positively with 9 variables and negatively with 10. While the 3 others are non-occurring categories. At the level of significance, the e1 appears to show a definite but small relationship only with the d3 variable as reported above.

E2 - Seeking Guidance when Identifying or Solving Problems

This variable correlates positively with 16 variables and negatively with 3. At the level of significance, the e2 shows a small but definite relationship with a number of other variables a4, - b1, b2, b3, c1, c2, d1, d3, and e4.

As has already been observed in previous paragraphs, all the positively correlated variables on the 5% to 1% level of significance are practical activity oriented, while the b1 which these teachers tended to use rather less than others is more an expository tactic.

E3 - Seeking Guidance when Making Inference, Formulating or Testing Hypotheses

This category correlates positively with 8 variables and negatively with 11. At the significance level, e3 shows a small but definite relationship with - a1, b4, and c4 already discussed.

E4 - Seeking Guidance on Experimental Procedure

This variable correlates positively with 10 variables and negatively with 9. While the 3 others are non-occuring categories. At the level of significance, e4 shows a definite though small relationship with a3, a4, and e2.

This suggests that teachers in whose lessons the e4 category was used tended to ask questions which pupils answered by employing the categories a3 and a4, and then allowed pupils to refer to them for the purpose of seeking guidance when identifying or solving problems (e2) which may have been diagrams on the board.

Conclusion

On the basis of the analysis of the correlation coefficients, it has become evident that there is inter-related use of the various STOS categories. Although more analysis is called for, it appears that between two and four groups of teachers who have employed the Science Teaching Observation Schedule (STOS) categories in different ways can be isolated. A clustering technique to establish any such associations will be reported in a later section.

4.4.3 Analysis of Variance:

In this study, as in all cases of variance analysis, an attempt will be made to find out whether there are any statistically significant differences between the means of the several and different groups of teachers whose intellectual interaction - and instructional - patterns are under study.

The computer program examined three groups of which group 01 represents the biology teachers (or Lessons), group 02 for chemistry teachers (or Lessons) and group 03 for the Integrated science teachers (or Lessons). The teachers in this will be described as variable TR, while the student - Newman-Keuls procedure was used as the post-hoc method of establishing differences between individual means after an ANOVA proved statistically significant.

What has been done here is to compare category a1, for instance, by the variable TR (types of lesson or teacher) to see which groups, that is, the biology (01), or chemistry (02), or Integrated science (03) teachers used the category most and significantly different from each other.

Thus, Variable: a1 (ie category A1)
By Variable TR (ie 3 groups of teachers: Biology, Chemistry and Integrated Science)

Analysis of Variance:

Source	D.F	Sum of Squares	Mean Squares	F-ratio	F-Prob.
Between Groups	2	20.7164	10.3582	1.589	0.2142
Within Groups	51	332.5429	6.5204		
Total	53	333.2593			

Table 4.7 Analysis of Variance (a1)

The above table shows the details required to compute the variance. The F-Prob. stands for the significance level or the probability that there is a difference between the Biology, Chemistry and Integrated Science teachers in their use of a variable, for example A1. When F-Prob. is 0.05 or less then there exists a statistically significant difference between the three groups of teachers. Thus values such as 0.05, 0.04, 0.03, 0.02, 0.01 and less, would be significant and invariably will show that there is a difference between the groups of teachers in their use of the category (variable).

By applying this to a1 (recalling facts and principles) there is no significant difference between the three teachers' groups as the value of the F-Prob. for a1 is 0.2142. This procedure was followed for all the 23 STOS categories and only in two did any statistically significant differences emerge. These are in b4 and e1. For all others it is that they are either incalculable because they were not used at all as with categories c3, d2, and d4, or that there was not a statistically significant difference in the way the three groups of teachers used the categories.

The features of the two analyses in which there is a statistically significant difference between the groups of teachers are as follows:

Variable: B4 (Teacher Makes Statements: of Experimental Procedure)

By Bariable TR

Analysis of Variance:

Source	D.F.	Sum of Squares	Mean Squares	F-ratio	F-Prob.
Between Groups	2	76.8323	38.4161	6.076	0.0043
Within Groups	51	322.4270	6.3221		
Total	53	399.2593			

Table 4.8 Analysis of Variance (b4)

The F-Prob. of 0.0043 is much lower than the usual cut off point of 0.05 and hence there exists a statistically significant difference between groups. To further establish which group is different from the other, the program further placed the groups in two subsets as shown here using the Student - Newman-Keuls procedure.

Subset 1

Group:	Group 03	Group 01
Mean:	2.5833	2.7368

- - - - - - - - - - - - - - -

Subset 2

Group:	Group 02
Mean:	5.0870

Placed in subset 1 are groups 03 and 01 showing that these two groups are homogenous. Homogenous subsets are groups whose highest and lowest means do not differ by more than the shortest significant range for the subset of that size, that is, they are not significantly different. While in subset 2, there is group 02 which differs markedly from the two groups in subset 1.

The existence of two subsets implies that Group 03 (Integrated Science) teachers differred in the way they used the b4 category compared with the chemistry teachers. At the same time, the chemistry teachers (Group 02) differred markedly in their use of the b4 category from the Biology teachers (Group 01). But then there is no statistically significant difference between Groups 03 and 01 in their use of the STOS category b4.

The second variable which is statistically significant is the STOS e1 subcategory - Pupils Refer to Teacher for the Purpose of Acquiring or Confirming Facts or Principles.

Variable: E1
By Variable TR

Analysis of Variance:

Source	D.F.	Sum of Squares	Mean Squares	F-ratio	F-Prob.
Between Groups	2	11.7193	5.8596	3.574	0.0353
Within Groups	51	83.6140	1.6395		
Total	53	95.3333			

Table 4.9 Analysis of Variance (e1)

Now, employing the Student - Newman-Keuls procedure which again looks for between-groups difference, the following subsets were obtained:

Subset 1

Group:	Group 02	Group 03
Mean:	1.0000	1.3333

- - - - - - - - - - - - - -

Subset 2

Group:	Group 03	Group 01
Mean:	1.3333	2.0526

This indicates that there is a significant difference between Group 02 and Group 01 teachers. While Group 03 (Integrated Science) teachers fall in between 02 and 01, and are not significantly different from them in their use of category e1.

The difference suggests that e1 occurred much more frequently in the Biology lessons than in the Chemistry lessons. While there is no significant difference between Group 01 (Biology) teachers and Group 03 (the Integrated Science) teachers, and between Group 02 (Chemistry) teachers and the Group 03 teachers.

Table 4.10 Summary of Analysis of Variance Showing Significance

Variable By TR	Total Mean	SUBSET 1		SUBSET 2		F-Prob.	SIGNIFICANCE
		Group	Mean	Group	Mean		
a1	5.7037	02 01 03	5.1304 5.7368 6.7500	-	-	0.2142	N.S.
a2	2.7222	01 02 03	2.6842 2.7391 2.7500	-	-	0.9950	N.S.
a3	0.0741	02 03 01	0.0435 0.0833 0.1053	-	-	0.7527	N.S.
a4	0.2037	03 01 02	0.0833 0.2105 0.2609	-	-	0.7103	N.S.
a5	0.7037	01 02 03	0.5263 0.5652 1.2500	-	-	0.1537	N.S.
a6	0.5556	02 01 03	0.4783 0.5263 0.7500	-	-	0.8135	N.S.
a7	0.4074	01 02 03	0.3158 0.4348 0.5000	-	-	0.8051	N.S.
b1	10.8148	03 02 01	10.7500 10.8261 10.8421	-	-	0.8987	N.S.
b2	1.7593	02 03 01	1.6522 1.8333 1.8421	-	-	0.9621	N.S.
b3	2.1481	03 02 01	1.3333 2.0000 2.8421	-	-	0.3412	N.S.
b4	3.7037	03 01	2.5833 2.7368	02	5.0870	0.0043	S
c1	1.5556	03 02 01	0.9167 1.5217 2.0000	-	-	0.3740	N.S.
c2	0.3333	02 03 01	0.2174 0.2500 0.5263	-	-	0.5243	N.S.
c3	-	-	-	-	-	-	-
c4	0.0556	03 01 02	0.0000 0.0526 0.0870	-	-	0.5800	N.S.

Cont'd.

d1	0.0926	02 01 03	0.0435 0.0526 0.2500	-	-	0.3889	N.S.
d2	-	-	-	-	-	-	-
d3	0.0370	02 03 01	0.0000 0.0000 0.1053	-	-	0.4057	N.S.
d4	-	-	-	-	-	-	-
e1	1.4444	02 03	1.0000 1.3333	03 01	1.3333 2.0526	0.0353	S
e2	0.2222	02 03 01	0.1304 0.2500 0.3158	-	-	0.6406	N.S.
e3	0.0370	03 02 01	0.0000 0.0435 0.0526	-	-	0.7457	N.S.
e4	0.0926	03 02 01	0.0000 0.0870 0.1579	-	-	0.5726	N.S.

From Table 4.10 above, it will be seen that majority of the categories had no statistically significant differences or results in terms of analysis of variance. In effect, significant differences exist between the means of the 3 groups of teachers in their use of b4 and e1 alone.

An explanation as to why the majority of the categories showed no significant differences in means in regard to use, may be attributed to two issues. The first one is the relatively small number (N=54) of the sample - Variable TR. This affects the F-ratio by bringing about more exacting levels of this F-ratio which would not give statistically significant results.

The second explanation may be due to the teachers' apparent failure to appreciate the fact that different branches of science such as biology, chemistry, physics, integrated science etc have their specialist language and hence their specific instructional strategies and tactics which the teachers have largely ignored.

4.4.4 Cluster Analysis:

In a further effort to determine the main cognitive interaction and instructional patterns employed by the science teachers in the 54 lessons constituting my sample, the data collected was subjected to Cluster Analysis. Cluster Analysis is a process which places cases, in this instance, teachers' use of the STOS categories, into recognizably identical patterns or clusters. In effect, the different clusters show marked differences while members of a cluster show more similarity than dissimilarity.

It is a well recognized system that has been employed by many researchers including Eggleston et al (1976), Hacker et al (1979), Ugwu (1980), and Ajeyalemi (1981)

S.T.O.S. Data and Findings:

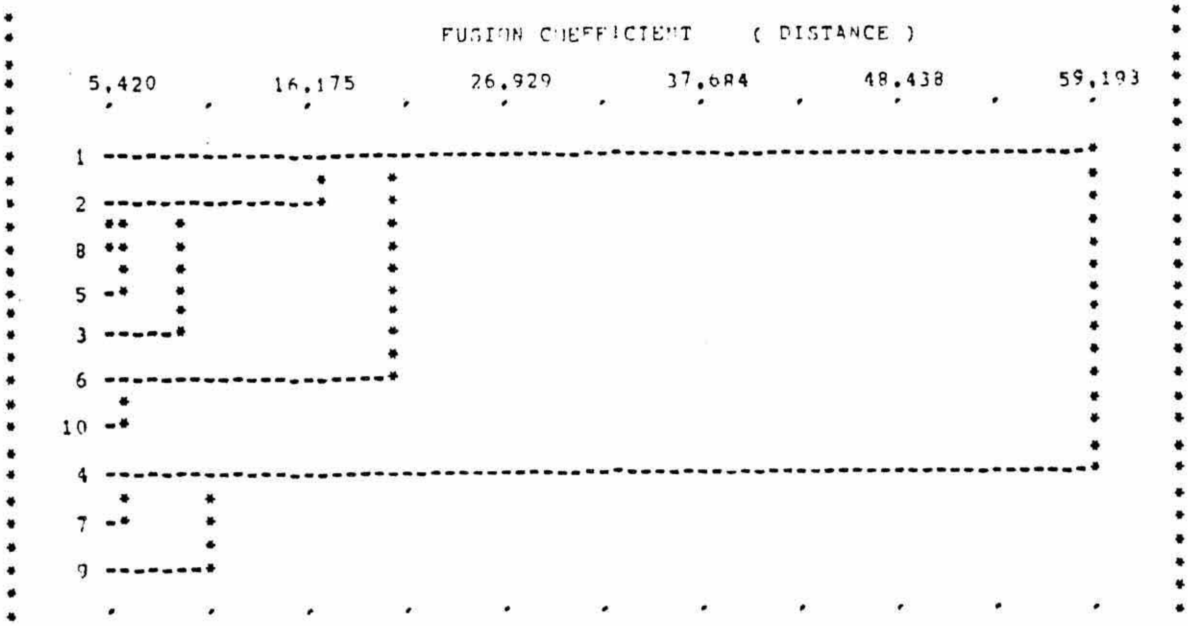
For a start, the computer was asked to place the 54 STOS data into 10 clusters. See centroids for the 10 clusters on Table 4.12. On the basis of that, the following data was obtained:

Clusters	1	2	3	4	5	6	7	8	9	10
Number of Members	6	8	11	5	5	4	3	5	3	10

The ten clusters were then reduced to nine, eight, seven, six, five, four, three and then two. The dendrogram was inspected (see Chart 4.2) and it showed that the useful number of clusters was likely to be four or two as the tables below will elucidate.

Chart 4.2: Dendrogram Showing 4 Clusters

SE CLUSTERS 1(1) 4(2) AT COEFFICIENT 59.193 - 1 CLUSTERS, NEW CLUSTER HAS CODE 1 AND SIZE 54



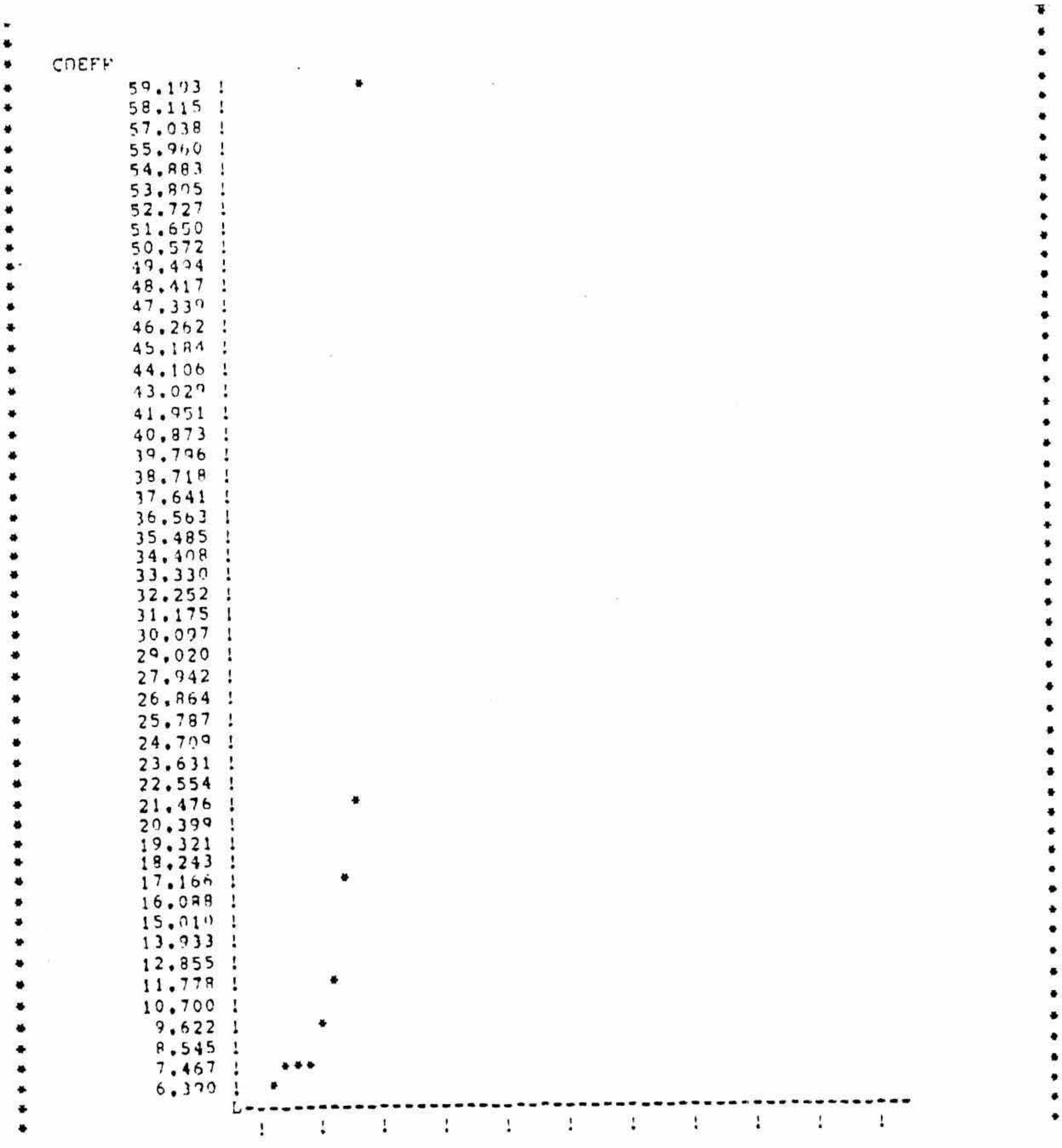


Table 4.11a Normalised Classification Array

Clusters	Number of Members	Identity of Lessons in Clusters
1	13	1,2,3,4,6,10,13,14,16,20,21,22, and 32.
2	21	5,7,8,11,15,17,18,19,23,24,25, 26,27,28,29,30,33,34,35,38 and 42.
3	9	9,12,31,37,39,40,41,45 and 46.
4	11	36,43,44,47,48,49,50,51,52,53, and 54.

On the basis of 4 clusters, the types of lessons which constitute each of the clusters was identified as follows:

Table 4.11b Distribution of Lessons

Clusters	Number of Members	Distribution of Lesson Types in Clusters	Percentage
1	13	Biology Lessons = 5 Chemistry = 6 Int. Science = 2	38.5 % 46.2 % 15.4 %
2	21	Biology Lessons = 6 Chemistry = 7 Int. Science = 8	28.6 % 33.3 % 38.1 %
3	9	Biology Lessons = 2 Chemistry = 6 Int. Science = 1	22.2 % 66.7 % 11.1 %
4	11	Biology Lessons = 6 Chemistry = 4 Int. Science = 1	54.5 % 36.4 % 9.1 %

Further, the Table 4.12 below for centroids of the four clusters shows quite clearly the profiles of the 4 clusters on the basis on which the lessons have been clustered.

Table 4.12 Centroids for the 4 Clusters

Normalised Code (Cluster)		1	2	3	4
Number of Members (Lessons)		13	21	9	11
Variable (STOS)	a1	3.15	7.62	4.89	5.73
	a2	1.00	3.19	2.89	3.73
	a3	0.08	0.00	0.00	0.27
	a4	0.15	0.10	0.44	0.27
	a5	0.46	0.71	0.89	0.82
	a6	0.31	0.43	0.89	0.82
	a7	0.46	0.24	0.67	0.45
	b1	10.85	10.95	10.89	10.45
	b2	0.08	0.86	1.44	5.37
	b3	0.31	0.90	2.33	6.55
	b4	2.15	2.71	7.22	4.55
	c1	1.00	0.57	0.78	4.73
	c2	0.00	0.00	0.22	1.45
	c3	0.00	0.00	0.00	0.00
	c4	0.00	0.00	0.22	0.09
	d1	0.00	0.14	0.00	0.18
	d2	0.00	0.00	0.00	0.00
	d3	0.00	0.00	0.00	0.18
	d4	0.00	0.00	0.00	0.00
	e1	1.08	1.71	1.33	1.45
	e2	0.08	0.10	0.00	0.82
	e3	0.00	0.00	0.11	0.09
	e4	0.00	0.05	0.22	0.18

These four clusters were obtained in Start cycle 7 when some earlier clusters (1(3) and 2(2)) were fused at coefficient 17.072.

4.4.4a Analytical Description of the 4 Clusters in Relation to The S.T.O.S. Categories:

Generally, all four clusters show similar patterns or trends of occurrence of the categories in a decreasing and descending order. In effect, the categories a1, b1, c1, d1 and e1 have higher occurrences than the a2, b2, c2, d2 and e2 categories and so on. Even so, there are certain important distinguishing features amongst the four clusters as will now be pointed out.

Cluster 1, N=13

The membership of this cluster consists of 13. This represents 24.07 per cent of the sample.

The main distinguishing features of this cluster, is the generally low occurrence of all the categories other than b1. This distinguishing feature automatically conveys the signal that these are teachers who have a very limited range of strategies and tactics of teaching to adopt apart from the transmission of facts and principles.

The occurrence of c1 (second amongst all four clusters) suggests that pupils were directed to some other sources, most likely their textbooks, for the purpose of acquiring or confirming facts or principles. The general picture that emerges is that they are teachers with traditional perspectives about teaching and that they rely on the amount of information (facts and principles) they can transmit to pupils who will in turn copy them down into their note books.

Table 4.13 Clusters Showing Distinguishing Features

STOS Categories	Cluster One	Cluster Two	Cluster Three	Cluster Four
Category a1	*	****	**	***
a2	*	**	**	***
a3				
a4				
a5				
a6				
a7				
b1	****	****	****	***
b2	O	*	**	****
b3	*	**	***	****
b4	*	*	****	**
c1	**	*	*	****
c2	O	O	*	**
c3				
c4				
d1				
d2				
d3				
d4				
e1	*	***	**	**
e2				
e3				
e4				

Cluster 2, N=21

This cluster has the largest membership with 21 out of 54. This represents 38.89 per cent of the sample. The general pattern or trend of occurrence of the categories is similar to Cluster 1 but for the following characteristic features that distinguish it from other clusters, a1 and e1.

In addition to the high use of b1 (statements of fact and principle), members of Cluster 2 distinguish themselves from other clusters by their questioning which were answered by recalling facts and principles (a1). Thus, this cluster has the highest occurrence of a1 (recalling facts and principles) and second highest for a2 (applying facts and principles to problem solving). What immediately comes to mind is the group of teachers who come to their classes and talk (teach) and ask questions which centre on fact recall. These teachers consider pupils ability to recall what they had previously taught as the ultimate proof of success, to the neglect of all other outcomes.

Interestingly, they have allowed the largest number of pupils' questions e1 (pupils refer to teacher for the purpose of acquiring or confirming facts or principles) in spite of its generally low occurrence amongst all clusters. In view of the fact that members of this cluster have allowed the highest number of pupils' questions (e1), it is almost natural that they should have the highest b1 occurrence as they attempt to repeat the facts and principles in response to the pupils' questions.

Cluster 3, N=9

Cluster 3 has the least membership with 9 out of 54. This represents 16.67 per cent of the whole sample.

Again, the trend in terms of occurrence or use of the categories is similar to the first two clusters, yet it has its distinguishing features. In addition to the general characteristic of making statements of facts and principles (b1), members of Cluster 3 went further towards experimentation by the use of b4 (statements of experimental procedure). However, this category was not entirely practical in practice. Rather, it was largely descriptive of the experiments/ demonstrations that should have accompanied the lessons.

The very high use of b1 and b4 places members of this cluster as the most informative and one of the more practically oriented clusters. This is supported by the levels of occurrence of b2 (of problems) and b3 (of hypothesis or speculation) which fall second amongst the four clusters. The above did not stop them from asking questions based on a1, and a2 much as the other clusters have done.

A closer look at the normalized classification array shows that there are more chemistry teachers (Lessons) in this cluster than in any other cluster, that is, percentage wise, as chemistry is present to the tune of 66.7 per cent - see Table 4.11b.

Cluster 4, N=11

The membership of this cluster consists of 11 out of 54 which represents 20.37 per cent of the sample. As with the first three clusters, the general trend in regard to occurrence of the categories is downwards.

Even so, this cluster stands out much more clearly with its distinguishing features. This cluster has the highest occurrence for b2 (of problems), b3 (of hypothesis or speculation) and c1 (acquiring or confirming facts or principles). This is in addition to the slightly lower use of the b1 category (statements of fact and principle) and their comparatively higher use of the questioning categories, a1 and a2. The lower occurrence of b4 compared to Cluster 3 makes it possible for members of Cluster 4 to be seen less in the light of statement of fact and principle (b1) and more of problems (b2) and of hypothesis or speculation (b3), thus de-emphasising b1 and b4.

Even though categories b2 and b3 have practical implications, the comparatively lower occurrence of b4 places Cluster 4 as less experimentation oriented compared to Cluster 3. This is reflected in their questioning strategies and tactics which tend towards recalling facts and principles (a1), and (a2) applying facts and principles to problem solving. Further, in questioning, this cluster comparatively emphasized applying facts and principles to problem solving (a2) more than any other clusters and this is an encouraging sign as it appears to move above rote memorization.

The high occurrence of c1 category in Cluster 4 goes further to support the lower inclination towards experimentation as they direct pupils increasingly to other sources of information for the purpose of acquiring or confirming facts or principles.

The general picture that emerges from Cluster 4 is that its members appear to be combining the traditional perspectives of teaching with some diversity in strategy and tactics including demonstrations during lessons, but not necessarily whole class practicals.

4.4.4b A Brief Comparison of Findings with Eggleston et al's (1976) Results:

Quite evidently the purpose of Eggleston et at's (1976) study as stated in Chaper 3 (3.3.2b) differs considerably from those for this study. Even so, some important similarities between the two studies in terms of findings appear to exist.

Eggleston et al's study involved a total of 94 science teachers of which 33 taught biology, 31 chemistry and 30 taught physics. They reported three types of teachers whose cognitive interaction patterns (of teaching) earned them descriptions labelled Type I (problem-solvers), Type II (Informers), and Type III (Enquirers). These were interpreted behaviourally to mean teaching Styles I, II and III.

PROBLEM-SOLVERS (STYLE I) are teachers who asked very many questions which are answered by observation, problem-solving and speculation in both practical and theoretical contexts, and teachers holding the over-all initiative.

INFORMERS (STYLE II) For these teachers, there was relatively infrequent use of teachers' questions except a1 and a2. There was also high teachers' statements of fact and teachers' directions of pupils to sources of information for fact finding, c1. They are also non-practical bias.

ENQUIRERS (STYLE III) The teachers have a more pupil-centred approach as initiative is held by pupils. Work in class is relatively practical with high level of intellectual engagement.

In case of this study, the purpose among others is to determine the teaching styles adopted by Nigerian Science teachers. From the outcome of Cluster analysis of STOS data collected from 54 science lessons of which 19 are biology, 23 chemistry and 12 integrated science, four clusters representing teaching styles (or strategies and tactics of teaching) were isolated. All the four clusters performed like the 'Informers' (Style II) yet retaining their small but unique features.

It is thought that if Eggleston et al (1976) had further analysed their Style II as to break it up, features which are characteristic of each of the four clusters would probably emerge.

Thus, the four teaching styles each with its distinguishing features have the following characteristics. Cluster 1 shows evidence of use of very limited teaching strategies and tactics as they relied on b1 (teacher makes statements: of fact and principle). Cluster 2, in addition to b1, asked many questions which were answered by a1 (recalling facts and principles), while Cluster 3 in addition to b1 also used b4 (teacher makes statements: of experimental procedure). Cluster 4, in addition to b1 also used b2, b3 and c1. The high use of c1 by members of Cluster 4 enables this cluster to compare with Style II of Eggleston et al.

Thus in more general terms, Cluster 2 of this study shares more common features with Style II with generally low use of teachers' questions except a1, and high b1. They are also non-practical bias in style. While Cluster 4 compares with Style I with higher use of a2. Even so, the features which distinguish Style III such as being more pupil centred as initiative is held by pupils does not form part of any substantial part of science teaching in Nigerian secondary classes.

4.5 Cluster Analysis on the Basis of Two Clusters:

Two clusters were obtained on further analysis of STOS data. On the basis of that, Cluster A of the two now has 41 members and Cluster B, 13 members.

On Table 4.14, the centroids, that is, the points within which the centres of the mass would be if the values were uniform (but if non-symmetrical as in these cases, centroids would be found by integration) for the two clusters are given as follows:

Table 4.14 Centroids for the 2 Clusters

Normalized Code (Cluster		A	B
Number of Members (Lessons)		14	13
Variables (STOS)	a1	5.61	6.00
	a2	2.46	3.54
	a3	0.02	0.23
	a4	0.20	0.23
	a5	0.54	1.23
	a6	0.51	0.69
	a7	0.31	0.54
	b1	10.90	10.54
	b2	0.68	5.15
	b3	0.83	6.31
	b4	3.37	4.77
	c1	0.68	4.31
	c2	0.05	1.23
	c3	0.00	0.00
	c4	0.05	0.08
	d1	0.07	0.15
	d2	0.00	0.00
	d3	0.00	0.15
	d4	0.00	0.00
	e1	1.46	1.38
	e2	0.07	0.69
	e3	0.02	0.08
	e4	0.07	0.15

Further, on the basis of the normalized classification Array, the 54 teachers (Lessons) variables were clustered as follows:

Table 4.15a Normalized Classification Array

Cluster	Number of Members	Members in Clusters
A	41	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20,21,22,23,24,25,26,27, 28,29,30,31,32,33,34,37,38,40,41,42, 45,46.
B	13	35,36,39,43,44,47,48,49,50,51,52,53, 54.

This means that, on the basis of the STOS data subjected to this analysis, Cluster A now consists of 41 members (Lessons) and Cluster B, 13, with the following table giving types of lessons in each cluster.

Table 4.15b Distribution of Lessons

Cluster	Number of Members	Distribution of Lesson Types in Clusters	Percentage
A	41	Biology Lessons = 12 Chemistry = 18 Int. Science = 11 41	29.3 % 43.9 % 26.8 %
B	13	Biology Lessons = 6 Chemistry = 5 Int. Science = 2 13	46.2 % 38.5 % 15.3 %

Without going too much into details, it is necessary to point out that the reduction of the number of clusters to two does little more than average out the main distinguishing features discussed in the first three clusters of the four clusters serial while the fourth remains largely unchanged as the second of the two clusters.

Cluster A, N=41

Following a further reduction in number of the four clusters discussed above, two clusters emerged. The first of the two designated as Cluster A has a membership of 41 or 75.92 per cent. From all indications, this cluster is the result of an amalgamation between Clusters 1, 2, and 3 of the previous four to give Cluster A.

On the basis of this outcome, it has become clear that apart from categories b1 and e1 which are slightly higher in occurrence for this cluster than with Cluster B, all others have a much lower occurrence than Cluster B.

Little only need be said here about the STOS categories which have had high or low occurrence as these have already been discussed under the four clusters. Yet, it may be said that the level of occurrence of the categories for this cluster have a lot in common with Cluster 1 above. Hence the higher occurrence of categories b1 and e1 compared with

Cluster B only goes to show Cluster A members as having very limited range of strategies and tactics of teaching to adopt. These further go to confirm the didactic, theoretical, informative factual and albeit, expository nature of teaching adopted by the majority of science teachers in many Nigerian schools. While the slightly higher occurrence of the e1 category goes to show that pupils, referred slightly more to teachers for the purpose of acquiring or confirming facts or principles as a result of the strategies and tactics adopted by the larger number of the sample teachers. Even so, most of the interesting differences or features have been lost owing to the amalgamation of Clusters 1, 2, and 3 to give Cluster A.

Cluster B, N=13

Cluster B has a membership of 13 representing 24.08 per cent. There is a higher occurrence of most of the categories in this cluster than in Cluster A above. Most prominent among them are categories b2, b3 and c1. Others which have had a fairly high occurrence in relation to Cluster A are categories a5, b4, c2 and e2.

This Cluster B shares a number of features with Cluster 4 already discussed. This is so as the amalgamation process which resulted in Clusters 1, 2 and 3 forming Cluster A did not affect Cluster 4 so much as it became Cluster B.

What appears to be striking is that following the amalgamation, b2, b3 and c1 have become the definitive features while b4 and a2 which were definitive among the four clusters have become less distinguishing in Clusters A and B. Rather a5 (direct observation) now becomes a contributory feature for distinguishing Cluster A from Cluster B.

4.5.1 Conclusion:

It is necessary to point out that the number of clusters necessary for use in any discussions depends largely on what purpose in terms of effective distinctions they are capable of serving. Little wonder both Ugwu (1980) and Ajeyalemi (1981) worked on the basis of two clusters of teachers.

Whereas the essence of briefly discussing these two Clusters, A and B is to point out how some interesting differences or features between Clusters 1, 2 and 3 have been lost in the amalgamation, it will also be emphasized that not much difference between Cluster 4 and Cluster B can be found as Cluster B is virtually the same as the fourth cluster of the previous analysis.

Chapter 5

5. DESCRIPTION OF THE EXPLANATION APPRAISAL SCHEDULE AND THE ANALYSIS OF THE E.A.S. DATA

5.1 Introduction:

Not only is this section a composite part of the study of the strategies and tactics of a sample of Nigerian secondary school science teachers, but a probe into the most displayed and practiced strategies and tactics of teaching as far as Nigerian science teachers are concerned. Most of the science teachers engage their pupils by employing the expository - descriptive and explanatory - strategies and tactics. Yet no one is certain how effective these descriptive and explanatory strategies and tactics are.

In order to appraise these descriptive and explanatory teaching strategies and tactics as part of this study, the EXPLANATION APPRAISAL SCHEDULE (herein after referred to as E.A.S.) was developed, (see Appendix 4).

After a comprehensive review of various works dealing with classroom teaching effectiveness, especially those of Dunkin & Biddle (1974), Eggleston et al (1975 & 1976), Brown (1978), Perrott (1982), Brown & Hatton (1982), and Brown & Armstrong (1984), it became necessary that a practical instrument be developed with which to evaluate the level of effectiveness inherent in largely expository teaching. In that way, the E.A.S. was developed on the basis of available evidence such as the fact, for instance, that effective lectures or lessons contain more explaining links. Thus explaining links are prepositions and conjunctions which indicate the cause, result, means or purpose of an event or idea, for example, because ..., in order to ..., if ... then, therefore ..., and consequently ... . According to Dunkin & Biddle (1974 p311), the more these explaining links occurred the better will be the explanations given during lessons.

Also, it has been suggested that vagueness is a function of the teacher and not of lesson topic, Dunkin & Biddle (1974 p312). In effect, vagueness as a function of the teacher occurs when the teacher does not sufficiently command the facts or the understanding required for maximally effective communication.

By the same token, using a working definition that explaining is an attempt to provide understanding of a problem to others, Brown and Armstrong (1984) argue that it must follow from the definition that explaining involves taking account of the problem in relation to the set of explainees. In effect, the explainer has to present or elicit a set of linked statements, each of which is understood by the explainees and which together lead to a solution of the problem. These linked statements have been labelled 'Keys' as they unlock understanding. This thinking is based on the Brown & Armstrong's (1978) work. It follows also that for explanations to be successful, they must be clearly structured and interesting involving the use of structuring moves such as framing statements which delineate sections of the explanation, focal statements which highlight its essential features and the use of carefully chosen examples. In essence, effective or successful explaining during teaching requires that the explainer should be clear, fluent and explicit, use emphasis and clear, appropriate and concrete examples in sufficient quantity, be logical in presentation, use link words or phrases, and provide opportunities for questions.

5.2 The Explanation Appraisal Schedule (E.A.S.)

The Explanation Appraisal Schedule (E.A.S.) is an instrument developed by this author for use in describing and quantifying certain characteristics of science lessons after a comprehensive literature review of various studies as pointed out above.

Thus the E.A.S. consists of 18 characteristics which are strongly represented in most expository lessons.

Essentially, the 18 characteristics come under two main features - the Pedagogic and Expository features. The pedagogic features consists of characteristics which give shape to the lesson hence the structural-features; the Content-related features and the Interaction-related features. These come under the pedagogic features as there is an element of deliberate choice in these strategies. In effect, a teacher can decide to ask questions or not to ask questions. Also, the teacher could decide not to encourage pupils' questions and vice versa. While the Expository features are, rather, instinctive styles and tactics about which teachers do not normally exercise much choice, and may indeed be unaware of. Schematically, it would be represented as follows:

THE EXPLANATION APPRAISAL SCHEDULE (E.A.S.)

A PEDAGOGIC FEATURES (involves element of deliberate choice)

Structural Features:	1 - Clear Introduction.
	2 - Clear Orientation.
	3 - Progressive Summaries.
Content-Related Features:	4 - Use of concrete examples or analogies.
	5 - Clear diagrams and/or Illustrations.
Interactional Features:	6 - Teachers' Questions.
	7 - Questions without Change for Pupils to Answer.
	8 - Verbal Cueing.
	9 - Pupils' Questions.

B EXPOSITORY FEATURES (These Tactics are Instinctive in Style)

10 - Main Ideas paraphrased rephrased and/or restated

* 11 - Unnecessary Repetitions.

12 - Use of Explaining Links.

* 13 - Discontinuities in Theme.

* 14 - Self-Interruptions and unfinished sentences.

* 15 - Long and Complex sentences/ statements.

* 16 - Vague Words and Sentences.

* 17 - Unexplained Difficult Vocabularies/Terms.

* 18 - Wrong use of Words/Terms (misinformation).

* expressed in their negative forms.

Characteristics 11 and 13 through 18 have been expressed in their negative forms in the E.A.S. as they are more easily identified in the breach, that is, when the rule is broken. Even so, their positive alternatives are given below to enable the reader to appreciate their values.

Characteristics Expressed in Both Negative and Positive Forms

NEGATIVE	POSITIVE
11. Unnecessary repetitions.	Use of repetition sparingly for emphasis.
13. Discontinuities in theme.	Logical presentation of materials.
14. Self-Interruptions and unfinished sentences.	Coherence in statements and sentences.
15. Long and complex sentences/statements.	Short and comprehensible sentences with good syntax.
16. Vague words and sentences.	Appropriate choice of words/ appropriate terminology.
17. Unexplained difficult vocabulary/terms.	Difficult words/terms clearly explained.
18. Wrong use of words and terms leading to misinformation.	Content accuracy leading to dissemination of correct information.

The initial judgement in respect of the level of occurrence of the 18 characteristics is that, for the achievement of effective teaching, some must occur highly, some moderately and others low. In effect characteristics 4, 5, 6, 9, 10 and 12 will be expected to have high occurrence in order to help achieve effective exposition. Characteristics 1, 2, 3 and 8 will be expected to have a moderate occurrence in order to help achieve effective teaching, while characteristics 7, 11, 13, 14, 15, 16, 17 and 18 will be expected to be of low occurrence in order to help achieve effective teaching including exposition. These initial judgements may need to be modified in the light of experience.

5.2.1 Clear Introduction (1):

As it implies, it is the unambiguously clear introduction of the lesson/topic and/or segment of a lesson about to be delivered by the teacher. Some examples of this characteristic will be as follows:

T4(0.01) "Today we shall talk of the sense organs."

T8(0.01) "Today we are going to treat the separation of components of mixtures using various techniques."

T7(0.01) "Last week we started treating chlorine and I mentioned to you that chlorine is one of the four members of the halogen family."

T2(0.12) "If there is no question we go over to the topic that we should treat today which is pollination."

By its nature, this characteristic will be expected to be of moderate occurrence in a lesson in order to help achieve effective teaching.

5.2.2. Clear Orientation (2):

This is the tactic whereby pupils are orientated towards a whole lesson or part thereof, or segments of the lesson. This provides pupils with insight into what course the lesson/topic will follow. Some examples of clear orientation statements follow, but it may be necessary to point out that statements of orientation may serve as introductory ones but introductory statements may not necessarily be orientational in view of their usually broad, brief and comprehensive nature. Statements of orientation are more specific and more indepth, and should also be of moderate occurrence in order to help achieve effective teaching.

T8(0.03) "And if you know what a mixture is then we will go on to the next stage which is the separation of mixtures using various techniques."

T6(0.05) "We are going to talk about a simple substance that we use almost everytime of our lives ..."

T2(0.13) "The process of sexual reproduction in flowering plants is sort of complex. Before a flower shall be said to have undergone sexual reproduction it must have gone through so many processes one of which is pollination."

5.2.3 Progressive Summaries (3):

This is the summarization of bits of ideas/concepts already explained to enable pupils get it in one piece before continuing with the lesson. This may occur also at the end of each segment or lesson.

Its occurrence should have a pattern which represents segments if it is to be effective. They are usually statements which commence with: So ..., As a result ..., From these we can say ... etc. Some examples are as follows:

T2(0.10) "So, the word superficial means that the ovule and the placenta are arranged on the chambers of the ovary."

T6(0.16) "So, you can make something to dissolve quicker by making it to be in smaller particules or by increasing the temperature of it."

T8(0.27) "So sublimation is one other method ... physical method of separating components from mixture."

This characteristic, by the original judgement made is expected to be of moderate occurrence in order to help achieve effectiveness in explaining.

5.2.4 Use of Concrete Examples or Analogies (4):

This is the use of very familiar (concrete) examples and others which have some resemblance in some aspect or aspects which the imagination finds in two or more things that are essentially different (analogies) to achieve understanding during explaining and describing.

By the initial judgement made, this characteristic is expected to be of high occurrence in order to help achieve effective explaining during lesson. Some examples of statements containing either concrete examples or analogies are as follows:

T2(0.29) "T: So, since it is a unisexual plant, cross-pollination must take place.
Ps: Take place
T: The anthers of the male Pawpaw tree must be taken to the stigma of the female pawpaw tree."

T8(0.30) "T: Now, em, if for example you have a mixture of oil ... palm oil ... the oil you use at home for cooking ... if you have a mixture of palm oil and em, kerosine, what method do you think that you should use?"

T2(0.10) "T: They are outside on the surface not inside. Just like that tomato that I talked of with axile placentation."

T22(0.23) "T: We have to treat mainly salts here. An example of them is sodium sulphate."

5.2.5 Clear Diagrams and/or Illustrations (5):

This is the use of diagrams and/or illustrations drawn or mounted on the board to enhance expository teaching. There is a clear distinction between this characteristic and characteristic 4 of concrete examples and analogies. Diagrams may be concrete but since these are drawn, they serve quite different functions and cannot be considered as concrete examples.

In view of the fact that this characteristic serves a vital role in expository teaching, it is expected to have a high occurrence in order to help achieve effective exposition. Some examples of statements suggesting use of diagrams/ illustrations are as follows:

T37(0.10) "T: So this man ... what he did was he mixed this two ... and when you mix this two, this one will go here:

$AgNO_3 + HCL$ (Illustration)

And this one will come here."

T36(0.18) "T: The dental formula of man is represented on the board:

$$\frac{i.2,\ c.1,\ pm.2,\ m.3}{i.2,\ c.1,\ pm.2,\ m.3}$$ (Illustration)

T11(0.01) "T: ... Let me draw the diagram first and foremost." (Draws a sketch of experiment of osmosis)

5.2.6 Teachers' Questions (6):

These are questions asked by the teachers during lessons which are used to establish the progress of learning going on.

These questions do not need to be of one kind as will be seen in subsequent chapters especially Chapter 7. Even so, questioning has an important place in achieving effective explaining as the accuracy of pupils' responses partly determines the level of effectiveness in expository lessons. However, the questioning strategies and tactics, types of questions, timing, prompting, casting and intellectual levels required are essential too.

Following are some examples of questions asked by some teachers.

T6 (0.03) "Who remembers how we prepared sodium chloride?"

T7(0.11) "Who knows why it should be dipped in water first?"

T11(0.42) "What material here do you think is acting as the semi-permeable membrane?"

T14(0.11) "So, what will be a negative curvature from what we've said?"

To qualify as questions, they must be followed by responses. Thus Teachers Questions by the initial judgement is expected to have a high occurrence in order to help bring about effective teaching.

5.2.7 Questions Without Chance for Pupils to Answer (7):

Generally, these are questions to which no response is offered because the teachers did not pause long enough for pupils to supply the answers or either that the teachers did not expect any response and thus went on and supplied the answers. One other possibility is that the pupils remained silent over the question.

All such questions are regarded as rhetorical questions as they are expected to supply their own answers by suggestion or quickly by the questionner. This characteristic is expected to have a low occurrence in effective explaining.

Some examples are as follows:

T14(0.32) "The one that is growing downwards where will it be? How will it turn? If this is the root before, now what about the shoot?"

T16(0.02) "Why is it that when you have OH^- and $SO4^{2-}$ in solution you have one being discharged in preference to the other? And then if you have H^+ and Cu^{2+} in solution one is discharged in preference to the other? There are three factors."

T35(0.21 "What is the function? If the whole part is the living part then what's the function of the nucleus? What did I say about the powerhouse of the cell? Hm?"

5.2.8 Verbal Cueing (8):

This is the strategy of emphasis employed by some teachers during a lesson. When they make statements or pronounce certain words, they deliberately slow down towards the end or pause to prompt pupils to join in the completion of the sentence or word. In some cases, the teacher completes the sentence or word just as the pupils are joining in. In others, the pupils complete word or sentence before the teacher. In some other circumstances they complete the word or sentence simultaneously. This use is slightly different from Brown's use of verbal cueing.

Even so, this characteristic is a single category of an uncertain nature. It is thus expected to have a moderate occurrence in an effective exposition.

Some examples of this characteristic are as follows:

T11(0.07) "T: Now, checking the control, you see that the reverse of what has happened here (pointing to diagram A) is what is happening in B.

Ps: 'B' "

T6(0.04) "T: And the solid that was left behind for us was our salt, sodium chloride

Ps: Chloride."

T36(0.28) "T: Whereas the molars are three pairs both on the upper jaw and lower jaw

Ps: Lower jaw."

5.2.9 Pupils' Questions (9):

This is the question asked by a pupil during the lesson. The more questions pupils asked during a lesson the more teacher-pupil interaction occurs. As a result, this characteristic is expected by the initial judgement to have high occurrence in order to help achieve effectiveness in expository teaching. Further, it is of high value provided teacher's response is positive and aimed at eliminating pupils' doubts and uncertainties.

Some examples of pupils' questions are as follows:

T35(0.24) "P: My question is; from which part of the plant cell does the cell ... the cell have its food?"

T16(0.35) "P: Why is it that hydroxyl ion is discharged before the chloride ion?"

T14(0.28) "P: What is tropism?"

5.2.10 Main Ideas Paraphrased, Rephrased and/or Restated:

This is the restatement either by paraphrasing or rephrasing or even repeating some important or correct responses or contributions made by pupils or by the teacher. At times, this is done to ascertain correctness of what pupil said. While at other times it may be used by teacher depending on voice/tone, to suggest incorrectness.

In view of its value in achieving effective explaining during lessons, it is expected to have a high occurrence in order to help achieve effective exposition.

Some examples of this characteristic are as follows:

T7(0.10) "T: Why do you say so? Can anybody try?

P: Yes

T: Yes!

P: If you breathe it, it is poisonous.

T: Yes. It is a poisonous gas if you breathe it in."

T11(0.32) "T: Yes! You try (appoints a pupil)

P: You use cellophane and tie ... and tie over the mouth of the thistle funnel.

T: Yes, you use cellophane paper and tie over the mouth of the thistle funnel."

T6(0.11) "T: Looking at it alone we will not be able to see whether it contains anything or not. But if we should taste it what will we discover?

Ps: We will taste it.

T: We will discover that the sugar is in the water."

5.2.11 Unnecessary Repetitions Used (11):

As defined in this schedule, this occurs when a teacher repeats unnecessarily what he/she may have just said. In view of the fact that the lessons were audio-recorded prior to transcribing, the irrelevance of such repetitions could be determined by discountenancing such repetitions against the background of the ensuing explanation.

Further, the clarity of the statements and the general context must be taken into consideration.

This characteristic is thus expected to have a low occurrence if explanations are to be effective. The following examples will reveal these details further:

T22(0.13) "When we say sulphuric acid, this one refers to the old name. Modern chemistry no more allows this name. Modern chemistry no longer allows this name."

T4(0.03) "Now, let us discuss what this eye look like. Let us discuss what this eye look like. What we have in one eye we also have in the other eye."

T6(0.12) "By saying that I mean the particles of water and the particles of sugar are so well mixed together that we cannot be able to say this one is the particle of water and this is that of the sugar. The particles of the sugar and those of the water are so well mixed together."

5.2.12 Use of Explaining Links (12):

These are prepositions and conjunctions which indicate the cause, result, means or purpose of an event, or idea. Explaining links express relationships between a noun, pronoun, or noun phrase, and another element of the sentence by providing the connection between statements. Common examples of explaining links are: because, in order to, if, the, and, but, or, as, through, therefore, consequently, which, when, between etc.

In view of the importance of explaining links in the achievement of effective exposition, it is expected that it should have high occurrence in expository lessons.

Some examples of statements with explaining links are as follows:

T2(0.33) "T: Hibiscus is a bisexual plant BECAUSE it has the male and female reproductive organs."

T36(0.05) "T: It consists of a central pulp cavity WHICH houses the blood vessels and nerve endings."

T8(0.03) "T: If you are given a substance you should be able to know if it's a mixture or a compound."

T7(0.07) "T: So all these are the products of the reaction BETWEEN potassium tetraoxomanganate and concentrated hydrochloric acid where no heat is needed."

5.2.13 Discontinuities in Theme (13):

This is the condition found in lessons in which there occurs breaks in the themes being explained. In this context, the idea, concept or principle being explained by the teacher becomes suddenly abandoned to say something else before returning to it or not at all.

This characteristic therefore is expected to be of low occurrence in order to help achieve effective explaining during lesson in view of the disconcertment it causes pupils and the lesson itself.

Some examples of statements under this condition are as follows:

T22(0.15) "T: If that is the case we have ..., I remember, each time you are calculating ... you are calculating for oxidation numbers, you are calculating the oxidation number for any atom or any element."

T8(0.25) "T: Now, em ... if you look at it, because ... I mean when you are heating the beaker or anything or I mean ... sorry, the testtube or whatever, you will notice that the top ..., at least, it is common knowledge ... ."

T2(0.23) "T: So dichogamy is the process of ..., okay let me explain it first."

T16(0.25) "T: I said that in a solution ..., you mean that I should go over the whole thing,the ... all the factors?"

5.2.14 Self Interruptions and Unfinished Sentences (14):

This is a situation in which there occurs unnecessary stoppages or long pauses within a sentence. The important difference between this characteristic and discontinuity in theme is in the fact that in the case of the former, the sentence or statement is re-commenced with any of the last two or three words already used. While in the case of the latter, the idea or concept is directly altered by the digression.

In view of this state of affairs which affects expository lessons adversely, this characteristic is expected by the initial judgement to have a low occurrence in order to help achieve effective exposition. Some examples of statements in which this characteristic is evident are as follows:

T16(0.11) "T: The concentration can only be effective if the ... em ... if the gap or when the two rival ions are closely positioned in the series."

T2(0.31) "T: Dichogamy which is when the two ... when the anthers and the stigma mature at different times."

T11(0.39) "T: So it moves. And there must be something ... there must be something in the ... in the way and that thing must be a semi-permeable membrane."

T36(0.16) "T: These different ... the different types of animals have their own different types of dental formulae."

5.2.15 Long and Complex Sentences/Statements (15):

This characteristic, as the name suggests locates long and complex sentences and/or statements which contain several explaining links. For the purpose of this study, a long sentence or statement may contain 15 words or more.

In view of the fact that long and complex sentences or statements should have adverse effects on explaining, it is expected to be of low occurrence in order to help achieve effective explaining.

Some examples of this characteristic are as follows:

T2(0.05) "T: The placenta is found in the receptacle in the case of basal placentation and that example of a plant that has or a flower that has basal placentation is sunflower."

T4(0.23) "T: You know that this cornea is now transparent and all these things here with the help of this gap, the pupil, light can travel from the atmosphere to the cornea, aqueous humour through the pupils, enter the lens, the vitreous humour and focus on the retina."

T16(0.26) "T: If you have these ions in a solution ... I told you that when you dissolve a ... em ... a compound in water, the ions present are not only the ions of the compound but also the ions of water."

5.2.16 Vague Words and Sentences (16):

The vague words and sentences are those used by the teacher which provide no ready meaning and comprehension to pupils. These may be new terms, technical words and some high sounding words which may be inappropriately employed.

In view of the fact that this characteristic should have adverse effects in explaining, it is expected to have a low occurrence in order to help achieve effective explaining.

Some examples are as follows:

T37(0.08) "T: So John Dalton mixed atoms ... he got ... he took atom of this and atom of this, mixed two of them together."

T8(0.32) "T: Like in this case now, like palm oil and kerosine, you all know kerosine, you all know palm oil."

T2(0.25) "T: So since they don't mature at the same time, assuming the anthers mature before the stigma, these matured anthers would be taken to another flower where it looks for the mature stigma."

T11(0.38) "T: At least, you have put something in the thistle funnel and put something in the beaker, leave it for two hours."

5.2.17 Unexplained Difficult Vocabularies and Terms (17):

These are generally 'umbrella' words which are either scientific or technical and used by the teachers without clarifying what they mean or at times fail to attempt an explanation. In view of the fact that the essence of exposition is to teach by explaining, any unexplained words/ terms would be an indication of failure on the teacher's part.

For this reason, this characteristic is expected to have a low occurrence in order to help achieve effective explaining and describing.

Some examples of this characteristic will be found in the following statements.

T4(0.28) "T: The <u>chromosomes</u> that come together to form you from your parents."

T11(0.10) "T: ... the <u>semi-permeable membrane</u> here, the living semi-permeable here is the yam."

T37(0.15) "T: What I mean by <u>a precipitate</u> is: when you get something ... water, em ... may be it contains some dirts, is not clean, it is not a clean water, and you keep it."

5.2.18 Wrong Use of Words/Terms (Misinformation)(18):

This is a situation of misinformation resulting from the teacher's failure to use words or terms correctly and yet fails to detect the same for correction. In view of the fact that situations of this sort could hamper effective explaining, it will be necessary that this characteristic should have a low occurrence to be able to help achieve effective explaining and describing.

Some examples of such wrong use of words/terms resulting in misinformation are as follows:

T16(0.22) "T: Now instead of these ones being discharged here they will walk to the anode."

T22(0.39) "T: Sulphur is one of the compounds ... is one of the atoms having variable oxidation numbers ... variable valency."

T37(0.10) "T: After the whole experiment he mixed two of them and at last he got silver chloride plus nitric acid."

An elaborated discussion about these characteristics will be met in Chapter 6 where the results of the analysis are discussed in conjunction with characteristics.

5.3 The Explanation Appraisal Schedule (E.A.S.) and Its Application:

Like the Science Teaching Observation Schedule (STOS), the E.A.S. is essentially a reductionist instrument as it reduces lessons to a set of coded characteristics while omitting others. But in contrast with the STOS, the E.A.S. consists of 18 characteristics which are felt to be important diagnostic features of explanation in both positive and negative senses.

The E.A.S. is used for lessons which have been pre-recorded and transcribed. In essence, it is to enable the effective and objective identification and coding of the characteristics. After transcribing the taped lesson, the transcript is timed on a one-minute basis for the analysis from the original audio tape.

It is a requirement that the observer/researcher be physically present in the classes during recording so as to note all important events which cannot be recorded by the recorder. These include notes, diagrams, illustrations, class size, teacher's writing on the board and certain non-verbal cues. With this extra information and details, it is expected that the transcripts will be complete. No correction of teachers' or pupils' grammatical errors or the clumsiness of any sentences or statements will be required as they are all part of what the E.A.S. should be looking for.

5.4 Coding Procedure:

The E.A.S. is similar to the S.T.O.S. in its coding procedure, the difference being that the S.T.O.S. is coded in 3-minute intervals while the E.A.S. is in one-minute interval. But whereas the STOS is coded in live classes and could incorrectly code certain categories when the lesson comes thick and fast, the E.A.S. codes transcripts and can thus be more reliable in terms of coding.

In practice, the coding process is relatively easy as it involves identification of any of the 18 characteristics within each one-minute timing interval. All the characteristics can occur within the period and will thus be coded. But no characteristic is coded twice within the minute irrespective of the number of times it may have occurred. See Appendix 4 for the E.A.S. coding sheet.

At the end of this exercise, some of the clear examples of each characteristic will be located for use in discussion. This follows the summing up of the respective occurrences as given in Table 5.1 below as data from the E.A.S.

Table 5.1

DATA FROM THE EXPLANATION APPRAISAL SCHEDULE (E.A.S.)

E.A.S. Characteristics / TEACHERS (lessons)	C.I 1	C.O. 2	P.S 3	CEA 4	CDI 5	T.Q 6	Q.C. 7	V.C 8	P.Q 9	MPR 10	U.R 11	E.L 12	D.T 13	SIUS 14	LCS 15	VHT 16	DVT 17	WUW 18	lesson duration (mins.)	Type of lesson
T2	07	12	17	08	05	21	11	03	02	23	03	22	03	06	17	04	06	00	39 mins.	B
T4	03	08	12	04	05	19	10	11	13	18	11	12	10	11	20	19	03	03	33 mins.	B
T6	02	05	12	05	00	22	09	08	00	22	06	05	03	14	07	02	01	00	29 mins.	C
T7	04	07	15	06	02	28	22	00	00	30	03	16	09	12	13	00	00	00	45 mins	C
T8	04	06	15	06	02	20	10	03	00	17	08	07	14	20	11	06	00	00	37 mins	C
T11	03	08	17	03	08	33	25	15	05	24	18	06	15	17	10	09	04	03	45 mins	B
T14	05	09	18	06	01	23	28	01	02	19	13	16	15	20	12	13	02	01	44 mins	B
T16	08	17	19	08	02	10	09	00	03	30	19	11	20	23	16	16	04	03	43 mins	C
T22	05	20	23	09	08	30	11	07	06	28	20	08	14	24	06	11	00	04	46 mins	C
T35	04	07	09	03	06	19	09	01	02	15	02	07	06	08	02	00	01	00	29 mins	S
T36	06	11	17	11	03	18	11	14	00	23	18	08	06	16	06	03	03	03	34 mins	B
T37	03	08	09	05	04	22	09	08	00	18	07	05	13	20	08	12	04	07	32 mins	C
TOTAL	54	118	178	74	46	265	164	71	33	267	128	123	128	191	128	95	28	24	456 mins	
MEAN	4.5	9.8	14.8	6.1	3.8	22	13.6	5.9	2.75	22.2	10.6	10.2	10.6	15.9	10.6	7.9	2.3	2	-	
1 occurrence per time	8.4	3.86	2.56	6.16	9.91	1.72	2.78	6.42	13.8	1.71	3.56	3.71	3.56	2.38	3.56	4.8	16.3	19	mins.	

5.5 Cluster Analysis of the E.A.S. Data:

In a further effort to determine and describe the instructional strategies and tactics employed by Nigerian science teachers, the E.A.S. data was subjected to cluster analysis using the same procedure that was used for the S.T.O.S. data in the last chapter. The data so cluster analysed comes from the 12 teachers whose lessons transcripts were analysed by means of the Explanation Appraisal Schedule (E.A.S.).

Commencing from a maximum possible number of five clusters, the programming threw out two main clusters of teachers which for the purpose of distinction have been labelled X and Y. The table 5.2 below gives the number and identity of the teachers in each of the two clusters thrown out in Chart 5.1.

Table 5.2

NORMALIZED CLASSIFICATION ARRAY

Cluster	Number of members	Identity of Members	Lesson Type	%
X	7	T2,T6,T7,T8, T35,T36,T37,	Biology = 2 Chemistry = 4 Int. Science = 1	28.6 57.1 14.3
Y	5	T4,T11,T14, T16,T22.	Biology = 3 Chemistry = 2 Int. Science = 0	60.0 40.0

NOW FUSE CLUSTERS 1(2) 2(1) AT COEFFICIENT 124.730 - 1 CLUSTERS, NEW CLUSTER HAS CODE 1 AND SIZE 12.
M

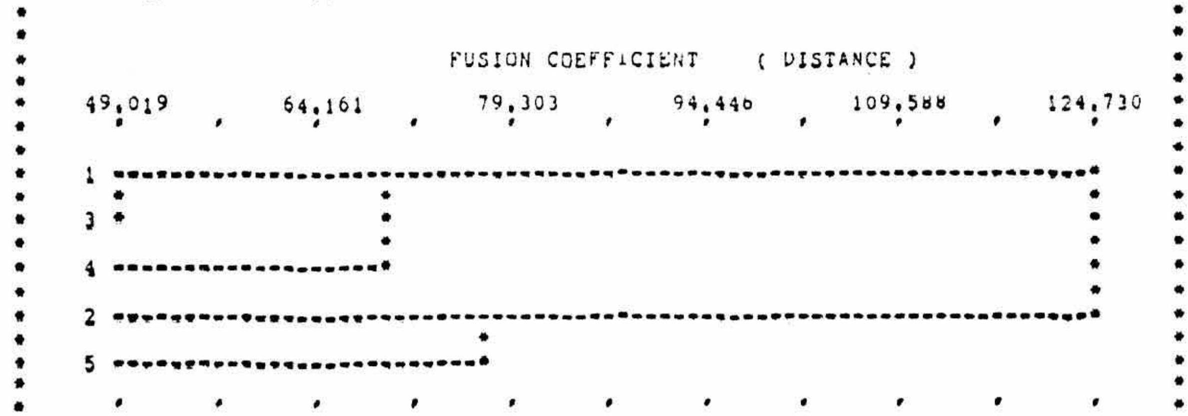
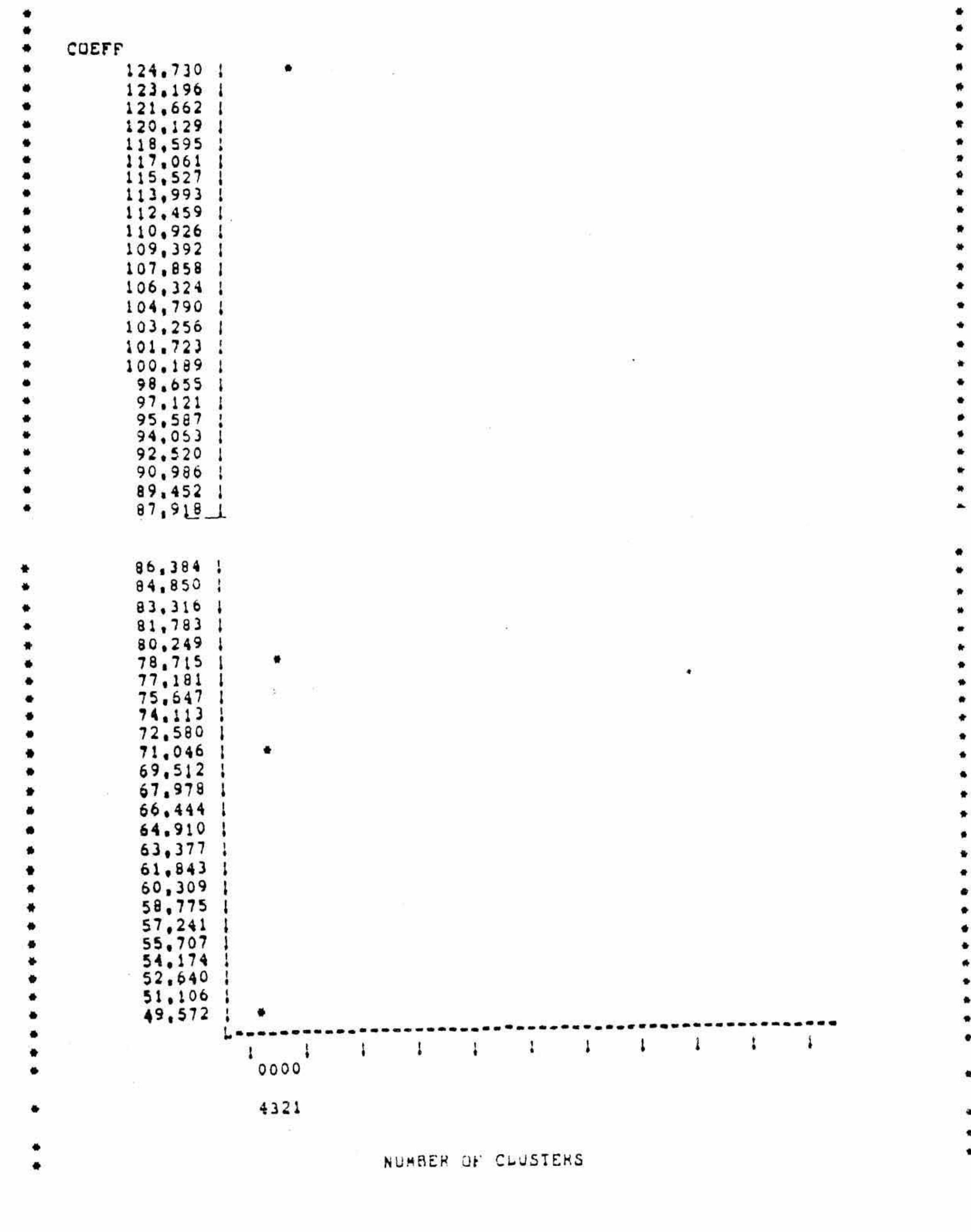


Chart 5.1 : Dendrogram Showing Clusters



Further, the centroids (mean scores) of the 18 variables as in Table 5.3 below gives the profiles of the two clusters.

Table 5.3

CENTROIDS OF THE TWO CLUSTERS

NORMALIZED CODE		(1) X	(2) Y
NUMBER OF MEMBERS		7	5
Variables (E.A.S.)	1	4.29	4.80
	2	8.00	12.40
	3	13.43	17.80
	4	6.29	6.00
	5	3.14	4.80
	6	21.43	23.00
	7	11.57	16.60
	8	5.29	6.80
	9	0.59	5.80
	10	21.14	23.80
	11	6.71	16.20
	12	10.00	10.60
	13	7.71	14.80
	14	13.71	19.00
	15	9.14	12.80
	16	3.86	13.60
	17	2.14	2.60
	18	1.43	2.80

A closer look at these two clusters will reveal differences which are important for this study. Since these differences are in quantitative terms, attempt will be made to appraise them in qualitative terms, and hence the next Table 5.4.

Table 5.4

CLUSTERS SHOWING DISTINGUISHING FEATURES

E.A.S. VARIABLES	CLUSTER X (SOFT-PEDALLING)	CLUSTER Y (FAST-PEDALLING)
1		
2	**	***
3	**	***
4		
5		
6		
7	**	***
8		
9	*	****
10		
11	*	****
12		
13	**	****
14	**	****
15	**	***
16	*	****
17		
18		

Whereas as in Table 5.3 above, Cluster X teachers used variable 4 (use of concrete examples or analogies) only slightly more frequently than Cluster Y teachers, Cluster Y teachers evidently used all other variables more frequently than Cluster X teachers. In some cases, the differences in terms of occurrence is very high.

For the purpose of describing the classroom behaviours of the teachers, two contrasting terms - SOFT-PEDALLING and FAST-PEDALLING - will be associated with the two Clusters X and Y, respectively. This follows a realization from listening to the audio-tapes that the teachers in Cluster Y talk a lot faster than Cluster X teachers who talk more softly.

5.5.1 Distinguishing The Two Clusters - Main Points:

The two clusters are very clearly differentiated on nine out of eighteen characteristics. Of the nine, five are, by definition, negative characteristics. Cluster Y (Fast-pedalling) shows a very high occurrence of the variables:

Unnecessary Repetitions (11), Discontinuities in theme (13), Self-Interruptions/Unfinished Sentences (14), Long and Complex Sentences/Statements (15) and Vague Words or Sentences (16) against Cluster X in which they are lower. Even though these characteristics are by no means absent in Cluster X (Soft-pedalling), Cluster Y is clearly identified as being the less coherent and less effective expositors.

These negative characteristics of Cluster Y are associated with a high occurrence of clear orientation statements (2) and progressive summaries (3), confirming impressions of the over use of these categories by certain teachers, and adding to the general picture of incoherence. More on this in the next chapter. The use of Teachers' Questions (6) does not differentiate the two clusters as much as other characteristics especially the negative ones, but will be explored slightly further. A closer examination of types of questions asked by teachers placed in the two clusters, reveal that the Cluster Y asked slightly fewer Analysis/Reasoning questions but asked more Application and Observational questions. But on the whole, there is only a small difference between the two clusters especially in the use of questions making higher intellectual demands of the pupils. More about questions can be read in Chapter 7.

Table 5.5

PROPORTION OF QUESTIONS ASKED BY THE TWO CLUSTERS

Categories of Teachers Questions	Cluster X (Soft-Pedalling) Number =7		Cluster Y (Fast-Pedalling) Number =5	
1. Comprehensive/Recall	141	67.5 %	68	32.5 %
2. Application	9	26.5 %	25	73.5 %
3. Observation (Identifying/Locating)	19	37.3 %	32	62.7 %
4. Analysis/Reasoning	16	55.2 %	13	44.8 %
5. Leading (Suggestive)	44	52.4 %	40	47.6 %
6. Management (Social and Class Control	42	53.2 %	37	46.8 %
7. Evaluation	2	50 %	2	50 %
Total	273	55.7 %	217	44.3 %

The more frequent use of the rhetorical questions or Questions Without Chance For Pupils to Answer (7) is however, not unexpectedly associated with the other negative characteristics of Cluster Y.

One of the most interesting outcomes of this analysis is the association of a higher occurrence of Pupils' Questions (9) with Cluster Y (Fast-pedalling) teaching style. They occur almost ten times as frequently as in Cluster X (Soft-pedalling) style. This variable which was originally judged to be a desirable characteristic is now seen to occur only in response to the generally more confused exposition of Cluster Y teachers. This in itself is no bad thing, but it is a long way away from the deliberate stimulation of pupils' into asking questions as a teaching strategy.

Table 5.6

OCCURRENCE OF PUPILS' QUESTIONS IN THE TWO CLUSTERS

Lessons	Cluster X (Soft-Pedalling) Number =7	Cluster Y (Fast-Pedalling) Number =5
T2	2	-
T4	-	18
T6	0	0
T7	0	0
T8	0	0
T11	-	7
T14	-	3
T16	-	4
T22	-	8
T35	2	-
T36	0	0
T37	0	0
Total	4	40

With one exception, that is, variable 4 (use of concrete examples and analogies), all other characteristics are more frequently found in Cluster Y. This may be attributed partly to the more rapid delivery observed from Cluster Y teachers. Even so, in many other characteristics the differences between the two clusters are too small to warrant detailed interpretation. Yet the use of explaining links (12) is almost identical in the two clusters, even though there is a variation at the individual level, which demonstrates that in this sample, at least, it is not an associated variable.

Verbal Cueing (8) is found slightly more frequently in Cluster Y but not sufficiently so to positively identify it with the negative features of Cluster Y. The original judgement that it is acceptable at a moderate level may thus be justified. Even so, it remains an interesting phenomenon deserving further studies.

5.5.2 Conclusion:

In concluding, one must be careful not to identify Cluster X (Soft-pedalling) as very effective and Cluster Y (Fast-pedalling) as wholly ineffective teachers. Cluster X certainly show evidence of negative characteristics, and without further evidence of effectiveness from outcome measures, it is impossible to say what level of use of certain characteristics, individually or in combination, is acceptable. The evidence suggests however that the E.A.S. is potentially a valuable new instrument for conducting such studies.

Chapter 6

6. THE E.A.S: A DISCUSSION OF FINDINGS

Although a quantitative treatment of the E.A.S. data based on cluster analysis has been presented in the last chapter, a more analytical discussion of the results in this section along with examples as evidence to support criticisms should help the reader to appreciate the essence of the evaluative processes of the E.A.S. and its findings.

For the purpose of enabling the reader to further appreciate the value of each characteristic, each will be discussed and in turn criticized before a cumulative picture is painted of the strategies and tactics employed by the sample teachers. This approach is in some cases reversed.

6.1 Clear Introduction (1):

As was expected every teacher opened a lesson with one form of statement or the other. Most of these statements were intended to reflect on their previous lessons, while a few others were in the form of questions to review the previous lessons, but soon afterwards, all the teachers made introductory statements about the lessons or the specific topics to be dealt with during the lesson.

Being introductory statements, they are not expected to present a detailed picture of what is to follow since that is how the separate category of clear orientation is defined. The purpose of identifying this characteristic is to help determine the number of segments each lesson contains, and thus evaluate same objectively against the main topics and time. However some of these introductory statements were not effectively made as they left too much to the pupils' imagination. An example of one such introductory statement is as follows:

T6(0.04) "Today, we are going to talk about another thing."

This is demanding too much from the pupils!

Data collected from the 12 lesson transcripts by means of the E.A.S. indicate that T16 was found to contain the highest number of introductory statements with 8, while the lowest number of 2 introductory statements were recorded from T6. However, the mean of 4.5 (or approximately 5) was quantitatively calculated for all 12 lessons. This suggests that on the average each lesson, lasting about 38 minutes (which is the mean of total duration of the 12 lessons), contains about 5 introductory statements. This includes the opening one and the subsequent ones introducing various key segments of the lessons.

For a single period lesson lasting about 38 minutes, more than 4 or 5 lesson segments will surely result. The lesson T16 is a chemistry one with: 'Factors Which Affect Discharge of Ions', as the topic, and was found to have eight introductory statements. Clearly, this topic, at least for O'level pupils' consumption should not contain more than five factors which should form the lesson's segments. Namely: Effects of (i) Heat, (ii) Concentration of the Electrolyte, (iii) Position of Elements in the Electrochemical Series, (iv) The Nature of the Electrodes and (v) The Electronegativity of the ions. Even so, it is doubtful that any teacher should claim to have achieved an effective lesson including all the above within a 38 minute period.

On the other hand, a lesson with only one introductory statement suggesting the presence of one lesson segment within the same lesson duration will be over indulging O'level pupils to details they probably do not need, while a lesson with two introductory statements suggesting the likely presence of two lesson segments for the same period of time will be quite satisfactory.

A few examples of statements introducing the topics and representing the clear introduction characteristic are as follows. First an example from one of the biology lesson

Table 6.1

THE E.A.S. DATA EXPRESSED IN RATES OF OCCURRENCE
(1 CHARACTERISTIC PER GIVEN TIME IN MINUTES)

E.A.S. Variable Teacher (lesson)	C.I 1	C.O 2	P.S 3	CEA 4	CDI 5	T.Q 6	Q.C 7	V.C 8	P.Q 9	MPR 10	U.R. 11	E.L 12	D.T 13	SIUS 14	LCS 15	VNS 16	DVT 17	WUW 18	Time (mins.)
T2	5.6	3.3	2.3	4.8	7.8	1.8	3.5	13	19.5	1.8	13	1.7	13	6.5	2.2	9.7	6.5	O	39
T4	11	4.1	2.8	8.2	6.6	1.7	3.3	3	2.5	1.7	3	2.7	3.3	3	1.6	1.7	11	11	33
T6	14.5	5.8	2.4	5.8	O	1.3	3.2	3.6	O	1.3	4.8	5.8	9.7	2.1	4.1	14.5	29	O	29
T7	11.3	6.4	3	7.5	22.5	1.6	2.1	O	O	1.6	15	2.8	5	3.7	3.5	O	O	O	45
T8	9.3	6.5	2.5	6.1	18.5	1.8	3.7	12.3	O	1.8	4.6	5.3	2.6	1.8	3.4	6.2	O	O	37
T11	15	5.6	2.6	15	5.6	1.4	1.8	3	9	1.3	2.5	7.5	3	2.6	4.5	5	11.3	15	45
T14	8.8	4.9	2.4	7.3	44	1.9	1.6	44	22	1.9	3.4	4.0	2.9	2.2	3.6	3.4	22	44	44
T16	5.4	2.5	2.3	5.4	21.5	4.3	4.8	O	14.3	4.3	2.3	3.9	2.2	1.8	2.7	2.7	10.7	14.3	43
T22	9.2	2.3	2	5.1	5.7	1.5	4.2	6.5	7.7	1.5	2.3	5.8	3.3	1.9	7.6	4.1	O	11.5	46
T35	7.3	4.1	3.2	9.7	4.8	1.5	3.2	29	14.5	1.5	14.5	4.1	4.8	3.6	14.5	O	29	O	29
T36	5.7	3.1	2	3.1	11.3	1.9	3.1	2.4	O	1.8	1.9	4.3	5.7	2.1	5.6	11.3	11.3	11.3	34
T37	10.7	4	3.6	6.4	8	1.5	3.6	4	O	1.4	4.6	6.4	2.5	1.6	4	2.6	8	4.5	32
TOTAL	54	118	178	74	46	265	164	71	33	267	128	123	128	191	128	95	28	24	456
MEAN OCCURRENCE	4.5	9.8	14.8	6.1	3.8	22	13.6	5.9	2.75	22.2	10.6	10.2	10.6	15.9	10.6	7.9	2.3	2	38
ONE CHARACTERISTIC Per minute	8.4	3.86	2.56	6.2	9.91	1.72	2.78	6.42	13.8	1.7	3.56	3.71	3.56	2.38	3.56	4.3	16.3	19	

transcripts:

> T2(0.16) "T: So now we have known the definition of the term pollination. We can go further to know the kinds or types of pollination that we have."

The second example comes from a chemistry lesson transcript as follows:

> T8(0.02) "T: Today, we are going to treat the separation of components of mixtures using various techniques."

These introductory statements are generally clear as they convey the message they are designed to. Even so, the second example in itself contains two terms - components and techniques - which pupils were unlikely to have understood prior to the lesson.

6.2 Clear Orientation (2):

Data from the E.A.S. show that the 12 teachers used a total of 118 statements of the clear orientation category. T16 recorded the the highest with 17 instances of occurrence of clear orientation and T6 recorded the lowest with 5. What these figures show is that there is a ratio of 1:2 between clear introduction and clear orientation. In effect the ratio of one clear introduction to two clear orientation exists for all the lessons appraised with the exception of T22 in which the ratio stands at 1:4. The mean-values give the ratio as 4.5 to 9.8.

The orientation statements by design are intended to elaborate on the introductory statements and with more specificity. The Lesson T22 with a ratio of 1:4 is a chemistry one that lasted for 46 minutes. The topic is: 'Oxidation Numbers and the I.U.P.A.C. Naming System'. As can be suggested also in the case of Clear Introduction, there can be no set limits to the number of statements of orientation that a teacher may make during a lesson. This is because it depends on the number of lesson segments and more importantly on the clarity and effectiveness of such statements in the judgement of the teacher.

As far as the above topic is concerned, it is not simply deriving the name of one compound through the appropriate mathematics based on some algebraic processes and then applying the same procedure to other compounds. It involves an attempt to lift the pupils' general mathematical interests, the calculation itself and derivation of the formula of the compound, and then the naming. On these grounds, it may not be out of place for this lesson to have contained as many as 20 orientation statements. This is not to suggest that there are as many as 10 lesson segments on the basis of 1:2 ratio applying to all other 11 lessons.

A few examples of statements of clear orientation are as follows:

> T2(0.22) "T: We will go further to discuss the characteristics we find in flowers that have each of these kinds of pollination."

Another example from a chemistry lesson is as follows:

> T8)0.03) "T: And if you know what a mixture is then we will go on to the next stage which is the separation of components of mixtures using various techniques."

This is one of the few characteristics that has its occurrence moderately as anticipated in order to help achieve effective exposition.

6.3 Progressive Summaries (3):

As described in Chapter 5, a progressive summary entails the summarization of bits of information/concepts, or lesson segments or some reaffirmation of these to enable pupils to get them all in one piece, before continuing with lesson. Also, it may occur towards the end of the lesson. If so, it may be difficult to place or suggest a limit to the number of times it should occur within a given period in a lesson. But, based on the data resulting from this study, an estimate of what may be considered as being effectively adequate based on the number of segments of a lesson can be suggested.

Evidence from the E.A.S. data expressed in rates of occurrence per minute time interval (Table 6.1) indicate that the mean-value of occurrence in regard to statements of progressive summaries is 14.8 (or approximately 15) in the 38 minutes the average lesson lasted. This works out to be that one statement of characteristic (3) occurred every 2.6 minutes. This is clearly too frequent.

When teachers are considered individually, it will be realized that the frequency of occurrence or use of statements of progressive summary varies considerably. For T22, there was a total occurrence of 23 within the 46 minutes the lesson actually lasted. This works out to be one statement of progressive summary occurring every 2 minutes. The lowest use was in T37 with 9 in the 32 minutes the lesson actually lasted. This works out at one every 3.6 minutes.

A few examples of these progressive summaries are as follows:

T6(0.16) T: "So you can make something to dissolve quicker by making it to be in smaller particles or by increasing the temperature of it."

Another example also from a chemistry lesson transcript is as follows:

T8(0.27) T: "So sublimination is one other method ...

physical method of separating components of mixtures."

And yet another from a biology lesson transcript is:

T2(0.15) T: "So pollination is the transfer of this pollen grain which is the male gamete from the anthers of a flower to the stigma."

As can now be visualized, the occurrence of this characteristic is rather high compared with the moderate occurrence judged to be desirable to help achieve effective exposition. If teachers are to continue to make statements of progressive summary at the rate of one every 2 - 2.5 minutes, then one may wonder what strategy of teaching is being employed. This rate of use amounts to providing summaries for all terms or words being used in the lesson.

One would have expected an occurrence rate about that of characteristic 1. But as it stands, there are more statements of this sort than necessary.

6.4 Use of Concrete Examples and Analogies (4):

Almost nothing else could on its own make expository - descriptive and explanatory - lessons more real to pupils than the correct use of concrete examples and/or suitable analogies. But whereas analogies supplement the concrete examples, the concrete examples on their own should provide the much needed real live situation that all lessons require to be effective, not least the expository type of lesson.

That being the case, the occurrence of this characteristic would be expected to be quite high if it is to help bring about much needed understanding on the part of the pupils. By giving a few of the concrete examples and anologies used in some of the lessons, a better appreciation of their relevance will be evident. First, an example from a biology lesson and it is as follows:

T2(0.19) T: "Assuming you have a hibiscus plant in front of the principal's house and you have another hibiscus plant in front of the biology lab., cross-pollination can occur between these two hibiscus plants in that the pollen grains from the anthers in the flower of the principal's house can be thrown to the stigma of the same hibiscus flower in front of the biology lab. You see, it now happens between two plants but these plants are of the same species. It cannot happen between the hibiscus flower and the crotalaria."

In this excerpt, some concrete and thus familiar examples have been used to produce a clear and effective mental picture of what cross-pollination entails. Even a negative example by way of the hibiscus and crotalaria flowers is used to clarify the fact that cross-pollination does not involve nor imply two different types of flowers pollinating each other. Even though no physical examples of hibiscus and crotalaria flowers were actually presented by the teacher during the lesson, the two flowers are familiar ones to the pupils.

This particular explanation, though long and complex for the pupils, still went down well during the lesson. This is not to suggest that all the examples/analogies used by the teachers actually went down well with the pupils. Some were examples but were not concrete as this example shows:

T14(0.05) T: "And movement of plant in response to external stimuli are known as induced or irritable movements. An example of this is the tropic movements but examples of the induced movement is tropic movement, nastic movement and tactile movements."

Clearly, this excerpt with all the examples given could not have helped this lesson in any appreciable way even as part of the process of explaining. This is because the examples fall outside the pupils' established concept range or vocabulary. This was further evidenced from the pupils' facial expressions which were of doubt and anxiety. Certainly, concrete examples would have been easy to provide if this teacher had planned the lesson in advance.

However, another clear and concrete example taken from a chemistry lesson transcript is as follows:

> T8(0.31) T: "Okay! Now em, if for example you have a mixture of oil ... palm oil ... the oil you use at home for cooking ... if you have a mixture of palm oil and em kerosine what method do you think that you should use?"

In this particular example of use of concrete examples, the substances intended to be separated were, again not present in the laboratory. At least, they were not used during the lesson to demonstrate the type of mixture anticipated, and subsequently to be separated. But they are concrete and practical examples that all Nigerian pupils are familiar with. Kerosine is used for lighting in almost all Nigerian homes, and for cooking in many homes, while palm oil is a staple part of Nigerian foods. So, at least, they are valid concrete examples.

Even so, the use of this characteristic during lessons by the science teachers whose lessons are subject of this analysis, is very low. The mean-value of occurrence is 6.1 within the 38 minutes the average lesson lasted. Thus, one instance of use of this characteristic took place about every 6.2 minutes. This rate of occurrence or use of concrete examples/analogies is considered inadequate for the achievement of effective exposition.

6.5 Clear Diagrams and Illustrations (5):

This characteristic represents the effective use of diagrams and/or illustrations drawn or mounted on the board to enhance exposition and teaching in general. Though this characteristic resembles characteristic 4 (use of concrete examples or analogies), it is different as the following examples will show.

First from a biology lesson transcript as follows:

T36(0.18) T: "The dental formula of man is represented on the board:

$$\frac{i.2,\ c.1,\ pm.2,\ m.3}{i.2,\ c.1,\ pm.2,\ m.3}$$ "

This type of illustration is clear and helpful to both the teacher and pupils. It helps to reduce the amount of verbal descriptions and explanations that would have been required to ensure that pupils understood. For the pupils, it enables them to build up a mental image or picture of the dentition of man, and save themselves the 'burden' of listening passively to the teacher's unending exposition.

One other example is as follows:

T37(0.10) T: "So this man ... what he did was he mixed this two ... and when you mix this two, this one will go here:

$$AgNO_3 + HCL \rightarrow AgCL + HNO_3$$

And this one will come here."

The 'arrows' were used to illustrate the exchange of radicals that occurs between the two reactants. However, the teacher deferred the development of this idea to some other date with the following words:

> T37(0.10) T: "Later we will learn why this thing was able to go here and this one coming here. But not today."

Other illustrations come in the form of diagrams drawn on the chalkboard which cannot be drawn here. Suffice it to say that some teachers made statements suggestive of the type of diagrams to be drawn. For example:

> T2(0.03) T: "Assuming (draws) this is the flower top and this is the placenta, and this is the receptacle."

Another example of a statement which is suggestive of what was done is as follows:

> T11(0.01) T: "Now for those of you who did this experiment, what did you observe? Let me draw the diagram first and foremost." (Draws a sketch on the board.)

Clearly, the use of such illustrations and diagrams have positive effects on teaching and learning. Yet it is difficult to stipulate how many such illustrations and diagrams should be used during a lesson. It is partly dependent on the subject matter of the lesson but it also depends on the teacher and his level of creativity in terms of being able to provide clear diagrams and illustrations relevant to the concepts being explained. There are signs that there are many science teachers whose illustrations and diagrams are as sketchy and undiagrammatic, and unillustrative as could possibly be imagined. There was one teacher who asked two pupils to come forward and draw diagrams of the cockroach because she could not draw a cockroach, before the lesson could continue.

The data obtained from the E.A.S. and translated as in

Table 6.1 shows that a total of 46 such illustrations/ diagrams were used by all 12 science teachers. This gives a mean of 3.8 for each lesson lasting 38 minutes on the average; one occurrence every 9.91 minutes. For T6, this characteristic was never used, while it occurred once every 44 minutes, 22.5 minutes, 21.5 minutes, 18.5 and 11.3 minutes respectively in lessons taught by T14, T7, T16, T8 and T36. Even when it is difficult to predict or speculate how many examples of this characteristic should occur in a science lesson, it is clear that a state of non-occurrence and/or rates of use as obtained in the lessons under study are insufficient to achieve effective explaining and describing, and teaching in general. At this rate, it will be difficult for pupils to conceptualize and internalize what was taught by most of the teachers. Hence, this characteristic may not have been sufficiently employed to help achieve effectiveness in explaining and describing in particular, and teaching in general.

6.6 Teachers' Questions (6):

The strategies and tactics, and the nature of questions employed by teachers during lessons constitute an important analytical chapter in this study. Nonetheless, the data obtained from the E.A.S. show that teachers' questions number 265 and thus the most employed single characteristic. Whereas a mean-value of 22 questions were asked by each of the twelve teachers, 33 questions were recorded in the lesson taught by T11 and was the highest in terms of number, while T16 recorded the least number of questions which is 10.

On the basis of occurrence, however, T6 had the highest frequency of one question being asked every 1.3 minutes. The lowest occurrence was recorded by T16 at one question every 4.3 minutes. From the above, it can be suggested that all the teachers appear to recognize the value of, and use of questioning during lessons. But how effective have these questions been towards improving the quality of teaching and explaining in particular?

On the basis of the number of questions asked by the sample teachers, it might have been possible to achieve effective teaching. But then, the types and quality of the questions are equally important. This will be the subject of the next chapter.

6.7 Questions Without Chance for Pupils to Answer (7):

This characteristic relates to the last one - Teachers' questions. But there is a difference which is that the teachers did not appear to require answers or responses and went on talking. With regard to the Science Teaching Observation Schedule (STOS) of Eggleston et al (1975), a question asked by a teacher who continues with the lesson without waiting for an answer must be accepted and classified as a statement. Grammatically such a question might be considered a rhetorical question - a question posed for rhetorical effect and emphasis and not meant to be answered because its context is expected to supply its own answer by suggestion. It is thought that this type of question would be difficult for pupils to comprehend. Most pupils do not accept them as statements which are factual or even suggestive. Most pupils would always accept them as questions which they should have answered but had no chance to.

Nonetheless data from the E.A.S. indicate that 164 rhetorical questions were used by the 12 science teachers whose lesson transcripts are the subject of this study. T14 recorded the highest with 28, while T6, T16, T35 and T37 recorded 9 each. However, the mean-value of 13.6 was recorded. This means that one rhetorical question was asked every 2.8 minutes. This rate of occurrence for rhetorical questions is surely too frequent to help achieve effective explaining in these largely expository lessons.

One other issue which has not helped effective explaining is the consecutiveness of these rhetorical questions. Confusion is compounded by a sequence of questions that the pupils have no opportunity to contemplate let alone answer.

The teachers could not wait or pause for a few seconds more to solicit responses because they did not want responses. Even though rhetorical questions may be tolerated during lessons, one wonders whether the frequency of occurrence as well as their consecutive occurrences can in any way help teachers achieve effective exposition.

Some examples of 'Questions Without Chance for Pupils to Answer', are as follows:

> T4(0.08) T: "At this point (points to diagram) where it leaves the eye we have the blind spot. <u>Why is this called the blind spot</u>? It has no sensitive cells at all. It has no rod, it has no cone."

If the above question is a rhetorical one and thus does not require an answer supplied as it should supply itself, why should the teacher go on and supply the answer? That the teacher should go further and supply the answer suggests that the pupils would not accept such rhetorical questions as supplying their own answers. Nothing could have stopped the teacher from allowing pupils to think of possible response to the question and then supply it.

In this example, from a biology lesson transcript based on 'osmosis', the teacher asked numerous questions consecutively without a chance for pupils to respond.

> T11(0.37) T: "Who can actually explain what has happened to the solution here? (Points to water level) What made it to increase in height? Instead of falling down it increased; why did it not fall down? Ilaye, talk! Alatoru, yes, why didn't this solution fall down? Why did it go up?"
>
> P: Mumbles (inaudible)

In this excerpt, the teacher asked as many as five questions consecutively probably without realizing that answers go with questions. At worst, each of the above five questions required an answer of its own which should have been from different perspectives. This is because, there is a 'Who' question, a 'What' question and 'Why' questions. Not to have allowed pupils to supply answers at each stage of questioning reveals that the tactics employed are faulty and thus ineffective.

Next is an example from a chemistry lesson transcript in which many questions were also asked before a pupil could attempt an answer. Yet, they all are consecutively occurring questions and considered as rhetorical since the teacher did not stop nor pause to solicit a response from the pupils.

T8(0.31) T: "Now em, if for example you have a mixture of oil ... palm oil ... the oil you use at home for cooking, if you have a mixture of palm oil and em kerosine, what method do you think that you should use? What technique will you use? Palm oil and kerosine! I want you to tell me what method you will like to use to separate the two components out from the mixture? You have an idea. Think of it. I want you to give me a sound answer, yes!"

P: You will use the ... the method of distillation.

T: Why do you want to use the method of distillation? In your distillation, what are you making use of?

In this excerpt, questions which have been asked consecutively and are yet rhetorical by definition are numerous and appear to have no justification. Indirect statements such as rhetorical questions are of doubtful significance in expository lessons, because in expository teaching strategies teachers are attempting only to achieve effective explaining and describing. Hence any tactics involving suppression, of the effort to achieve effectiveness either knowingly or otherwise will be highly unnecessary. This characteristic clearly has a high occurrence instead of the low occurrence that was judged necessary to achieve effective exposition.

6.8 Verbal Cueing (8):

This characteristic in the first instance was expected to be of moderate occurrence in order to help achieve effective explaining and describing. But data from the E.A.S. shows that it has had a rather high occurrence with 71 during the 456 minutes total duration of the lessons. This gives a mean occurrence of 5.9 in the 38 minutes the average lesson lasted. From this it works out that one verbal cueing instance occurred about every 6.4 minutes.

In view of the fact that verbal cueing is employed by teachers apparently without realizing its effects, it is considered to have had a high occurrence. One occurrence every 6.4 minutes may seem moderate, but when it is realized that this is a characteristic typical of primary school teaching, then the reader may wish that it had a much lower occurrence. Further, when individual teachers are considered, it is observed that some teachers had a much higher occurrence rates than others. For example this characteristic occurred 14 times in the lesson taught by T36 during the 34 minutes this lesson actually lasted. This implies that occurrence may have been at a rate of one every 2.4 minutes.

Much as verbal cueing may be necessary at some point in time during a lesson, it is not necessary that it should be employed as frequently as it occurred for most of the teachers.

A few examples of the use of verbal cueing from the lesson transcripts are as follows:

T4(0.05) T: "The cornea is now transparent. Remember, behind it is opaque but in front it forms the cornea which is ... transparent.

Ps: Transparent (chorus)

T: The second layer is the ... choroid.

Ps: Choroid (chorus)."

The next excerpt is an example from a chemistry lesson transcript and is as follows:

T6(0.20) T: "It will be clear because gradually the particles of the sand will settle to the bottom of the ... testtube.

Ps: Testtube (chorus)

T: Right now, if you look at it you will see large particles of the sand at the bottom of the testtube. While you see fine particles, that is, smaller particles of sand still moving in the ... water.

Ps: Water (chorus)."

A major criticism of the use of verbal cueing especially in secondary schools is that it prevents the teachers from identifying which pupils understood the preceding explanation and/or description.

Further, there is no doubt that verbal cueing has its origin in the early primary school teaching in a formal setting. To employ it as frequently at secondary school level where pupils should have matured enough to refuse to be led, suggests that the teachers are still operating in a pre-literate style.

6.9 Pupils' Questions (9):

As the significance of teachers' questions during lessons comes to be appreciated, so does the issue of pupils' questions during lessons aimed at clearing doubts and uncertainties.

In a total teaching time of 456 minutes used by the 12 science teachers whose lesson transcripts are under study, only 33 pupils' questions were recorded against 265 teachers' questions and 164 rhetorical questions. For 5 of the 12 teachers, not even one pupil asked a question. In effect, in lessons taught by T6, T7, T8, T36 and T37, not a single question by a pupil was recorded.

Thus, this characteristic had a mean occurrence of 2.75 (or 3 approximately). This further suggests that just about 3 questions may have been asked by pupils on the average in an average lesson duration of 38 minutes.

The implications of this will be dealt with in the next chapter which deals with questions generally. Also, the responses given to some of the pupils' questions by teachers will be analysed to establish just how much encouragement to pupils from teachers are implicit in them. But suffice it to say that this characteristic has very low occurrence. Even so, it further indicates that it is one of the defining characteristics alongside several negative characteristics such as Unnecessary Repetitions, Discontinuities in Theme, Self-Interruptions/Unfinished Sentences etc which suggest that these pupils' questions were asked only in response to these features. Thus, the positive role of pupils' questions and their planned contributions to lessons are surely not realized.

6.10 Main Ideas Paraphrased, Rephrased or Restated (10):

Generally, statements representing this characteristic resemble progressive summaries. But they are essentially different in space and time. Whereas Progressive Summaries could not be very frequently occurring, this characteristic was judged to require a high occurrence in order to help achieve effective explaining.

This characteristic entails rephrasing, paraphrasing or even restating ideas suggested by pupils. It also embraces the situation whereby the teacher restates some of those ideas or concepts which he/she may have stated earlier. This time, it is being restated, rephrased or paraphrased for the benefit of the pupils.

A few examples from biology and chemistry lessons transcripts will now be given. First a biology one which borders on restatement of what the pupil just said:

T2(0.14) T: "You must have been taught of pollination in your primary schools in the Integrated Science. So, who can try to define the term pollination?

P: It is the transfer of the pollen grains from the anthers to the stigma.

T: <u>Is the transfer of a pollen grain from anthers to the stigma</u>."

The last statement by the teacher above represents a restatement of what the pupil just said. It is, in effect, a way of emphasing what the pupil said almost exactly in the words used by the pupil. At times it takes this form. Next is an example, from a biology lesson transcript giving a situation of paraphrasing and rephrasing.

T14(0.14) T: "From these, what do you think geotropism will be? What is geotropism?

P: Response to gravitation.

T: Yes. That is, geotropism is the movement of roots in response to gravitational force."

In this instance of paraphrasing, the teacher restructures the idea/concept so as to constitute a more effective response without necessarily discarding the pupil's ideas or concepts.

In some other instances, it may become necessary to discard some of the ideas which are not relevant to the response required, and others added to embellish that response. For example:

T6(0.11) T: "Looking at it alone we will not be able to see whether it contains anything or not. But if we taste it what will we discover?

Ps: We will taste it.

T: We will discover that the sugar is in the water. So we can say the water and the sugar have now given us ... ."

This is an example of rephrasing as the pupils' idea/concept remained even though the teacher had to restructure the general idea intended for development by the pupils.

In this fourth example from a chemistry lesson transcript, the pupil's response has been paraphrased to help emphasize the crucial aspects needed to be understood by the pupils.

T37(0.02) T: "What is an atom?

P: An atom is the smallest indivisible particle.

T: Yes, an atom is the smallest indivisible particle of an element that can retain the properties of that particular element."

All the above examples have one thing in common which is that they, in a number of ways, have enabled the pupils to understand what the teachers had tried to explain prior to asking the questions which necessitated the paraphrasing, rephrasing and/or restatement of the pupils' responses.

Data from the E.A.S., shows that this characteristic had the highest occurrence of all the 18 characteristics with 267 and a mean of 22.2. This implies that one statement of paraphrasing, rephrasing and/or restatement occurred every 1.7 minutes on average. In effect, the rate of occurrence of this characteristic is high which satisfies its anticipated requirement towards helping to achieve effective explaining.

It is therefore one of the few characteristics that occurred as anticipated in order to help achieve effective explaining. Yet for some individual teachers, their rates of use of this characteristic is even higher and thus presumably better. For example T6 and T11 had 1.3 minutes rate to one of this characteristic. One every 1.4 minutes for T37 and one in 1.5 minutes for both T22 and T35.

6.11 Unnecessary Repetitions Used (11):

Data from the E.A.S. show that the use or rate of occurrence of these unnecessary repetitions by all 12 science teachers stood at 128 within the 456 minutes total lesson duration. This gives a mean of 10.6 per teacher within the average time of 38 minutes a lesson lasted. On this basis, one instance of unnecessary repetitions occurred every 3.5 minutes.

The highest occurrence of 18 was recorded from T36 and this amounts to one every 1.9 minutes within the 34 minutes this lesson actually lasted. This was followed by T16 with 19 during 43 minutes. On the other hand, the lowest occurrence came from T7 with just 3 during the 45 minutes the lesson lasted. This gives one occurrence of unnecessary repetitions every 15 minutes. This was followed by T35 with 2 within 29 minutes, giving one occurrence every 14.5 minutes, and T2, one every 13 minutes. (see Table 6.1). These three teachers, T7, T35 and T2 stand out from the others whose use of unnecessary repetitions ranges from one every 1.9 minutes to one every 4.8 minutes.

The type of repetitions the E.A.S. tries to identify are those considered unnecessary in view of the fact that they have not been relevant to any appreciable extent in enhancing teaching and especially explaining. It is thought that the fewer the number of occurrences of these unnecessary repetitions, the better the prospects of achieving an effective, crisp, style of explaining during lessons.

It is observed that where such repetitions are removed, the presentation becomes much more crisp and effective, while the essence of the basic statements is not diminished by such removals. A few examples of these repetitions are as follows:

T22(0.13) T: "When we say sulphuric acid, this one refers to the old name. <u>Modern chemistry no more allows this name. Modern chemistry no longer allows this name</u>. So we have to find out the new name and find out the new name from the oxidation numbers of the sulphuric which is there."

This extract is also an example of misinformation because the name sulphuric acid itself is still very much in use. Another example is a biology one which also demonstrates unnecessary repetition.

T4(0.03) T: "In the eye socket. We either call it socket or the orbit. <u>Now let us discuss what this eye look like. Let us discuss what this eye look like</u>. What we have in one eye we also have in the other eye."

The significance of the point of contention is that even where the repeats are removed, the point made is unaffected. And if so, why should the point be so repeated? Further, why is it that these unnecessary repetitions were so frequent in 9 cases out of 12? A number of explanations may be advanced for it. First, it is likely that it is a habit which teachers are presently unaware exists. Another explanation which goes slightly further is that it may have its origin in the linguistic context. That is to say, teachers do it to enable pupils whose grasp of the language is weak to have a chance to pick up. The third possible explanation is that, it could be an instinctive attempt to reinforce the input in the absence of sufficient feedback and pupils' questions which should have enabled teachers to assess the effectiveness of their input. In the absence of further research on this, no more can be suggested.

6.12 Use of Explaining Links (12):

Explaining links are prepositions and conjunctions which indicate the cause, result, means or purpose of an event, idea or concept by forming a bridge between two or more concepts. In the process they ensure a logical presentation during explaining. The examples which will follow will show the functions of explaining links.

The first example is from a biology lesson transcript as follows:

T2(0.03) T: "Do you remember it?

P: Yes.

T: The receptacle is the small tip on the flower bud that bear the modified leaves. And we have been talking of placentation <u>as</u> the arrangement of the ovum and placenta in the ovary."

The next example also is from a biology lesson transcript and as follows:

T4(0.07) T: "The retina has light sensitive cells called the rods and cones. At a point, the spot just opposite the lens in the retina, we have the yellow spot or fovea <u>which</u> has more cones than rods."

Another example but from a chemistry lesson transcript is as follows:

T6(0.20) T: "But if we allow this to rest for sometime, what do you think will happen to the dirty water?

P: It will clear.

T: It will be clear <u>because</u> gradually the particles of the sand will settle to the bottom of the testtube."

The last example of the use of an explaining link comes from another chemistry lesson transcript as follows:

T8(0.36) T: "There is also another one, anhydrous iron III chloride. Just like iodine, if you heat it, it moves from the solid state to the gaseous state <u>without</u> passing <u>through</u> the liquid phase."

From the above excerpts, the role of explaining links can be appreciated. For this reason, this characteristic was judged to be one that should be of high occurrence. But data from the E.A.S. shows a rather low occurrence. All 12 teachers recorded a total occurrence of 123 within the 456 minutes all the lessons lasted. This gives a mean of 10.2 within the 38 minutes the average lesson lasted; one explaining link occurring every 3.7 minutes. In view of this, it is considered to be of low occurrence instead of the high occurrence expected of this characteristic in order to help achieve effective explaining and describing.

When individual teachers are considered, the state of occurrence changes for better in respect of some teachers and for worse for others. T2 recorded 22 instances of use of explaining links implying that one was used every 1.7 minutes as against one every 3.7 minutes calculated from the mean. While T7 and T14 each recorded 16 and thus having occurrence rates of one every 2.8 minutes and 2.7 minutes respectively. The lowest occurrence came from T11 with an occurrence of 6 within the 45 minutes this lesson lasted. This means one instance of use of explaining link occurred every 7.5 minutes.

In view of the fact that all the lessons were expository-explanatory and descriptive , a much higher use of this characteristic would have been expected in the lessons. It would have fostered a much more logical approach in the way these expository lessons are taught. Since use of explaining links foster logical thinking and association of ideas and concepts on the part of the pupils, low occurrence of this characteristic is a clear indication of how deficient most teachers' strategies and tactics of teaching have been. This probably accounts for the relatively illogical way most of the teachers' questions have been presented and the corresponding lack of logical presentation inherent in the pupils' responses.

6.13 Discontinuities in Theme (13):

Discontinuities in theme, being the abandonment of the subject theme which may be a concept, an idea, or a principle being explained, either partially or wholly by the teacher without any observable reason for doing that, it is considered that this should be low in occurrence in effective explaining. In fact, data from the E.A.S. show that rather than a low occurrence, this characteristic had a high occurrence.

In effect, a total occurrence of 128 and a mean of 10.6 was recorded; one instance of discontinuity in theme occurred every 3.5 minutes. Even so, when the teachers are considered individually, it became clear that T2 with one every 13 minutes was the better lesson taught judged on the basis of this characteristic alone. T2 is closely followed by T6 with one occurrence of this characteristic every 9.7 minutes, while the rest of the teachers had occurrences of this characteristic more frequently than the above two teachers.

In view of the fact that these lessons are largely expository, any such discontinuities in theme render parts of the explanation disjointed and ineffective. Clarity, fluency, continuity and understanding or assimilation suffer. This would happen because pupils would be unable to put the bits into perspective because of the jerky and disconnected manner in which the explanations have been provided by the teacher concerned.

Frequent discontinuities in theme, on the part of the teacher reveal a great deal about the teacher, namely, lack of confidence in terms of the contents being taught, and above all, lack of knowledge of appropriately effective teaching strategies and tactics to employ.

A few examples of instances of discontinuities in theme during lessons starting from a biology lesson transcript now follow:

T14(0.29) T: "So now you arrange these bean seeds in such way that it will give you certain things. And these are ... you arrange one ... a bean seed that is germinating with the roots in horizontal manner."

T4(0.12) T: "If this watery substance are not there, they will tend to lose the shape. Do you understand this now?

Ps: Yes

T: So their presence gives the eye its shape. Look at the ..., now is the lens hanging in the air?"

From the same teacher is another example as follows:

T4(0.17) T: "The size is getting smaller. And when the image is formed on the retina ... you know that the retina has the light sensitive cells, the rods and cones. They are now stimulated."

Some other examples derived from chemistry lessons transcripts are as follows:

T15(0.26) T: "They are ions with similar charges. If you have these ions in a solution ..., I told you that when you dissolve em a compound in water, the ions present are not only the of the compound but also the ions of water."

T8(0.25) T: "Now, em ... if you look at it, because ... I mean, when you are heating the beaker or anything or I mean ... sorry, the test-tube or whatever, you will notice that the top ... at least is common knowledge ..., if you are heating it, the temperature at the top will be different from the temperature at the bottom."

The last example to be given is as follows:

T16(0.25) P: "I don't understand the factors affecting discharge of ions in electrolysis of compounds.

T: I said that in a solution ... you mean that I should go over the whole thing, the ... all the factors?

Ps: Yes.

T: But you have ..., if you have a solution ..., in a solution ions with similar charge, that is, they could be ions with positive charge or ions with negative charge."

From the six examples of excerpts from lessons transcripts, the disjointed nature of the teachings can be appreciated. Beside the disjointedness, the concepts being developed were in most cases abandoned without cause. This may be the way some individuals talk, but to teach like that will be most unhelpful to pupils especially with lessons that are largely expository. Fluency, crispness and clarity help to achieve effective explaining for the benefit of the students.

6.14 Self Interruptions and Unfinished Sentences and Statements (14):

Although this characteristic resembles the discontinuities in theme, it is different in that this is a situation which occurs when a teacher unnecessarily stops or pauses unnaturally within a sentence, but then suddenly recommences the sentence with any of the last two or three words already used. Further, it differs from that characteristic as it does not necessarily use the instance of pause to digress from the theme being explained or described. Rather, the teacher returns to the same theme or idea or concept being explored.

Apart from the embarrassment these self interruptions are capable of causing the teacher if they should suddenly realize how often they occurred, they do untold damage to lessons. In Nigerian schools mixed-ability teaching is practised. As a result pupils from a wide ability range are present in the classes. There are, as a result, many pupils who may be able to piece such self-interrupted sentences/statements together, but there are many more who may not be able to piece them together and subsequently become disinterested in the lessons. And as we know, the first priority is to keep the pupils' interest high in whatever the teacher may want to teach.

It is in view of this, that this characteristic requires to be of very low occurrence in order to achieve effective explaining. But data from the E.A.S. and now represented in the form in Table 6.1 as rates of occurrence, show that this characteristic had a total occurrence of 191 which is the third highest occurring characteristic. This gives a mean of 15.9 with an occurrence rate of one instance of self-interruption/unfinished sentences every 2.38 minutes. Clearly, this rate of occurrence is too high for the achievement of effective explaining.

For individual teachers, there will be found some whose rates are better. In effect, lower than the mean. T2 had a rate of one every 6.5 minutes as against T37 for whom it occurred once every 1.6 minutes. A few examples will now be given from the transcripts. First, from a biology lesson:

T11(0.12) T: "To show that osmosis ... to demonstrate osmosis ... using a non-living membrane."

In this case, the teacher talks as if unsure of what words or terms to use. This may be how many people talk, but in teaching there is a need to present lessons much more fluently and effectively. Another example is as follows:

T8(0.22) T: "So at that temperature ... and that is the boiling point of water ..., you have vapour ... water vapour coming up. Is that clear?

Ps: Yes

T: When in ... in that state ... in the vapour state it comes up above the solution or above the liquid."

Also, another example is as follows:

T6(0.14) T: "If you want the sugar to dissolve quicker there is one more thing ... there is something you can do to the sugar before adding it to the water."

And the last excerpt is as follows:

T7(0.12) T: "So the bleaching action ... the bleaching action of chlorine is brought about ... by the formation ... by the formation of hypochlorous acid."

Whether these self-interruptions occurred as a natural way of talking or not, it is clear that the teachers do not realize what effects they have on their lessons.

6.15 Long and Complex Sentences/Statements (15):

In view of the fact that long and complex sentences may contain many ideas and words, and thus be difficult to comprehend, especially for pupils whose levels of thinking as well as their actual methods of processing data received through senses may differ due to both cognitive developmental levels and chronological age - experience, it is thought that long and complex sentences/statements would not readily convey meaning and understanding for the pupils. This thought derives from the work of Shayer & Adey (1981, p6) whose work has been based on the Piagetian theory on the Structure of Knowledge. In effect, there is a link between knowledge (cognition) and the mental structure of the child. As a result, the way a child thinks (processes information received) depends on some distinct stages or patterns which are dependent on the complexity of the mental structures of the pupils for instance. Hence long and complex sentences/ statements may not readily convey meaning to a pupil whose intellectual level may be functioning below an anticipated level.

To put this in perspective therefore, a long and complex sentence/statement is defined to mean a sentence or statement with 15 words or more, and having more than one explaining link. A few examples of this characteristic will now be given and examined. First from a chemistry lesson transcript:

> T8(0.25) T: "Now, em ... if you look at it, because ..., I mean when you are heating the beaker or anything or I mean ... sorry, the testtube or whatever, you will notice that the top ... at least it is common knowledge ... if you are heating it the temperature at the top will be different from the temperature at the bottom."

A second example from another chemistry lesson is as follows:

> T16(0.13) T: "The effect of concentration ... the concentration will not be effective here because if you increase ..., no matter em ... how you increase the concentration of sodium ion in solution, hydrogen will always be discharged first because of the gap between them in the electrochemical series."

Now, from the biology lessons transcripts we have the following:

> T2(0.08) T: "The word superficial means on the surface. Something that is not deep inside but something near the surface or on the

surface. So knowing this meaning now, it means that in superficial placentation the ovule and the placenta are not deeprooted inside the ovary but they are sort of near the surface."

And lastly,

T4(0.20) T: "That stimulation is being transformed into nervous impulse by the light sensitive cells and carried by the optic nerve to the cerebral cortex of the brain and the feedback is seen as real image and you see the person."

As though the complexity of the sentences were not enough the frequency of their occurrence is even more thought-provoking.

Data from the E.A.S. suggest that it occurred 128 times within the 456 minutes all 12 lessons lasted. In effect, it occurred 10.6 times within the 38 minutes the average lesson lasted. Further, this provides for one such long and complex sentence/statement to have been made once every 3.45 minutes. This situation is serious enough to be able to reduce comprehension on the part of the pupils.

A closer look at Table 6.1, reveals that the mean value of about 11 may seem insignificant if T4 is considered. Instances of use of long and complex sentences/statements occurred as many as 20 times for this lesson. In this case, one instance of this characteristic occurred every 1.65 minutes. Further, the lesson taught by T2 recorded 17 instances of use of the long and complex sentences/statements characteristic in 39 minutes, that is, one occurrence every 2.2 minutes. The most acceptable level of occurrence is with T35. For this teacher, one instance of occurrence of this characteristic occurred only every 14.5 minutes. It is an occurrence at this rate that could help in the achievement of effective explaining, and the fact that such a rate was recorded shows that it is possible to avoid using such sentences when teachers are made to become conscious of the situation.

6.16 Vague Words or Sentences (16):

As may be expected, vague words or sentences are those words/sentences used by the teachers during lessons involving explaining and describing which do not provide ready meaning to pupils. This is largely due to the fact that the teachers and pupils do not always share similar concepts. Those which the teachers have, most of the pupils do not have them. Some examples will show what vague words/sentences mean:

First, an example from a chemistry lesson:

> T37(0.04) T: "And what we want to see is how he got that proof. We want to plan why atom can neither be created nor destroyed."

Another example would clarify this the more.

> T37(0.08) T: "So John Dalton mixed atoms ... he got ... he took atom of this and atom of this, mixed two of them together. At last he found out that the amount he started was exactly the total amount he got."

These statements, are probably as vague to the reader as they must have been to the pupils. It is not possible "to plan why" something can or could not be done. What the teacher probably meant in the first example is that the class would attempt to demonstrate with an experiment that matter could neither be created nor destroyed in a reaction involving chemical changes. But as the pupils do not share similar experiences or concepts, and level of thinking, it becomes vague and incomprehensible at least, to them.

It may be asked: If it were vague and thus incomprehensible to the pupils, why don't the pupils ask questions? This is a fair challenge. But soon it will be appreciated that pupils have grown to live without questioning. This is attributable to two factors which will be discussed.

Further examples from some biology lessons transcripts will now be given:

T4(0.12) T: "So the gap between this iris is called the pupil."

T4(0.19) T: "So when this impulse is carried by the optic nerve to the cerebral cortex it interpretes it. <u>This image being focussed on the retina will make you see the actual size. Make you see the object as erect ... up right</u>."

To say the 'gap' between this iris is called the 'pupil' is vague. To describe the pupil thus suggests that other layers of the eye such as the sclerotic and choroid do not extend even in any modified forms towards the aperture called the pupil. Viewed from this perspective, it will be appreciated that the first example is rather a vague statement capable of misleading the pupils.

For the second example, it is necessary to point out that the underlined statements are vague and misleading. The image being focussed on the retina will NOT make you see the actual size. That quality lies with the cerebral cortex that does the interpretation. Beside, what is focussed on the retina is very much diminished. So there is no way what is being focussed on the retina could "make you see the actual size."

Data on Table 5.1 show that there was an occurrence of between 0 - 4 of this characteristic which is quite low, while in others occurrence is between 6 and 10 and yet for others occurrence is above 10. Interpretation of the above given in Table 6.1 indicate that this characteristic did not occur in lessons T7 and T35, which is an encouraging sign that this characteristic is capable of being minimized to achieve effective exposition. Further, this characteristic occurred once in 1.7 minutes, 2.6 minutes, 2.7 minutes, 3.4 minutes and 4.1 minutes in lessons T4, T37, T16, T14 and T22 respectively. Surely, these rates of occurrence are too frequent and therefore inhibitive of the achievement of effective exposition.

6.17 Unexplained Difficult Vocabularies and Terms (17):

These unexplained difficult vocabularies and terms are usually 'umbrella' words which are either scientific or technical and used by teachers without ensuring that they were understood by the pupils. As may have been appreciated thus far, the failure by a teacher to explain such words or terms clearly results in ambiguity and failure in comprehension of the new ideas or concepts which the teacher anticipated pupils would share with him/her. This implies that it is by clarity and simplicity in the use of such words/terms and clear explanation of difficult words or terms by the teachers that effective teaching could be achieved especially with lessons that are largely expository.

Unfortunately, quite a few such words or terms have been used by the teachers. For example, in the various biology lessons in transcripts, terms such as: diastema, wedge, resistant, unsexuality, dichogamy, self-sterility, protandry, protogyny, variation, chromosomes, genes, semi-permeable, membrane, growth-curvature, placentation, osmosis, superficial, basal, chamber, marginal, bisexual, opaque, pigment, rods, cones, refract, and many more were used. It is quite certain that most of the pupils simply heard the words/terms without being aware of their meanings or implications. Similar words/terms also occurred in the chemistry lessons. For example: Sucking-back, displacement, decomposition, affinity, reactive agent, fume, Fume chamber, solubility, neutralization, crystallization, evaporation, suspension, dissolution, sublimation, anhydrous, revert, electrolysis, discharge, tendency, electrode potential and many more.

It is realized that these words/terms cannot be understood in isolation. Yet, when they were used they were not clearly presented so as to enable pupils to appreciate their meanings. Besides, it is not enough to use them once or twice only if they are to be learned by the pupils.

Some examples of how some words/terms have been used will now be given:

T11(0.10) T: "The semi-permeable membrane here, the living semi-permeable here is the yam."

In this case pupils need to know what the nature of a membrane is, and then proceed to learning about permeability, whether semi, wholly or not at all, before they can appreciate why yam is acting as a semi-permeable membrane in that instance. So, the teacher ought to have devoted more time to clarifying what it means to be semi-permeable.

Another example is as follows:

T37(0.15) T: "This thing here stayed as precipatate. What I mean by a percipitate is: when you get something ... water, em ... may be it contains some dirts, is not clean, it is not clean water and you keep it. After some time what will happen?

P: The dirt will settle.

T: The dirt will settle on the bottom.

Ps: Bottom.

T: Yes. And so, this one will settle as a precipitate."

In this excerpt, the teacher has failed to explain to the pupils exactly what differences exist between a 'sediment' and a 'precipitate'.

Another example of the situation when words/terms which teachers took for granted were not understood is as follows:

T8(0.02) T: "Today we are going to treat the separation of components of mixtures using various techniques."

In this excerpt, the teacher probably overestimated the pupils' vocabulary levels which is a dangerous tendency.

It is clear that only a very low occurrence of this characteristic can be tolerated. But data from the E.A.S. and translated in Table 6.1 above show that a total occurrence of 28 was recorded from the 12 teachers. This gives a mean of 2.3 during the 38 minutes the average lesson lasted, that is, one occurred about every 16.3 minutes. Even so, the rate of occurrence is nought for T7, T8, and T22 which is encouraging. This implies that these teachers were cautious in their use of such words and terms, and at worst, attempted to explain those used even if not effectively.

On the otherhand, there was an occurrence rate of one every 6.5 minutes which is much more frequent in terms of occurrence than the mean rate of occurrence. On the whole 6 lessons out of 12 had occurrence rates more frequent than the mean rate of occurrence.

6.18 Wrong Use of Words and/or Terms (Misinformation) (18):

This is the situation whereby the teacher uses words or terms wrongly, leading to misinformation. Identical situations are implied in some of the characteristics already discussed. In this case, however, there is a chance that they may occur inadvertently.

It is observed that where the teachers realized an error had been committed they quickly tried to correct the impression already created. Those that were not corrected passed on wrong concepts or impressions to the pupils.

An example from a chemistry lesson transcript is as follows:

> T16(0.22) T: "Now, instead of these ones being discharged here, they will <u>walk</u> to the anode."

Misinformation of this sort ought to have been detected and corrected by the teacher but was not. And because electrons or ions do not 'walk', it begins to be seen as sheer carelessness in the use of language. Many pupils may have gone away with the impression that ions 'walk' rather than move, while a few others may have detected this unfortunate terminology and use it as a measure of the teacher's worth.

The next example represents one in which the teacher quickly realized an error had been committed and corrected it with an apology.

> T36(0.21) T: "But the copper atom ... copper atom goes into solution, loses its one electron, loses two electrons sorry, and becomes an ion."

In a situation of this sort, because a correction was made, the pupils will get the acceptable description of events.

Another example will show how teachers used words wrongly to pupils' detriment. In this example, the teacher went on and corrected the error without apologies. But it is not clear whether all the pupils realized it was a correction and not additional information.

For example:

T22(0.39) T: "You cannot leave the sulphur because you don't know the oxidation number of sulphur. Sulphur is one of the compounds ... is one of the atoms having variable oxidation numbers ... variable valency."

There was a correction of an error committed with the use of compound for sulphur without indication but the same pattern was followed when additional word - valency, was used apparently in preference to number.

In the last example, the whole concept of 'reaction' has been reduced to mixing. For example:

T37 (0.10) T: "After the whole experiment he mixed two of them and at last he got silver chloride plus nitric acid."

The fact that this teacher made similar statements several times in the course of this lesson without apparently realizing the amount of misinformation being disseminated is quite worrying.

However, data from the E.A.S. suggest that this characteristic occurred about 24 times within the 456 minutes all the lessons lasted. This allows for a mean of two instances of 'wrong use of words or terms' leading to misinformation within the 38 minutes the average lesson lasted, that is, one in every 19 minutes. This figure appears to be low as it did not occur in the five lessons taught by T2, T6, T7, T8 and T35. It occurred once in T14 within the 44 minutes the lesson lasted. But for the rest of the teachers particularly T37 whose occurrence rate was one every 4.5 minutes against a mean rate of one every 19 minutes. For other teachers, their rates are more frequent than the mean rate.

The mean rate may not appear to be large enough to cause any alarm. But when it is realized that the same teacher may teach two or three arms of a class each of which may consist of about 50 pupils, then the spread of misconception and misinformation can be appreciated. In effect, one such misinformation repeated in three classes would lead to 150 pupils being misinformed with its attendant embarrassments and failures on the part of the pupils.

6.19 Conclusion:

In conclusion, it may be necessary to point out that majority of the teachers have used the characteristics at varying rates. Whereas some teachers used a particular characteristic at a rate which may be regarded as tolerable, they used other characteristics beyond levels of tolerance. In this way, a lesson that may have achieved a degree of effectiveness, drops back following the neutralizing effects of the latter occurrence rates.

In the next chapter, the types and quality of questions asked by both the teachers and taught, will be the subject of analysis and discussion.

Chapter 7

7. QUESTIONING: WHAT TEACHERS MAKE OF IT

7.1 Introduction:

In Chapter 2 under the subsection - Effective Questioning and Science Teaching (2.5), the strategies and tactics of effective questioning in teaching have been discussed. Also, the place of timing and pausing in questioning, and prompting have been discussed. In 5.5.1 and 6.6, the characteristic 6 (Teachers' Questions) was only briefly analysed on the basis of the E.A.S. data and subsequently deferred to this chapter.

On the basis of the E.A.S. data, which as had already been pointed out, is reductionist in approach, 265 teachers' questions were recorded from the 12 lessons. 164 questions which were considered rhetorical were also recorded together with 33 pupils' questions. But data collected comprehensively from all 12 lessons transcripts indicate that a total of 749 questions were asked by the teachers. Of these 490 were considered questions as they were either followed directly by some verbal or non-verbal responses, or that the teachers paused sufficiently long to allow pupils' responses to follow even though they were not supplied. 259 of the total were classified as rhetorical questions as the teachers either did not expect responses and went on talking or they were impatient with pupils' delay in supplying answers and went on and supplied the anticipated responses.

From the data presented in Table 7.1 below it will be noticed that the average number of questions asked by each teacher is 41, while on average, the number of rhetorical questions asked stands at 22. All were within the average lesson time of 38 minutes. On these bases, one question was asked every one minute. But then, there are teachers who asked many more questions than the average during their lessons. T11 asked 72 questions and 47 rhetorical questions within the 45 minutes the lesson actually lasted. That allows for 1 question every 0.62 minutes, and almost 1 rhetorical question every minute. On the other hand, if the rhetorical questions are taken as actual questions, it would mean that this teacher (T11) asked 2.6 (or approximately 3) questions every minute. This compares very well with 100 questions per hour which Brown & Edmondson (1984, p97) estimate that teachers could ask. In contrast, 19 questions and 10 rhetorical questions were asked within 43 minutes by T16. For this teacher, one question was asked every 2.26 minutes and one rhetorical question every 4.3 minutes.

However much the number of questions a teacher may ask during lesson counts in determining the effectiveness of the teaching strategy and tactics employed, the nature and types of questions asked, as well as the level of thinking demanded by the questions count even more. There are no set standards by which questions are realistically classified. Yet, researchers have been able to establish some form of classification of questions used by the teachers. In effect, the complexities have not deterred researchers. As a result, an attempt will be made to classify the questions asked by the 12 secondary schools science teachers under study. It may be necessary to state here that the questions were asked of pupils in the classes as given below:

Class 5:	4	lessons
Class 4:	5	lessons
Class 3:	2	lessons
Class 1:	1	lesson
Total	12	(lessons)

All the questions may be referred to in the lessons. (see Appendix 5). But for the present purpose, all the questions will be pooled together as questions asked by the teachers under study.

Table 7.1

DATA OF QUESTIONS USED BY TEACHERS AND PUPILS

Teacher (Lesson)	Teachers' Questions	Questions Without Chance (Rhetorical)	Pupils' Questions	Duration of Lessons
T2	27	12	2	39 mins.
T4	40	10	18	33 "
T6	49	14	-	29 "
T7	55	48	-	45 "
T8	31	16	-	37 "
T11	72	47	7	45 "
T14	33	45	3	44 "
T16	19	10	4	43 "
T22	53	11	8	46 "
T35	36	12	2	29 "
T36	30	22	-	34 "
T37	45	12	-	32 "
Total	490	259	44	456 mins.
Mean	40.83	21.58	3.66	38 mins.
Approx. Mean	41	22	4	38 mins.

7.2 The Nature of the Questions Asked by The 12 Science Teachers:

Earlier in Chapter 2, it was pointed out that there are various ways of classifying questions. In effect, questions may be classified as: memory, informational, rhetorical, leading, and probing like Ogunniyi (1984) when he attempted to identify and describe the nature of teachers' verbal behaviour (including the types of questions asked by the science teachers who constituted his sample). Also, questions may be classified in terms of the mode of delivery such as threatening, neutral, or encouraging, or they may be based on target, whether to particular individuals, groups or the whole class. Questions may also be classified according to their degree of clarity, or according to the type of question asked, whether it is primarily cognitive, affective, or procedural. Further, questions may be classified (Barnes, 1969) by the categories: factual, reasoning, open but not reasoning, and social including control.

However, the most widely adopted system of classification stems from Bloom's Taxonomy of Educational Objectives (1956). Bloom's Taxonomy provides for six levels which require a response that uses a different kind of thought process. These six levels are: Knowledge (Recall), Comprehension, Application, Analysis, Synthesis, and Evaluation. However, there is a suggestion implicit in the direct application of this system of classification. It is that it is possible from the type of responses given by the pupils to determine the level of thinking demanded by the question. This may not be a wholly acceptable presumption as pupils more often than not misconstrue or even mis-read and misunderstand questions. This was identified in the West African Examinations Council's Chief Examiners' Annual Report (1982) as a major factor responsible for pupils' weak performances and failure in the examinations conducted by the council.

From the responses of pupils, some insight about what teachers require may of course, be deduced. Yet, it is frequently asserted that before ever questions are asked teachers will have determined the level of thinking required of the pupils. But in actual practice, especially in Nigerian schools, this presumption does not appear to hold in view of the constant modification of questions which may have become habitual. For example:

T6(0.15) T: "Now, as a scientist when you say hot water, what strikes you at the back? What is that main thing that is there? Yes!, when you say hot water, what are you really talking about?

P: Very hot water.

T: What about water?

P: The temperature of the water.

T: Is the degree of hotness of that water which we normally call it the temperature of that water."

In this excerpt of classroom Teacher-pupil dialogue, the teacher appears to require the mention of the word 'temperature' but fails to devise a straight forward question that could have a direct and effective impact on the pupils to supply the right answer. This situation is observable in almost all lessons transcribed for this study.

The above seems to confirm the suggestion that cultural influences impinge on Nigerian teachers' strategies and tactics of teaching and questioning. It is largely for this reason that a more practical mode of classification of teachers' questions is contemplated in this section. The cultural influence derives from the Nigerian languages and background to which both teachers and taught are part. Thus, questions for example, do not always conform strictly with the strategies and tactics of questioning a British or an American teacher would adopt. For example, whereas a British teacher might say:

T: All I want to know is: What you can observe?

the Nigerian teacher asked:

T6(0.19) T: "All I am asking from you is what are you seeing?"

and obtained the following response:

P: "The sand is at the bottom while the water is at the top of the sand."

This teacher's question suggests a verbatim translation from some Nigerian languages. Otherwise, it would have been a lot more direct.

7.2.1 A Description of the Categories Used in the Classification of The Questions:

In spite of the complexities of classifying questions, the 490 questions asked by the 12 science teachers will be classified and the following categories will be employed: Comprehension/Recall, Application, Observational, Analysis/Reasoning, Leading (Suggestive), Management (Social and Class Control) and Evaluation.

1. COMPREHENSION/RECALL QUESTIONS

These questions would have terms such as: What, Name, Define, List etc. As a result, they will require pupils to recall facts and principles already acquired after understanding the question.

2. APPLICATION QUESTIONS

Application based questions require pupils to supply answers or responses which should show ability to apply knowledge already acquired. Application questions therefore would use terms such as: Classify, Apply, Employ, Use, Solve etc.

3. OBSERVATIONAL QUESTIONS

Observational questions require pupils to give answers or responses based on some form of observation of diagrams, demonstration experiments set up, or some related concrete objects. As a result these questions employ terms or phrases such as: Do you see ...?, Can you notice, feel, taste, etc ...?

4. ANALYSIS/REASONING QUESTIONS

Questions based on analysis/reasoning employ words/terms such as: Why, Analyse, Deduce, Infer etc. As well, they require pupils to supply answers or responses which show logical thinking yet based on facts and principles.

5. LEADING (SUGGESTIVE) QUESTIONS

Leading questions generally tend to lead pupils towards a particular answer or response. In effect, they require pupils to provide single word or sometimes longer responses as they appear to be objective in context. Pupils are sometimes led by the questions to make guesses even where they are unsure or ignorant.

This category of questions is based on such examples: Is it short sight or long sight? Which colour - red or green do we require?

6. MANAGEMENT (SOCIAL AND CLASS CONTROL) QUESTIONS

Questions in this classification are generally social, and tend to be aimed at directing pupils' attention to the lesson.

7. EVALUATION QUESTIONS

Evaluation questions require pupils to assess a situation and/or statements or facts or principles which are either judgemental and contentious in general context. Terms like: Judge, Assess, Justify, Evaluate etc are very much associated with evaluation based questions.

The following chart provides a summary of the seven (7) categories used to classify the teachers' questions with some examples.

Chart 7.1

Summary of Mode of Categorization of Teachers' Questions:

Categories of Questions and some Key Words	Level of Thinking Anticipated by Teachers	Some Examples of Questions from Lesson Transcripts
1. COMPREHENSION/RECALL What, Name, Define, Describe, Who etc.	Recall of facts. Definitions giving descriptions. Stating main ideas. Compare and contrast. Describing and Interpreting.	1. Who remembers how we prepared sodium chloride? 2. What structure surrounds the pulp cavity? 3. So who can try to define the term pollination? 4. How does chlorine bleach litmus paper?
2. APPLICATION Classify, Apply Solve, Use, Employ,	Applying rules, techniques to solve problems having a single correct answer.	1. So, in this case can we call it a solution ... a uniform solution? 2. You have Plus 1 here, Plus 1 here making what? 3. What do you think was happening?
3. OBSERVATIONAL (IDENTIFYING AND LOCATING) Which, Where, Are you seeing.	Stating observations, confirming observations, identifying things with known criteria.	1. In which of these cases does the sugar dissolve quicker? 2. Which one do you regard as the membrane here? 3. Now, in these two solutions here, salt and water, which one do you think is higher in concentration and which one is lower?

Cont'd.

4. ANALYSIS/REASONING Why, Analyse, Deduce, Infer, What Factors? etc.	Identifying motives or causes, making inference, finding evidence to support generalizations.	1. Who knows why it should be dipped into water first? 2. Why are we placing it in a dark cupboard? 3. But why do you want to use the method of distillation?
5. LEADING(SUGGESTIVE) Will you ..., Is it ..., etc.	Giving specific answers. They are led to through questioning: To confirm with few words.	1. Is it the living part or the non-living part of the cell? 2. So this movement now, is it positive or negative response? 3. You mean you will throw away the sulphur?
6. MANAGEMENT(SOCIAL AND CLASS CONTROL) Is that clear? Can you ... . What is the problem? etc.	Confirming facts. Reassuring teacher that they are following. Giving answers which sooth classroom tempo.	1. Are you following up? 2. Do you understand what I am saying? 3. Is now you are coming to the classroom? 4. Do you have any questions?
7. EVALUATION Judge, Assess, Decide, Justify, What in your opinion ...? etc.	Giving opinion on issues. Judging the validity of ideas and merit of solutions to problems.	1. Is it correct? 2. Yes, what is wrong with the diagram on the board? 3. Is there any person having any other alternative view?

7.3 Result of Classification of Questions:

Having put the categorization in perspective, this author went on and classified the questions asked by all 12 science teachers.

As Table 7.2 below shows, a total of 490 questions were classified into the main 7 categories (see Chart 7.1) but not without difficulties. Some of the questions are single word questions such as: This?, Here?, What?, etc, which were classified on the bases of the trend of lesson and pupils' responses after taking cognizance of the levels of thinking required.

7.4 Strategies and Tactics of Questioning Employed by The Teachers and Pupils:

Following the E.A.S. analysis of both teachers' and pupils' questions, a comprehensive analysis was undertaken of the types of questions asked by the teachers, the strategies and tactics employed, and cognitive demands made by the questions. Also the drawbacks inherent in the questioning strategies and tactics used by the teachers was also mooted.

In this section, more of the above will be discussed under the following subheadings: Number and types of Teachers' Questions and Pupils' Questions and Teachers' Responses to them.

Table 7.2

TEACHERS' QUESTIONS: TYPES AND PERCENTAGE PROPORTIONS

Categories	1		2		3		4		5		6		7		Total Number of Questions
Teachers	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	
T2	21	77.7	1	3.70	-	-	-	-	1	3.70	4	14.81	-	-	27
T4	16	40.0	5	12.50	12	30.0	2	5.0	3	7.50	2	5.0	-	-	40
T6	21	42.85	5	10.20	11	22.25	6	12.25	5	10.20	1	2.04	-	-	49
T7	22	40.0	-	-	1	1.82	3	5.46	19	34.54	8	14.55	2	3.64	55
T8	4	12.90	-	-	7	22.58	1	3.23	5	16.13	14	45.16	-	-	31
T11	21	29.17	2	2.78	15	20.83	6	8.33	15	20.83	12	16.67	1	1.39	72
T14	8	24.24	4	12.12	2	6.06	2	6.06	8	24.24	9	27.27	-	-	33
T16	6	31.58	-	-	2	10.53	2	10.53	4	21.05	5	26.31	-	-	19
T22	17	32.08	14	26.45	1	1.89	1	1.89	10	18.87	9	16.98	1	1.89	53
T35	28	77.8	-	-	-	-	2	5.56	4	11.1	2	5.56	-	-	36
T36	17	56.67	1	3.33	-	-	2	6.67	2	6.67	8	26.67	-	-	30
T37	28	62.2	2	4.44	-	-	2	4.44	8	17.78	5	11.1	-	-	45
Total	209		34		51		29		84		79		4		490
Mean	17.42		2.83		4.25		2.42		7		6.58		0.33		
Percentage	42.65		6.94		10.41		5.91		17.14		16.12		0.82		

7.4.1 Number and Types of Teachers' Questions:

So far, it has become clear that all 12 science teachers appear to recognize the value of questioning during teaching especially when the strategies and tactics being employed centre on exposition. This assumption is based on the number of questions asked by the teachers collectively. This number has been given as 490 for the teachers and just 44 by the pupils. Also, the teachers used 259 rhetorical questions.

However, it is not so much the number of questions asked that matters but the types and the levels of thinking demanded by such questions. Somehow, it is possible to establish the levels of thinking demanded from the pupils from the types of questions asked by the teachers. On this basis, therefore, a teacher who based most of his/her questions on fact recall may be attempting to develop pupils' abilities to recall facts and principles. A teacher who based questions on application may be attempting to develop pupils' abilities to apply facts and principles to problem-solving. On the other hand, a teacher who based questions on the category, Observational, may be attempting to improve the pupils' abilities to make observations of some kind. Yet, it is acceptable that no teacher knowingly concentrates on one type of question at the exclusion of others all things being equal.

<u>Comprehension/Recall Questions</u>

From the table above, it will be noticed that almost 43 per cent of all questions are based on the Comprehension/ Recall category. What this suggests is that all the teachers asked questions which demand from pupils the mere recalling of facts and principles.

Some examples of this category based questions are as follows:

T2(0.14) T: "So, who can try to define the term pollination?

P: It is the transfer of the pollen grains from the anthers to the stigma."

T4(0.09) T: "What is the shape of the lens?

P: Round.

P: Oval."

T6(2.27) T: "What is a solvent?

P: A solvent is a substance which can dissolve a solute."

T7(0.33) T: "What are the other properties of hydrochloric acid?

P: It turns blue litmus red."

T8(0.31) T: "I want you to tell me what method you will like to use to separate the two components out from the mixture?"

P: You will use the method of distillation."

T11(0.33) T: "What actually did you tie at the mouth of the thistle funnel?

P: Is the cellophane paper."

T14(0.13) T: "What is geotropism?

P: Response to gravitation."

T16(0.14) T: "I said, what are the ions present in copper chloride?

P: Cu^{2+} and $2CL^{-}$."

In fact, all the teachers asked Comprehension/Recall based questions, the lowest recorded being 12.90 per cent of this type of question, while others ranged from 24.24 to 77.8 per cent of all their questions. (see Table 7.2).

Almost all the teachers devoted large amounts of their time to asking questions which appear to be of no major intellectual significance, in view of the fact that the levels of thinking demanded by these questions centre on recall of facts and giving of definitions, and do probably little more. There is no suggestion that teachers should stop asking questions based on this category. Rather, that an attempt be made to ensure a balance in the types of questions being employed. Not to do that, as it has been, will be to continue to deprive pupils of some major intellectual interaction processes.

Leading (Suggestive) Questions

The next category of questions in terms of use is the category of Leading (Suggestive) questions. Generally, the questions classified under this category are of less intellectual value than the Comprehension/Recall category. This is because they suggest answers, and at some point may even present two alternative answers in course of the question. This almost automatically provides the pupils with the cue to the answers.

Some examples of questions classified as Leading (Suggestive) are as follows:

T22(0.39) T: "You mean you will throw away the sulphur? (Tone was important)

P: No."

T35(0.19) T: "Is it the living part or the non-living part of the cell?

P: The living part of the cell."

T4(0.14) T: "Now, we know that light travels in a straight line. Is that correct?

Ps: Yes."

T11(0.31) T: "What when you pour salt solution inside the thistle funnel, won't it pour away?

P: You will hold the ... you take the retort stand to hold the thistle funnel."

T7(0.15) T: "You don't understand it or you didn't hear what I said?

P: I didn't hear."

T7(0.30) T: "What did you say ... you say it is ...?

P: Forms salt and water."

From Table 7.2, this category of questions had the second largest use with 84 questions in all. As pointed out earlier, this category of questions are of less intellectual value than the Comprehension/Recall questions. That being so, one wonders why these teachers have employed them as much. One possible explanation could be, as had already been pointed out, that the teachers may not possess the necessary skills for asking questions in order to achieve objectives that are of intellectual value. This suggestion is supported by already cited situations arising from this study in which teachers' questions became modified each time from the very first question to the last before a response by pupils followed. This shows that the teachers apparently decide, most of the times, to ask questions almost by whim without really thinking of the nature of the question, and the strategy and tactic to employ in order to achieve a direct impact on the pupils so as to achieve results.

Two examples will now be given to elucidate this constant modification of questions arising from failure by teachers to think about the questions before asking.

T6(0.15) T: "Now, as a scientist when you say hot water, what strikes you at the back? What is that main thing that is there? Yes, when you say hot water, what are you really talking about?

P: Very hot water

T: What about water?"

In this case, the teacher appeared to be unsure of what the question should be and what answers to therefore expect. The last question goes to support the fact that the teacher decided to ask a question by whim having not thought about it, and ended up with four questions still without the desired answer. The second example is as follows:

T7(0.31) T: "What do you mean by alkaline? No idea! Does anybody know? Do you know what alkaline metals are? You don't know? So you don't know too what alkaline are? You don't know? Yes, yes, what are alkaline metals?

P: They are ones that are soluable in water.

T: What are they? I am not asking you their properties. Don't you think this is an alkaline? This is an alkaline metal."

This excerpt shows how some teachers cause the failure of pupils through their own faulty questioning strategies and tactics. This teacher asked a few questions which were not responded to until the one: "Yes, yes, what are alkaline metals?" Then a pupil responded, almost correctly by implication, to the particular question saying "They are ones that are soluble in water." This, the teacher dismissed and claimed she did not ask for the properties. Clearly "What are alkaline metals?" does not call for listing their names as such. It requires a definition of what they are which certainly centres on their properties. At that level of questioning, one wonders whether any pupils could have given the teacher what she had in mind if definition was not good enough.

Management (Social and Class Control)

The third largest occurring category of questions is that classified as Management (Social and Class Control). There were 79 such questions and constituting 16.12 per cent of all the questions asked. Like the above category, this is also not of much intellectual value. This is because they merely seek to keep the class under some control to enable the lesson to progress. Also, some of them seek to invite pupils to give teacher their attention in regard to following the progress of the lesson. Thus, the following examples:

T2(0.02) T: "How many of you read it?

Ps: (Raise of hands)."

T2(0.09) T: "Do you understand what I mean?

Ps: Yes ma."

T14(0.31) T: "Can you see from the place?

Ps: Yes."

T11(0.24) T: "Do you understand?

Ps: No."

T36(0.03) T: "Is that clear?

Ps: Yes."

From the above examples, the reader will appreciate why this category of questions is considered to be of low intellectual value.

Evaluation Questions

On the other hand, the categories of questions which are of much higher intellectual value such as: Analysis/ Reasoning (4), Evaluation (7), and Application (2) have had very low uses. While Analysis/reasoning had a total occurrence of 29 (5.91%), and Application 34 (6.94%), Evaluation had just 4 (0.82%). This again shows how deficient the strategies and tactics of questioning employed by the teachers have been.

The following are the 4 questions which required the pupils to evaluate a situation or an idea or even a written contribution on the board.

T11(0.09) T: "Is there any person having any other alternative view?

P: Yes

T: Yes tell us! What is your own semi-permeable membrane?"

T7(0.35) T: "Is it correct?

Ps: No."

T7(0.36) T: "Is it correct?

Ps: Yes."

T22(0.44) T: "Is it correct?

Ps: Yes."

The ability to evaluate a situation, an idea and some other forms of contributions appears to be an important skill. Yet it needs development like all others which are essential to learning. Viewed from this perspective, one wonders why most teachers in this sample, failed to appreciate that this attribute needs development through classroom interaction processes.

Observational (Identifying/Locating)

The category labelled Observational (Identifying/Locating) had a moderate use. It had 51 occurrences which accounts for 10.41 per cent. Questions within this category are capable of being confused with other categories, especially that of Evaluation. The temptation becomes even greater where the reader was not present in the lesson and relies upon the audio-recorded lessons from which the transcripts were made.

For example:

T11(0.26) T: "Do you see any correction there?

P: Water."

In this example, it would have been possible to classify it as an evaluation question. But in view of the fact that the question was merely intended to enable pupils to locate the letter 't' which was not crossed by the pupil on the board thus giving the spelling "waler" makes it possible to be classified as an observational question. Other observational questions are as follows:

T4(0.08) T: "Do you see the optic nerve?

Ps: Yes."

In this case, it was aimed at prompting the pupils to note from the diagram on the board, how the optic nerve runs towards the brain sketched at one corner of the chalkboard.

Questions classified under this category have some intellectual value as it enables pupils to develop and improve on their observational skills. But not as much as the category, Analysis/Reasoning.

Analysis/Reasoning Questions

This category has an occurrence figure of 29. This constitutes 5.91 per cent of all the questions. As with the last category discussed, there is the temptation to classify questions which are either of Application, Comprehension/Recall, Evaluation or Leading (Suggestive) as coming under Analysis/Reasoning. This is because in one form or the other, all the five listed require some processing of knowledge (previous) to supply response. Yet there are clear distinguishing features between them as the following examples will show.

T6(0.18) T: "Now, do you think all solids will dissolve in water as sugar has done?

Ps: No."

T7(0.11) T: "Who knows why it should be dipped into the water first?

P: So that it can react with the water."

T11(0.08) T: "Amongst these two materials here which one do you think is regarded as semi-permeable membrane?

P: I don't know."

From these excerpts, it would be appreciated that to be able to give an answer would suggest that the pupils may have processed the necessary information adequately by their intellectual standards, to be able to give the answers. In the last question however, the pupil could not give an answer because she failed to successfully process the question.

Even so, that this category had an occurrence of just 29, suggests that teachers either do not possess the necessary skills to ask questions classified under this category, or it may be attributed to some belief that young pupils do not need to bother their heads thinking, which is clearly idiosyncratic of the old.

Application Questions

The last category for discussion is the Application based one. This is the third least employed category of questions by the teachers. This category of questions, as had already been pointed out, could be confused for Comprehension/Recall or Analysis/Reasoning questions. This is because, to be able to apply, the knowledge must be present while some degree of Analysis/Reasoning in the way of information processing is required.

Yet application-based questions are clearly identifiable from the questioning strategies and tactics employed and, not least, from the pupils' responses. The following examples will help to elucidate what has been discussed thus far about application based questions:

T14(0.31) T: "Em ... how will it grow if this is the shoot?

P: Turn itself."

T22(0.14) T: "What is the oxidation number of it?

P: Minus eight (-8)

T: What is the oxidation number?

P: Plus two (+2)."

T6(0.07) T: "In the industry, what do we use this water for?

P: Cooling of Industrial Instruments."

T4(0.16) T: "And getting to the lens, what happens too?

P: It will refract."

The questions above generally caused pupils to reflect on the knowledge they already had in order to provide the required answers. Even though, the pupils' answers are not explicit, they give the impression that they have applied knowledge they already had to get at the answers.

Unfortunately, as with other categories of higher intellectual value it has had a low occurrence. Four teachers failed to apply it while the rest employed it very rarely. For this reason, it may be suggested that the few recorded from some teachers occurred by chance. The high level of use in lesson T22 is due to the nature of the lesson that was taught - Deriving and Applying a formula for naming chemical compounds.

7.5 Pupils' Questions and Teachers' Responses to Them:

As a follow up to the issue of lack of encouragement by teachers for pupils in order to ask questions, a further analysis of pupils' questions was undertaken.

Data from the E.A.S. given in Table 5.1, give the number of pupils' questions as 33. On the basis of a comprehensive analysis of the 12 lessons transcripts, the total number of questions asked by all the 432 pupils who were involved in the twelve lessons recorded, came up to 44

(Table 7.1). Even so, this does not represent an effective involvement on the part of the pupils. It must be pointed out also, that the 44 questions were asked by pupils in 7 out of the 12 classes recorded for this particular analysis. In effect, no pupils' questions occurred in 5 of the 12 classes, taught by T6, T7, T8, T36, and T37.

Generally, the rate of occurrence of pupils' questions as recorded in this study is low by any known standards. All it has shown is the level of teachers' insensitivity towards encouraging pupils to participate in the lessons irrespective of the teaching styles being employed. Whereas, the pupils are not particularly being encouraged to ask questions to clear whatever doubts they may have, the teachers overwhelm them with questions at a ratio of 1:11 and 1:17 including the rhetorical questions.

While the failure by pupils to ask a sufficient number of questions is largely being attributed to the lack of encouragement by the teachers, it is necessary to ask why this should be so. Or could it be that the teachers deliberately behave in ways that tend to minimize pupils' questions?

7.5.1 Cultural Effects on Pupils' Questions:

As was claimed in Chapter 1 especially (1.1.5), cultural effects play a role in the perspectives of peoples. This is carried into classrooms where both teachers and taught act out their various parts as members of that culture. The Nigerian culture is as diverse and complex as its peoples. Even so, there is one aspect of Nigerian culture which is common to all linguistic groups of Nigeria, and that is respect for the elders. The elders are never blamed for mistakes and their authority never questioned. It is this aspect of the Nigerian culture that is transplanted into the classrooms. In the classroom, the teacher is invariably the elder, the age notwithstanding. As a result, whatever the teacher says is accepted. Not to accept would amount to challenging a teacher's authority, and school authorities do not take kindly to such situations which they describe as 'insubordination' on the part of the pupils.

This culturally imbibed characteristic is clearly evident in schools as pupils are too much in awe to ask questions and teachers fail to encourage them to do so. Although some teachers do call on pupils to ask questions, the general attitude has never been favourable.

Teachers have been known to display almost hostile attitudes towards pupils' questions, but this was not observed by this author. Even so, this author's presence is not sufficient reason for the status quo to change to the point that many more pupils should summon up courage to ask questions to clear their doubts. In the same way, the teachers appear to develop cold shoulders to the few pupils' questions by way of returning question for question, or encouraging other pupils to answer the questions. This latter strategy humiliates pupils and is not always a suitable one in the Nigerian situation to employ.

Even so, a critical study of the pupils' questions reveals that they are much more probing than the questions asked by the teachers. Some examples of pupils' questions and the responses given by the teachers will now be given.

T4(0.26) P: "What will happen to the eye if there is lack of sugar and protein in the aqueous and vitreous humour?

T: Do you know that the eye is functioning constantly? And it needs energy, do you know? That is what ... why it is being supplied with it."

In the case of the teacher's response to the pupil's question, it is easy to discover its weaknesses. It did not answer the question in the best interest of the pupils. The answer is rather implied. Hence, this author supposes that pupils who looked forward to a simple logical answer as to what may happen to the eye, left the class disappointed. The question was quite straight forward - "What will happen to the eye ...?" But the teacher failed to deal with the crunch of the question.

Another example is as follows:

T35(0.24) P: "My question is: from which part of the plant cell does the cell ... the cell have its food?

T: Now the ... the plant ... you know that the plant contains chlorophyll. You can see that ... you can still see it from the diagram ... . The chlorophyll are inside the protoplasm and with this chlorophyll, the plants are able to make use of energy ... energy from the sun and produce food. It's this food produced during photosynthesis that the ... em ... that the plant take in."

In this example, the pupil's question touches on an area not previously explained by the teacher. Thus, the teacher is compelled to attempt an explanation which is generalized on plants. This does not satisfy the implications of the pupil's question.

It is thought that the generally probing nature of the pupils' questions prompt teachers generally to be either evasive to the pupils' questions or discourage pupils' questions either wittingly or unwittingly. This could be done in various ways. One such way could be to evade the question completely and ask the pupils to 'sit down' as often noticed in some classes. Although, this did not occur during this author's period of observation, it is highly likely that this author's presence prevented such incidents from occurring.

One other method which was used by some teachers in this sample was to ask a counter question. For example:

T2(0.33) P: "What is an example of a bisexual flower?

T: Give me an example of a bisexual flower?"

Another similar example is as follows:

T22(0.35) P: "Why is it that that sodium nitrite, we do say sodium nitrite (v)?

T: Sodium what?"

In the next example of a pupil's question to follow, the teacher attempts to evade the question with a counter question. But then went on probably on becoming conscious of the fact that this author was in the class, and provided an answer as follows:

T2(0.32) P: "Excuse me Ma! Are the flowers from the same plant?

T: What is cross-pollination? They are on different plants of the same kind."

On the whole, 14 pupils' questions out of the 44 (or 31.8%) were answered by the teachers with some form of counter ques tions first before the deserved responses were given as the above example shows.

Another noticeable trend is that most of the teachers' responses to the pupils' questions have been inadequate and border on dismissal of the questions. This is so as most of the answers are insufficiently clear to resolve the pupils' doubts. For example:

T14(0.28) P: "Excuse me, what is positive geotropic movement?

T: Positive ... This one that you've seen."

Similar situations occur in many classes/lessons and are not peculiar to this study alone. These teachers' responses amount to saying 'Go and find out what it means' in each case. This is because the responses have been generally inadequate, brief and often implicit thus making it difficult for the pupils to appreciate the value of asking questions.

7.6 Conclusion:

On these grounds, therefore, it has become possible to suggest that the teachers strategies and tactics, and styles are not beneficial and encouraging to the pupils, while, the teachers' responses to the few pupils' questions could be described as not being motivating. The implications of this attitude to pupils' questions over many years would be the continued reduction in the number of questions pupils could genuinely have asked the teachers. Instead, now they have appeared to be pupils who lack the courage and zeal to ask questions.

It is therefore ironical that many teachers should request pupils to ask questions openly but covertly and wittingly dissuading them from asking questions through various tactics.

Chapter 8

8. SUMMARY, IMPLICATIONS OF FINDINGS FOR THE TEACHING OF SCIENCE IN NIGERIAN SCHOOLS, TEACHER EDUCATION CURRICULUM AND CONCLUSION

8.1 Introduction:

This study has been in two parts. In the first part, the Science Teaching Observation Schedule (STOS) was employed to authenticate earlier studies which suggest that science teaching in Nigerian schools is largely didactic, theoretical, teacher-dominated and above all, expository. The second part was aimed at determining the level of effectiveness of these largely expository lessons using some internal criteria constituted into an instrument: the Explanation Appraisal Schedule (EAS).

8.2 Summary of S.T.O.S. Findings:

Evidence from previous research confirmed by this study on the basis of the Science Teaching Observation Schedule (STOS) has shown that the teaching of science in Nigerian Secondary Schools is primarily expository in nature. Practical work, that is, class practicals and teacher demonstrations, and higher-order intellectual transactions based on formulating and testing of hypothesis, solving of problems and interpretation of data have been very limited in their use. Even so, four main teacher groups representing four instructional strategies and tactics (Styles) have been distinguished on the basis on their use of the 23 STOS categories. The fourth group is however found to consist of lessons coded from transcripts rather than insitu, which may suggest that the method is more sensitive to variations in style, but this should not conceal the fact that the predominant characteristic of all the groups is the teachers' exposition of facts and principles.

On the whole, the distinguishing features reside in a few areas which suggests that the teachers have more in common in teaching than they are different. Most prominent among those common features is the use of the b1 category: teacher makes statements of fact and principle. All the teachers employed this category much more extensively than any other STOS category. The four main types of teaching strategies and tactics used in the lessons have been labelled as Clusters (Styles) 1, 2, 3, and 4.

Cluster (Style) 1, Number = 13

This Cluster (Style) 1 represents lessons taught by teachers who made use of b1 category of teachers' statements of fact and principle, almost to the utter exclusion of other categories. This signifies that these teachers have a very limited range of strategies and tactics of science teaching.

Their lessons are thus taught in a didactic, factual, teacher-directed and authoritarian manner with the strategies and tactics limited to exposition, explaining and describing. This is clearly the traditional, informative method of teaching adopted by teachers in many Nigerian schools.

Cluster (Style) 2, Number = 21

This group represents teachers who employed the b1 category as much as the first group, but in addition, asked many questions which pupils answered by recalling facts and principles, (a1). This cluster thus has the highest occurrence rate for a1 category compared with other groups.

Thus, there was a high incidence of questions and answers centred around fact recall with the initiative being held by the teachers. By the same token, the teachers' questions failed to evoke higher-order intellectual interactions. The above implies that these lessons also were factual, teacher-directed, informative and hence expository but with a greater attempt to involve the pupils.

Cluster (Style) 3, Number = 9

This group has the smallest membership of all the clusters and represents teachers who taught their lessons with visible interest in the practical aspects of science but did not necessarily change from the expository strategies and tactics. This arises from the high incidence of statements of experimental procedure, b4, in addition to the high use of the b1 category.

The use of the b4 category equally distinguished the chemistry teachers from both the biology and integrated science teachers as 66.7 per cent of members of this cluster taught chemistry lessons, that is, 6 out of the 9 as Table 4.10b shows in Chapter 4.

Nonetheless, the lessons were primarily didactic, theoretical, factual and expository.

Cluster (Style) 4, Number = 11

This group represents lessons taught using a more diversified strategem and tactics. In addition to the high use of the b1 category of teachers' statements of fact and principle, a number of other categories occurred appreciably. Prominent among them are the b2 category (statements of problems), b3 category (statements of hypothesis or speculation) and the c1 category of teacher directs pupils to sources of information for the purpose of acquiring or confirming facts or principles.

These three categories are the main distinguishing features for this cluster of teachers. By the same token, they also identify their teaching strategies and tactics as being expository, and didactic even though they are able to put across to their pupils a rather more scientific view of science. The comparatively high use of the c1 category suggests that it has been used to forestall pupils' questions by directing them to sources of information for the purpose of acquiring or confirming facts or principles, even when the teachers knew that the pupils would not be able to do so owing to non-availability or inaccessibility of the reference books.

Generally therefore, we have further confirmation that science teaching in Nigerian Secondary Schools is didactic, theoretical, teacher-directed and expository with limited use of practical work, which is mainly teacher demonstration. Invariably, most higher-order intellectual transactions such as formulating and testing of hypotheses, interpretation of data and problem-solving are very infrequently used during science lessons.

This confirms reports in earlier studies by Ugwu (1980) and Ajeyalemi (1981) about the nature of intellectual transactions in science lessons in some States in Nigeria.

8.3 Summary of E.A.S. Findings:

A further attempt aimed at analysing science lessons and evaluating the quality of the largely expository science teaching using internal criteria, resulted in the development of The Explanation Appraisal Schedule (E.A.S.). In the process of developing the E.A.S., it was considered that the effectiveness of expository teaching could be judged on the basis of the presence in such lessons of some characteristics which have either positive or negative effects.

Thus the E.A.S. consists of 18 characteristics of which the first nine are pedagogic and the remaining nine, expository. Of the pedagogic categories three define the structual features of a lesson, the next two are content-related and the other four are interactional. The second batch of nine characteristics are expositional as they consist of tactics which, in terms of style, are instinctive as against the pedagogic categories with an element of choice.

Following the analysis of the 12 science lessons from transcripts, the data obtained was subjected to cluster analysis which produced two main clusters of teachers. Their clearly contrasting delivery rates and use of the E.A.S. characteristics earned Cluster X, the term 'SOFT-PEDALLING' and Cluster Y, 'FAST-PEDALLING'. Whereas Cluster Y teachers used most of the characteristics more frequently than Cluster X teachers, it remains true that teachers of both clusters used the negative characteristics that is, most of the expository features which were identified in their negative form very frequently.

Although there is variation in use of the characteristics at individual level, collectively members of both clusters used the characteristics: Unnecessary Repetitions (11), Discontinuities in Theme (13), Self Interruptions and Unfinished Sentences (14), Long and Complex Sentences/Statements (15), and Vague Words or Sentences (16), very much more frequently than was originally judged to be desirable in order to achieve effective exposition. Even so, a few other characteristics had occurrences which were as initially judged to be necessary to achieve effectiveness in teaching including exposition. These include: Clear Introduction (1), Clear Orientation (2), Teachers Questions (6) and Main Ideas Paraphrased, Rephrased and/or Restated (10). That is to say, characteristics 1 and 2 had moderate occurrences as required, and 6 and 10 had high occurrences also as anticipated in order to achieve effective exposition.

However, the level and rates of occurrence of the negative characteristics and the failure of some positive characteristics to occur at rates or levels initially judged to be desirable swayed the balance towards ineffective teaching or exposition. By the same token, the negative characteristics of Cluster Y are associated with a high occurrence of orientation statements (2) and progressive summaries (3) thus confirming the general picture of incoherence evident in Cluster Y by their high occurrence.

One other outcome of this analysis which distinguishes

Cluster X from Cluster Y is the association of pupils' questions (9) with Cluster Y. They occurred almost ten times as frequently as in Cluster X and occurs in response to the generally more confused exposition of Cluster Y teachers. This makes it difficult to consider the higher occurrence of pupils' questions (9) as with Cluster Y as satisfying the deliberate stimulation of pupils to ask questions as a teaching strategy.

The number and types of questions asked by the 12 science teachers failed to differentiate the clusters as occurrence is almost identical in the two clusters. Collectively, the teachers asked 490 questions. Of these, it was found that almost 43 per cent (or 209) is based on the category designated as Comprehension/Recall. This was followed by Leading (Suggestive) questions with 17 per cent, Management (Social and Class Control) with 16 per cent and Observational (Identifying/Locating) with 10 per cent. Clearly these are the less intellectually demanding categories of questions.

The more intellectually demanding categories based on: Application, Analysis/Reasoning, and Evaluation had occurrence which in percentage terms are 6.9, 5.9 and 0.82 respectively. These rates of occurrence are presumably too low to help develop the pupils' cognitive interactional abilities, while in general terms the spread is too disproportionate to achieve effective teaching including exposition. Yet, there is variation at individual teacher's level with the individual teachers asking between 12.9 and 77 per cent Comprehension/Recall questions.

On the part of pupils, they were not encouraged to ask questions. Teachers employed various tactics to discourage pupils from asking questions. This is in addition to the culturally derived thinking which dissuades young pupils from asking questions and extends to the classrooms. Even where the pupils asked questions, it was found that the teachers did more to evade them than they did to answer them satisfactorily.

On the strength of all the evidence, it becomes difficult to consider these largely expository lessons as effective.

8.4 The Relationship Between The Findings of The S.T.O.S. and The E.A.S.:

Contextually, the Science Teaching Observation Schedule (S.T.O.S.) and the Explanation Appraisal Schedule (E.A.S.) were supposed, by design and structure, to serve different but not wholly unrelated purposes. Whereas by means of the STOS information regarding the nature of intellectual transactions especially between teacher and taught, and pupil and pupil were to be obtained, the E.A.S. was to enable this study to determine (or evaluate) the effectiveness of the expository (explanatory and descriptive) strategies and tactics adopted by the science teachers.

In effect, after the STOS had provided information regarding the nature of intellectual transactions during science lessons, which confirmed a high degree of expository teaching, the E.A.S. was used to evaluate the effectiveness of the exposition using the internal criteria which constitute its characteristics.

There appears to be a great deal of similarity or relationship in their respective findings, though they retain their distinguishing features. These similarities will be considered on the following bases: Level of Involvement in Lessons by both Teachers and Pupils, Level of Involvement in Questioning by both Teachers and Pupils and General Effectiveness.

8.4.1 Level of Involvement in Lessons by Both Teachers and Pupils:

From all that has been deduced so far, a general profile of the levels of involvement in the lessons by both the teachers and pupils can be built up. While there are few instances of science teaching in secondary schools requiring the employment of strategies and tactics in which pupils will dominate lessons, no matter how pupil-centred it may be, and whereas teachers have always dominated lessons, there is now sufficient evidence, especially from this study, of teachers dominating the lessons beyond acceptable levels. Whereas education involves the teacher and the taught, there are clear levels of participation expected from each side in the complex process of intellectual engagements resulting in pupils learning and teachers achieving effectiveness in teaching.

But when one side of this doublepronged enterprise is subdued by the other, then the entire process becomes overwhelmed and unworthy of being what it was thought to be - the enterprise of bargaining between teacher and taught. This is the prevailing situation with the teacher dominating during science lessons in many Nigerian secondary schools classes. Pupils' development, that is supposed to be the concern of teachers during lessons, is given a secondary position as the teachers' primary concern appears to be the delivery of the lesson (content) not minding what the outcomes may be. All the evidence from the S.T.O.S. analysis suggests that the science teachers dominated all the lessons by concentrating on the (1b) Teacher Makes Statements of b1, b2, b3 and b4, and by the extremely low occurrence of the two pupils' categories of 2d and 2e.

Similar evidence emerged from the E.A.S. analysis in which teachers talked most of the time during lessons. In some lessons the teachers talked (by explaining and describing) for several minutes without apparently realizing that they were supposed to be teaching (interacting with pupils) and not lecturing them. Lessons taught by T2, T7, T8, T14, T16 and T22 are found to have long intervals of between 4 - 10 minutes during which times only the teachers' voices are heard lecturing away with the pupils seated passively listening and watching the teacher.

8.4.2 Levels of Involvement by Teachers and Pupils in Questioning During Lesson:

From the data collected and analysed from both the Science Teaching Observation Schedule (S.T.O.S.) and the Explanation Appraisal Schedule (E.A.S.), it has become clear that the levels of involvement by both teachers and pupils in asking questions during lessons tilts heavily towards the teachers. In effect, from both units of analysis, the teachers have been found to have asked a lot more questions than the pupils did.

From the S.T.O.S., the teachers' questions concentrated on those which are answered by recalling of facts and principles, and followed by those answered by applying facts and principles to problem-solving. Similar finding has been reported on the bases of both coded E.A.S. data on teachers' questions, and the comprehensively obtained data on teachers' questions. The findings have shown that the teachers asked questions 11 times more often than the pupils. When the rhetorical questions are included, then it becomes 17 times more than the pupils.

On classifying all the 490 questions asked by the teachers, it became known that 42.65 per cent of them have been Comprehension/Recall type of questions. While the teachers individually based between 12 and 77 per cent of their questions on this category.

The reliability of both instruments has been vindicated by the similarity in their findings especially on the levels of involvement of both the teachers and pupils in the lessons.

8.4.3 General Level of Effectiveness of The Instructional Strategies and Tactics Employed by the Teachers:

The level of effectiveness of lessons taught by teachers are generally determined by using criteria based on success rates of pupils in some predetermined tests and examinations. Even so, the effectiveness of lessons can also be determined on the bases of the internal criteria which comprise the E.A.S. and to some extent the S.T.O.S.

From the STOS analysis, it may be suggested that the lessons have not been entirely effective, because of the paucity of most of the categories, especially those that should have promoted greater intellectual interactions between teachers and pupils, and between pupil and pupil. Also, the relatively high incidence of teachers' statements of fact and principle (b1) and directions to sources of information to confirm facts or principles (c1) and the teachers' questions answered by recalling facts and principles (a1) confirm the potentially overloaded didactic nature of the lessons.

From the E.A.S. viewpoint, a more critically diagnostic picture emerges. The general level of effectiveness of these primarily expository lessons has been very low. This follows the failure of 14 out of 18 characteristics to meet their anticipated rates of occurrence. More specifically, the negative characteristics occurred very much more frequently than required for effective exposition. All these are coupled with the failure of the teachers to employ questioning strategies which would have enabled pupils to interact effectively with teachers during lessons.

The general implications of these findings for science teaching in schools will now be considered.

8.5 Implications of the Findings for Science Teaching in Nigerian Secondary Schools:

The implications of the findings of this study for science teaching in Nigerian schools are numerous. First, this study has shown that science teaching in Nigerian schools is primarily expository in as much as it is theoretical, factual, didactic and teacher directed. This means that pupils have little or no chance to be fully involved in the lessons supposedly designed for them to learn.

There is no question that effective teaching involves effective interaction between teacher and the taught both in practical and theoretical (intellectual) contexts. For science lessons to continue to be taught theoretically and expositorily implies that pupils' intellectual development with regard to being intellectually versatile will not be achieved through those lessons which should be the most appropriate channel.

A further implication of such ineffective science teaching is that many pupils end up with many fundamentally wrong ideas and concepts as this study has shown through the analysis of misinformation. That Nigerian pupils in the higher forms of secondary schooling do show fundamental misconceptions about growth, reproduction and transport mechanisms in living organisms as reported by Okeke and Wood-Robinson (1980) must be attributed to the methods used by science teachers which have relied on exposition exclusively with all its inherent shortfalls.

Further evidence arising from this study shows that even these largely expository lessons have failed to show evidence of effective exposition and thus could not have been achieving even the most basic desired objectives. Some may argue that pupils are passing the West African General Certificate of Education (W.A.G.C.E.) examinations inspite of these limitations and that the results of such examinations may be the best way to assess teaching strategies. In the light of the overall pass rate in these examinations this hardly seems likely.

It is clear that science teaching has become an activity of sheer rote-memorization of existing facts as this study has shown. Little wonder that Shuaibu & Ogunsola (1983) concluded in their study that Nigerian students have a preferential cognitive style for recall followed by principles. If all that the teachers do is encourage rote memorization through the strategies which they adopt, then the pupils have no choice other than to develop such a preference, which is retrogressive viewed from current trends in science teaching.

Questions used to aid learning need not be geared towards fact recall as most of the teachers' questions have turned out to be. Rather, questions requiring or inviting higher-order intellectual engagements must be employed by teachers to enable pupils to develop and use their intellectual potentials. What needs to be changed in order to achieve this lies with the teachers.

The implication of this is that teachers do not formally learn the skills of asking effective questions. Training programmes, especially in-service, requires the incorporation of the development of such essential skills necessary to improve the teachers' strategies and tactics of questioning. Also, the situation whereby teachers asked less intellectually rewarding questions during science teaching results in pupils not being able to exercise their intellectual processes. Teachers must thus be encouraged to appreciate the limitations of using one type of question to the utter neglect of other more intellectually rewarding types of questioning strategies and tactics.

This study has also shown that the pupils asked far fewer questions than the teachers while the teachers apparently made little or no attempts to prompt pupils to ask more questions. This situation has been attributed partly to some culturally imbibed characteristics. Even so, it has implications for science teaching in schools.

First, this can bring about frustration even in the best taught lessons if pupils should just sit, listen to the teacher and watch his activities as the teacher takes all the initiatives. A second implication of failure or reluctance on the part of the pupils to ask questions during science lessons could result in pupils not learning at the appropriate time.

It is therefore important that pupils, especially Nigerian pupils who are under such cultural strains or influence, be helped to cultivate the habit of asking questions on the bases of which doubts should be put right and a good deal more learned by the pupils. Teaching has a linear progression, as teachers tend to follow what they planned to teach, and it is only through questions asked by pupils that more salient details are divulged by the teachers.

This study also shows that these largely expository lessons are themselves not effectively disseminated or taught. This follows the realization that most of the characteristics especially the negative ones occurred far more frequently than anticipated in order to help achieve effective exposition or teaching.

The implication of this to science teaching is that most of the positive characteristics constituting the E.A.S. will not feature well during science teaching while the negative ones feature a lot more resulting in a number of learning difficulties for the pupils. These difficulties will result in incomprehension and lack of confidence and in consequence, high failure rates.

8.6 Implications of the Findings for Teacher Education Curriculum:

Teacher education, like other aspects of the present educational set up in Nigeria was developed along the patterns of the British educational structures. But in the most recent past, owing to several factors prominent among which is cost, the Nigerian educational provision has changed both in structure and ideology to reflect national needs and resources. By the same token, it appears to have fallen short of expectation in several dimensions, most prominent of which is in the secondary and teacher education sectors which are intertwined.

Secondary education has grown to the point that it has overwhelmed teacher education. In effect, the demand for teachers rose very sharply. The result of this demand was the introduction of massive teacher production programmes which resulted in the production of all manner of teachers through programmes described as 'crash programmes'. Unfortunately many teachers who came into teaching under the auspices of such programmes and indeed others who had science qualifications and were subsequently employed did so as a last resort. They saw teaching as the possible means of livelihood until they secured more lucrative jobs. Thus, it served as a stepping-stone for many. This group of teachers tend in practice to ignore all the tenets of effective teaching at the expense of the pupils, who always bear the brunt.

As this study has shown, science teaching in Nigerian secondary schools is largely expository, factual, didactic, and teacher directed. This means that practical work has largely been relegated to the background in favour of explaining and describing. Yet, this study has further shown that these expository lessons have not been effective. If so, what could teacher education do to alleviate the present unsatisfactory state of science teaching? The answer may be found in the following suggestions.

There is no question as to the relevance of practical activities (both class activities and teacher demonstrations) in science teaching as this author has stressed elsewhere, Buseri (1982). In addition to the existing programmes for science teaching (as well as for other categories of teachers) attempts should be made to train teachers to acquire the skills of teaching using practical activities which will include some very basic teaching skills. The range of skills is discussed in Chapters 1 and 2, but suffice it to say that these skills are primarily the describing, explaining and questioning skills. Teacher education programmes presently provide largely for theories - psychological, philosophical and sociological - which are not interpreted in clear practical terms.

The major implication for teacher education is that the teacher education curriculum should be revised to provide for the development of skills which can have positive effects in teaching. As emphasized in Chapter 2, explaining is giving understanding to another person or persons who, in school circumstances, are pupils who in relation to the teacher have much lower cognitive developmental levels and experiences. It therefore follows that to give an explanation, the teachers should know what they are trying to explain. Knowing what is to be explained is, even so, not enough. The teachers must take account of the pupils to whom they are trying to give the explanation. This, is in addition to developing the necessary and appropriate skills required to achieve effective exposition.

8.6.1 Pre-Service Training:

Training of teachers takes several years to achieve. This is because it involves both theoretical and practical training in schools resulting in pre-service teachers being exposed to a number of teaching situations before ever they become qualified teachers. In recent times however, it is gradually being realized that the initial training falls short of what teachers require to be effective especially in the area of the development of essential skills. It is in this light that the findings of this study becomes significant. Since in-service re-training programmes are becoming a matter of luxury in Nigeria owing to financial constraints, it is suggested that special efforts must be made to improve teaching strategies and tactics through the improvement of the more important skills at the pre-service stage.

Since teaching is largely expository, those characteristics which affect expository teaching as identified in the Explanation Appraisal Schedule (E.A.S.) should constitute part of teacher skills development programmes. Also, the Science Teaching Observation Schedule (STOS) should be employed to try and up grade the intellectual transactions that could exist between pupils and teachers, and pupil and pupil. With these two instruments reconstituted into topics to be discussed and explored, as against being used as observational instruments, it is hoped that many more competent teachers could be produced from amongst the pre-service teachers in training. It is also anticipated that such teacher education programmes will be more beneficial to teachers in their later careers in contrast with the present theoretical perspectives on which teacher education programmes hinge.

The STOS and other instruments are currently being very usefully employed in initial and in-service teacher training programmes in the United Kingdom thus enabling all teachers to benefit from current research in science teaching. Hence, it must surely be beneficial if teacher education programmes are revisited to include these realistic and practical approaches to developing teaching skills in teachers.

8.7 Implications of Findings for Re-Training Programmes:

Teaching is a complex and demanding, and yet an isolated job performed away from other adults. There is, therefore, the tendency for teachers to decline in quality if not regularly exposed to improvement programmes. Of all teachers who constitute the sample for this study only one has ever had any in-service training while nearly 70 per cent of them have taught for four years and more since they obtained their first teaching appointments.

From the outcomes of this study, it is clearly apparent that teachers should be encouraged to undergo in-service training to enable essential skills to be developed. Since science teaching in Nigerian secondary schools is primarily expository, it will be necessary for teachers to develop the skills which will ensure that they present lessons logically, employing the services of explaining links, correct vocabulary, short and clear sentences, use of clear and concrete examples and analogies etc which must be relevant to the pupils. Teachers must learn that to open an explanation, pupils' attention must be secured and maintained by indicating directly or indirectly (clear introduction) what is to be explained.

Questioning skills resulting in the use of appropriate strategies and tactics, and the variation of types of questions asked with appropriately effective wording, should be developed.

Yet, very little can be achieved unless the University departments and Colleges responsible for teacher education restructure their teacher education curriculum to include the development of essential skills as an integral part of the training programmes. The lead taken in this direction by the Department of Education and Science's Teacher Teacher Education Project, Focus Books edited by Trevor Kerry, in the United Kingdom which includes Explanations and Explaining, Effective Questioning etc, all of which are teaching skills workbooks, is certainly a welcome development. The development of such a programme was not part of this study but must surely follow to enable Nigerian teachers to improve their teaching skills which are very limited.

8.8 Limitations of This Study:

A number of limitations capable of affecting this study are appreciated. First among them is untried nature of the Explanation Appraisal Schedule. The E.A.S. is new and had not previously been employed. As a result, some may wonder how effective it is likely to be. What is hoped is that its value and significance, like that of the Science Teaching Observation Schedule (STOS) lies not so much in how evaluative it may be but in how it could help in developing the relevant skills in teachers.

Further, the objective analysis of the E.A.S. characteristics should enable the reader to appreciate its value, not least, in circumstances as in Nigeria, where science teaching is largely expository and yet ineffective. Nonetheless, this author will acknowledge with deep appreciation any suggestions aimed at improving the E.A.S. as an instrument to be used to evaluate science lessons taught largely by exposition as presently obtaining in many Nigerian secondary schools.

To date the E.A.S. had not been used in live classes like the STOS (even though this study has shown that lessons coded from transcripts by means of STOS, rather than in situ, appear to be more sensitive to variation in style) it is intended that, in future it will be so tried to determine the differences in outcome.

Another probable limitation of this study is the number of sample teachers/lessons involved. The STOS was used to analyse 54 lessons taught by 42 science teachers of which 12 lessons were coded from transcripts. Eggleston et al (1976) observed 94 science teachers each of whom was observed about three times. Hacker et al (1979) in Canada observed 33 science teachers, Ugwu (1980) observed 53 biology teachers and Ajeyalemi (1981) observed 9 chemistry teachers. Whereas the number of teachers constituting the sample for any study is important, it should depend on the purpose of each of the studies and several other constraints which may or may not have been foreseen.

For this study, the STOS was employed to confirm or reject claims by earlier studies that science teaching in Nigerian schools is primarily didactic, teacher-directive, factual and above all, expository and this served as the platform on which this study was founded. On the E.A.S., a total of 12 science lessons comprising 5 Biology, 6 Chemistry and 1 Integrated Science lessons, are probably not adequate for any major generalization of outcomes. But suffice it to say that the data obtained from these twelve lessons is sufficient for the field testing of the instrument. Besides, the instrument should be more relevant as a basis of teaching skills development than merely as an evaluative tool, hence the number of lessons appraised with it is less significant.

8.9 Recommendations:

Much has been written in this study concerning effective teaching including exposition. This is in the light of the fact that the strategies and tactics of science teaching adopted by Nigerian science teachers are didactic, factual, whole-class centred, teacher-directed and above all expository. These features can be improved if:

1. - initial training programmes for science teachers could be revised to include skills improvement programmes;

2. - in-service training facilities are promoted to enable long serving teachers to re-train so as to acquire more effective skills of teaching;

3. - the strategies and tactics of teaching adopted by Nigerian science teachers could become more flexible so as to try to de-emphasize whole-class teaching at certain crucial stages during science lessons;

4. - the strategies and tactics of questioning by teachers are improved through skills development programmes to include use of more intellectually demanding strategies and tactics; and

5. - pupils could in turn be encouraged to participate more in lessons and not rely so much on the teacher, and be helped to appreciate the essence of asking questions during lessons.

8.10 Suggestions for Future Research:

The findings of this study, it is appreciated, cannot be useful unless there is a willingness, desire and zeal on the part of teachers and teacher-educators to accept the basic premises of this study and attempt to utilize the full potential of the Explanation Appraisal Schedule (E.A.S.).

As pointed out, the important factor is not the power to determine whether teachers' lessons contain too many or too few of the characteristics constituting the E.A.S., but the ability of researchers and educators to utilize the benefits inherent in this instrument. In effect, future studies could be fruitful if based on:

1. - determining what other characteristics capable of affecting lessons positively or negatively should be included;

2. - determining just how useful both the S.T.O.S. and the E.A.S. could be for pre-service and in-service teacher education programmes;

3. - how best the E.A.S. and possibly the S.T.O.S. could be incorporated into teacher education curricula;

4. - attempts to explore how present day teachers in Nigerian schools could be encouraged to adopt their teaching to the E.A.S. and S.T.O.S. requirements; and

5. - attempting to try the S.T.O.S. and the E.A.S. in many different circumstances in representative States in Nigeria so as to be able to determine what transpires nationally and any existing variations.

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Appendix 1 The Science Teaching Observation Schedule

LESSON .... FORM ....

Name of observer......................................

1 *TEACHER TALK*

1a *Teacher asks questions (or invites comments) which are answered by:*

- a_1 recalling facts and principles
- a_2 applying facts and principles to problem solving
- a_3 making hypothesis or speculation
- a_4 designing of experimental procedure
- a_5 direct observation
- a_6 interpretation of observed or recorded data
- a_7 making inferences from observations or data

1b *Teacher makes statements:*

- b_1 of fact and principle
- b_2 of problems
- b_3 of hypothesis or speculation
- b_4 of experimental procedure

1c *Teacher directs pupils to sources of information for the purpose of:*

- c_1 acquiring or confirming facts or principles
- c_2 identifying or solving problems
- c_3 making inferences, formulating or testing hypotheses
- c_4 seeking guidance on experimental procedure

2 *TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS*

2d *Pupils seek information or consult for the purpose of:*

- d_1 acquiring or confirming facts or principles
- d_2 identifying or solving problems
- d_3 making inferences, formulating or testing hypotheses
- d_4 seeking guidance on experimental procedure

2e *Pupils refer to teacher for the purpose of:*

- e_1 acquiring or confirming facts or principles
- e_2 seeking guidance when identifying or solving problems
- e_3 seeking guidance when making inferences, formulating or testing hypotheses
- e_4 seeking guidance on experimental procedure

	0	3	6	9	12	15	18	21	24	27	30	33
a_1												
a_2												
a_3												
a_4												
a_5												
a_6												
a_7												
b_1												
b_2												
b_3												
b_4												
c_1												
c_2												
c_3												
c_4												
d_1												
d_2												
d_3												
d_4												
e_1												
e_2												
e_3												
e_4												

TOPIC:

AIM AND CONTENT OF LESSON:

HOW THE LESSON WORKED OUT:

CLASSROOM MANAGEMENT:

Coleg Prifysgol Gogledd Cymru
University College of North Wales

Appendix 2

Cyfadran Addysg : Faculty of Education,
Lôn Pobty, BANGOR, Gwynedd LL57 1DZ

Tel. Bangor (0248) 351151, ext. 580/576

September, 17, '84

Letter To Science Teachers in Schools in Nigeria

Dear Colleague,

I wish to solicit your cooperation by way of allowing me to come into your Science Class to observe the intellectual transactions going on.

As the over riding objective of this research is to find ways to help young teachers to become more effective teachers, it is my belief that by tapping your expertise and experience in teaching, most of our future teachers, including some of the present generation can benefit and consequently become much more effective teachers.

On precisely what I will be doing in your classroom, I should say that I hope to concentrate on the response of pupils to the different ways different teachers explain things. After all, there is no one way of teaching. Hence every teacher has something unique which should be beneficial to both our present and future teachers.

In view of this, I wish also to assure you that this study is not meant for use to evaluate your work, nor will the anonymity which this observation process is expected to maintain be violated without the teacher's consent.

To this end, I implore you to give me your fullest cooperation.

Thanking you in anticipation.

Very Sincerely Yours,

JBuseri

John Cecil Buseri

Appendix 3

P E A R S O N   C O R R E L A T I O N

C O E F F I C I E N T S -

- .

	A1	A2	A3	A4	A5
A1	1.0000 (54) P=*****	0.4012 (54) P= .003	-0.1884 (54) P= .172	-0.0582 (54) P= .676	0.1334 (54) P= .336
A2	0.4012 (54) P= .003	1.0000 (54) P=*****	-0.1717 (54) P= .214	0.1569 (54) P= .257	-0.0288 (54) P= .836
A3	-0.1884 (54) P= .172	-0.1717 (54) P= .214	1.0000 (54) P=*****	0.2622 (54) P= .055	0.1406 (54) P= .311
A4	-0.0582 (54) P= .676	0.1569 (54) P= .257	0.2622 (54) P= .055	1.0000 (54) P=*****	0.1789 (54) P= .196
A5	0.1334 (54) P= .336	-0.0288 (54) P= .836	0.1406 (54) P= .311	0.1789 (54) P= .196	1.0000 (54) P=*****
A6	0.0790 (54) P= .570	0.2051 (54) P= .137	0.0466 (54) P= .738	0.6355 (54) P=0.000	0.2837 (54) P= .038
A7	0.1251 (54) P= .367	0.0954 (54) P= .493	0.0335 (54) P= .810	0.2217 (54) P= .107	0.1404 (54) P= .311
B1	0.1594 (54) P= .250	0.1551 (54) P= .263	-0.2921 (54) P= .032	-0.1702 (54) P= .218	-0.2761 (54) P= .043
B2	0.1347 (54) P= .331	0.4126 (54) P= .002	0.2374 (54) P= .084	0.0218 (54) P= .875	0.0721 (54) P= .605
B3	0.0396 (54) P= .776	0.1382 (54) P= .319	0.4127 (54) P= .002	0.0041 (54) P= .976	0.2299 (54) P= .094
B4	-0.1458 (54) P= .293	0.2082 (54) P= .131	-0.0472 (54) P= .735	0.0954 (54) P= .492	0.1193 (54) P= .390

	A6	A7	B1	B2	B3
A1	0.0790 (54) P= .570	0.1251 (54) P= .367	0.1594 (54) P= .250	0.1347 (54) P= .331	0.0396 (54) P= .776
A2	0.2051 (54) P= .137	0.0954 (54) P= .493	0.1551 (54) P= .263	0.4126 (54) P= .002	0.1382 (54) P= .319
A3	0.0466 (54) P= .738	0.0335 (54) P= .810	-0.2921 (54) P= .032	0.2374 (54) P= .084	0.4127 (54) P= .002
A4	0.6355 (54) P=0.000	0.2217 (54) P= .107	-0.1702 (54) P= .218	0.0218 (54) P= .875	0.0041 (54) P= .976
A5	0.2837 (54) P= .038	0.1404 (54) P= .311	-0.2761 (54) P= .043	0.0721 (54) P= .605	0.2299 (54) P= .094
A6	1.0000 (54) P=*****	0.2361 (54) P= .086	-0.2708 (54) P= .048	0.1403 (54) P= .312	0.0700 (54) P= .615
A7	0.2361 (54) P= .086	1.0000 (54) P=*****	-0.3432 (54) P= .011	0.0529 (54) P= .704	0.0147 (54) P= .916
B1	-0.2708 (54) P= .048	-0.3432 (54) P= .011	1.0000 (54) P=*****	-0.2057 (54) P= .136	-0.1628 (54) P= .239
B2	0.1403 (54) P= .312	0.0529 (54) P= .704	-0.2057 (54) P= .136	1.0000 (54) P=*****	0.7217 (54) P=0.000
B3	0.0700 (54) P= .615	0.0147 (54) P= .916	-0.1628 (54) P= .239	0.7217 (54) P=0.000	1.0000 (54) P=*****
B4	-0.0641 (54) P= .645	0.0045 (54) P= .974	0.0129 (54) P= .926	0.2789 (54) P= .041	0.2649 (54) P= .053

	B4	C1	C2	C3	C4
A1	-0.1458 (54) P= .293	-0.0285 (54) P= .838	0.0588 (54) P= .673	99.0000 (54) P=*****	-0.3512 (54) P= .009
A2	0.2082 (54) P= .131	0.1622 (54) P= .241	0.1325 (54) P= .340	99.0000 (54) P=*****	-0.0469 (54) P= .737
A3	-0.0472 (54) P= .735	0.3355 (54) P= .013	0.0522 (54) P= .708	99.0000 (54) P=*****	0.2401 (54) P= .080
A4	0.0954 (54) P= .492	0.2270 (54) P= .099	-0.1276 (54) P= .358	99.0000 (54) P=*****	-0.0838 (54) P= .547
A5	0.1193 (54) P= .390	0.0727 (54) P= .602	0.0809 (54) P= .561	99.0000 (54) P=*****	0.0654 (54) P= .639
A6	-0.0641 (54) P= .645	0.1547 (54) P= .264	0.0695 (54) P= .618	99.0000 (54) P=*****	-0.1141 (54) P= .411
A7	0.0045 (54) P= .974	0.1583 (54) P= .253	0.2798 (54) P= .040	99.0000 (54) P=*****	-0.0230 (54) P= .869
B1	0.0129 (54) P= .926	-0.3031 (54) P= .026	-0.2876 (54) P= .035	99.0000 (54) P=*****	-0.2135 (54) P= .121
B2	0.2789 (54) P= .041	0.6789 (54) P=0.000	0.6083 (54) P=0.000	99.0000 (54) P=*****	-0.0095 (54) P= .946
B3	0.2649 (54) P= .053	0.6251 (54) P=0.000	0.4913 (54) P=0.000	99.0000 (54) P=*****	0.2460 (54) P= .073
B4	1.0000 (54) P=*****	0.2376 (54) P= .084	0.3043 (54) P= .025	99.0000 (54) P=*****	0.4724 (54) P=0.000
C1	0.2376 (54) P= .084	1.0000 (54) P=*****	0.5674 (54) P=0.000	99.0000 (54) P=*****	0.1308 (54) P= .346
C2	0.3043 (54) P= .025	0.5674 (54) P=0.000	1.0000 (54) P=*****	99.0000 (54) P=*****	0.1791 (54) P= .195
C3	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	1.0000 (54) P=*****	99.0000 (54) P=*****
C4	0.4724 (54) P=0.000	0.1308 (54) P= .346	0.1791 (54) P= .195	99.0000 (54) P=*****	1.0000 (54) P=*****

	D1	D2	D3	D4	E1
A1	0.2210 (54) P= .108	99.0000 (54) P=*****	0.2307 (54) P= .093	99.0000 (54) P=*****	0.0987 (54) P= .478
A2	0.0914 (54) P= .511	99.0000 (54) P=*****	0.1554 (54) P= .262	99.0000 (54) P=*****	-0.0092 (54) P= .947
A3	-0.0593 (54) P= .670	99.0000 (54) P=*****	-0.0389 (54) P= .780	99.0000 (54) P=*****	-0.0414 (54) P= .766
A4	-0.0724 (54) P= .603	99.0000 (54) P=*****	-0.0475 (54) P= .733	99.0000 (54) P=*****	-0.0920 (54) P= .508
A5	0.2090 (54) P= .129	99.0000 (54) P=*****	-0.0879 (54) P= .527	99.0000 (54) P=*****	-0.0873 (54) P= .530
A6	-0.0631 (54) P= .650	99.0000 (54) P=*****	0.0517 (54) P= .711	99.0000 (54) P=*****	-0.0275 (54) P= .843
A7	-0.0020 (54) P= .989	99.0000 (54) P=*****	0.2797 (54) P= .041	99.0000 (54) P=*****	-0.1030 (54) P= .459
B1	0.0710 (54) P= .610	99.0000 (54) P=*****	0.0465 (54) P= .738	99.0000 (54) P=*****	0.1133 (54) P= .415
B2	0.1096 (54) P= .430	99.0000 (54) P=*****	0.3035 (54) P= .026	99.0000 (54) P=*****	-0.0366 (54) P= .793
B3	0.1530 (54) P= .269	99.0000 (54) P=*****	0.3836 (54) P= .004	99.0000 (54) P=*****	0.1162 (54) P= .403
B4	0.1770 (54) P= .200	99.0000 (54) P=*****	0.0655 (54) P= .638	99.0000 (54) P=*****	-0.0661 (54) P= .635
C1	0.0655 (54) P= .638	99.0000 (54) P=*****	0.2962 (54) P= .030	99.0000 (54) P=*****	-0.0158 (54) P= .910
C2	0.2013 (54) P= .144	99.0000 (54) P=*****	0.5580 (54) P=0.000	99.0000 (54) P=*****	0.1853 (54) P= .180
C3	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
C4	-0.0508 (54) P= .715	99.0000 (54) P=*****	-0.0333 (54) P= .811	99.0000 (54) P=*****	-0.0203 (54) P= .884

	E2	E3	E4
A1	0.1446 (54) P= .297	-0.2840 (54) P= .037	0.0270 (54) P= .846
A2	0.1366 (54) P= .325	-0.1678 (54) P= .225	-0.1298 (54) P= .349
A3	0.2375 (54) P= .084	-0.0555 (54) P= .690	0.2898 (54) P= .034
A4	0.3277 (54) P= .016	-0.0678 (54) P= .626	0.3936 (54) P= .003
A5	0.0685 (54) P= .623	-0.1255 (54) P= .366	-0.0643 (54) P= .644
A6	0.1580 (54) P= .254	-0.0922 (54) P= .507	0.1271 (54) P= .360
A7	0.0795 (54) P= .568	-0.1022 (54) P= .462	-0.0022 (54) P= .987
B1	-0.2574 (54) P= .060	0.0664 (54) P= .633	-0.0915 (54) P= .511
B2	0.4209 (54) P= .002	0.1439 (54) P= .299	0.0629 (54) P= .651
B3	0.3377 (54) P= .013	0.2338 (54) P= .089	0.0706 (54) P= .612
B4	0.2011 (54) P= .145	0.2738 (54) P= .045	0.0596 (54) P= .668
C1	0.5337 (54) P=0.000	0.1375 (54) P= .322	0.1858 (54) P= .179
C2	0.3917 (54) P= .003	0.0362 (54) P= .795	-0.0860 (54) P= .536

	A1	A2	A3	A4	A5
C1	-0.0285 (54) P= .838	0.1622 (54) P= .241	0.3355 (54) P= .013	0.2270 (54) P= .099	0.0727 (54) P= .602
C2	0.0588 (54) P= .673	0.1325 (54) P= .340	0.0522 (54) P= .708	-0.1276 (54) P= .358	0.0809 (54) P= .561
C3	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
C4	-0.3512 (54) P= .009	-0.0469 (54) P= .737	0.2401 (54) P= .080	-0.0838 (54) P= .547	0.0654 (54) P= .639
D1	0.2210 (54) P= .108	0.0914 (54) P= .511	-0.0593 (54) P= .670	-0.0724 (54) P= .603	0.2090 (54) P= .129
D2	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
D3	0.2307 (54) P= .093	0.1554 (54) P= .262	-0.0389 (54) P= .780	-0.0475 (54) P= .733	-0.0879 (54) P= .527
D4	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
E1	0.0987 (54) P= .478	-0.0092 (54) P= .947	-0.0414 (54) P= .766	-0.0920 (54) P= .508	-0.0873 (54) P= .530
E2	0.1446 (54) P= .297	0.1366 (54) P= .325	0.2375 (54) P= .084	0.3277 (54) P= .016	0.0685 (54) P= .623
E3	-0.2840 (54) P= .037	-0.1678 (54) P= .225	-0.0555 (54) P= .690	-0.0678 (54) P= .626	-0.1255 (54) P= .366
E4	0.0270 (54) P= .846	-0.1298 (54) P= .349	0.2898 (54) P= .034	0.3936 (54) P= .003	-0.0643 (54) P= .644

	A6	A7	B1	B2	B3
C1	0.1547	0.1583	-0.3031	0.6789	0.6251
	(54)	(54)	(54)	(54)	(54)
	P= .264	P= .253	P= .026	P=0.000	P=0.000
C2	0.0695	0.2798	-0.2676	0.6083	0.4913
	(54)	(54)	(54)	(54)	(54)
	P= .618	P= .040	P= .035	P=0.000	P=0.000
C3	99.0000	99.0000	99.0000	99.0000	99.0000
	(54)	(54)	(54)	(54)	(54)
	P=*****	P=*****	P=*****	P=*****	P=*****
C4	-0.1141	-0.0230	-0.2135	-0.0095	0.2460
	(54)	(54)	(54)	(54)	(54)
	P= .411	P= .869	P= .121	P= .946	P= .073
D1	-0.0631	-0.0020	0.0710	0.1096	0.1530
	(54)	(54)	(54)	(54)	(54)
	P= .650	P= .989	P= .610	P= .430	P= .269
D2	99.0000	99.0000	99.0000	99.0000	99.0000
	(54)	(54)	(54)	(54)	(54)
	P=*****	P=*****	P=*****	P=*****	P=*****
D3	0.0517	0.2797	0.0465	0.3035	0.3836
	(54)	(54)	(54)	(54)	(54)
	P= .711	P= .041	P= .738	P= .026	P= .004
D4	99.0000	99.0000	99.0000	99.0000	99.0000
	(54)	(54)	(54)	(54)	(54)
	P=*****	P=*****	P=*****	P=*****	P=*****
E1	-0.0275	-0.1030	0.1133	-0.0366	0.1162
	(54)	(54)	(54)	(54)	(54)
	P= .843	P= .459	P= .415	P= .793	P= .403
E2	0.1580	0.0795	-0.2574	0.4209	0.3377
	(54)	(54)	(54)	(54)	(54)
	P= .254	P= .568	P= .060	P= .002	P= .013
E3	-0.0922	-0.1022	0.0664	0.1439	0.2338
	(54)	(54)	(54)	(54)	(54)
	P= .507	P= .462	P= .633	P= .299	P= .089
E4	0.1271	-0.0022	-0.0915	0.0629	0.0706
	(54)	(54)	(54)	(54)	(54)
	P= .360	P= .987	P= .511	P= .651	P= .612

	B4	C1	C2	C3	C4
D1	0.1770 (54) P= .200	0.0655 (54) P= .638	0.2013 (54) P= .144	99.0000 (54) P=*****	-0.0508 (54) P= .715
D2	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
D3	0.0655 (54) P= .638	0.2962 (54) P= .030	0.5580 (54) P=0.000	99.0000 (54) P=*****	-0.0333 (54) P= .811
D4	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
E1	-0.0661 (54) P= .635	-0.0158 (54) P= .910	0.1853 (54) P= .180	99.0000 (54) P=*****	-0.0203 (54) P= .884
E2	0.2011 (54) P= .145	0.5337 (54) P=0.000	0.3917 (54) P= .003	99.0000 (54) P=*****	-0.0857 (54) P= .538
E3	0.2738 (54) P= .045	0.1375 (54) P= .322	0.0362 (54) P= .795	99.0000 (54) P=*****	0.3805 (54) P= .005
E4	0.0596 (54) P= .668	0.1858 (54) P= .179	-0.0860 (54) P= .536	99.0000 (54) P=*****	-0.0565 (54) P= .685

	D1	D2	D3	D4	E1
D1	1.0000 (54) P=*****	99.0000 (54) P=*****	0.2822 (54) P= .039	99.0000 (54) P=*****	0.1507 (54) P= .277
D2	99.0000 (54) P=*****	1.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
D3	0.2822 (54) P= .039	99.0000 (54) P=*****	1.0000 (54) P=*****	99.0000 (54) P=*****	0.3676 (54) P= .006
D4	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****	1.0000 (54) P=*****	99.0000 (54) P=*****
E1	0.1507 (54) P= .277	99.0000 (54) P=*****	0.3676 (54) P= .006	99.0000 (54) P=*****	1.0000 (54) P=*****
E2	0.5929 (54) P=0.000	99.0000 (54) P=*****	0.3885 (54) P= .004	99.0000 (54) P=*****	0.2365 (54) P= .085
E3	-0.0411 (54) P= .768	99.0000 (54) P=*****	-0.0269 (54) P= .847	99.0000 (54) P=*****	0.0820 (54) P= .556
E4	-0.0488 (54) P= .726	99.0000 (54) P=*****	-0.0320 (54) P= .818	99.0000 (54) P=*****	0.2376 (54) P= .084

	E2	E3	E4
C3	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
C4	-0.0857 (54) P= .538	0.3805 (54) P= .005	-0.0565 (54) P= .685
D1	0.5929 (54) P=0.000	-0.0411 (54) P= .768	-0.0488 (54) P= .726
D2	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
D3	0.3885 (54) P= .004	-0.0269 (54) P= .847	-0.0320 (54) P= .818
D4	99.0000 (54) P=*****	99.0000 (54) P=*****	99.0000 (54) P=*****
E1	0.2365 (54) P= .085	0.0820 (54) P= .556	0.2376 (54) P= .084
E2	1.0000 (54) P=*****	-0.0693 (54) P= .618	0.3623 (54) P= .007
E3	-0.0693 (54) P= .618	1.0000 (54) P=*****	-0.0457 (54) P= .743
E4	0.3623 (54) P= .007	-0.0457 (54) P= .743	1.0000 (54) P=*****

Appendix 4

EXPLANATION APPRAISAL SCHEDULE (E.A.S.)

	CHARACTERISTICS	OCCURRENCE WITHIN 1 MINUTE TIME INTERVAL
1	CLEAR INTRODUCTION	5 10 15 20 25 30 35 40 45
2	CLEAR ORIENTATION	
3	PROGRESSIVE SUMMARIES	
4	USE OF CONCRETE EXAMPLES AND ANALOGIES	
5	CLEAR DIAGRAMS AND ILLUSTRATIONS	
6	TEACHER'S QUESTIONS	
7	QUESTIONS WITHOUT CHANCE FOR PUPILS TO ANSWER	
8	VERBAL CUEING	
9	PUPILS' QUESTIONS	
10	MAIN IDEAS PARA-PHRASED, OR REPHRAS-ED, AND/OR RESTATED	
11	UNNECESSARY REPETITIONS USED	
12	USE OF EXPLAINING LINKS	
13	DISCONTINUITIES IN THEME	
14	SELF-INTERRUPTIONS/ UNFINISHED SENTENCES	
15	LONG AND COMPLEX SENTENCES/STATEMENTS	
16	VAGUE WORDS OR SENTENCES USED	
17	UNEXPLAINED DIFFICULT VOCABUL-ARIES/TERMS	
18	WRONG USE OF WORDS AND TERMS (MISINFORMATION)	

Appendix 5

T2

Lesson: Biology
Class: 5 (in the Lab)
Time: 12.35-1.14 (39 mins)
No. of Pupils: 28 (all boys)

Time: Topic: <u>Placentation and Pollination in Flowering Plants</u>:

0.00) T: Good afternoon.
Ps: Good afternoon ma.
T: Sit down. I think we have started with placentation.
Ps: Yes ma.
T: But we have got to placentation.
Ps: Yes. Its placentation.
T: Okay! Who can tell me what placentation is?
P: Placentation is the arrangement of the ovaries on the placenta.
0.01) T: Okay, and I told you to read up basal placentation. Who can try to explain what basal placentation is? Who can try? You didn't read! How many of you read it?
Ps: (Raise hands)
T: Okay, if you did, try! Hm, I hope you are not going to read that which I copied for you.
P: Basal placentation is just like marginal ... just like a minor...
0.02) T: When we studied the structure of a flower, I remember telling you the parts of the flower that is called the receptacle. Do you remember it?
Ps: Yes
T: The receptacle is the small tip of the flower bud that bears the modified leaves. And we have been talking of placentation as the arrangement of the ovum and placenta in the ovary. But in basal placentation we find out that the placenta is or directly develop inside the receptacle. Assuming (draws) this is the flower top and this is the placenta, and this is the receptacle.
0.03) Okay, in basal placentation, the placenta itself develop in the receptacle and you find out that there is just one single ovum inside the placenta. And this ovum is normally found at the base of the ovum. This my diagram is upside down. So this is the flower top, this is the receptacle. Then you know, quite often, since this is the receptacle, the ovary and the other parts of the flower will be around here.
0.04) So the ovum normally should be found at the base of the ovary. But attached to the placenta which you find inside the receptacle. The placenta is found in the receptacle in the case of basal placentation and that example of a plant that has or a flower that has basal placentation is Sun flower.
0.05) (Writes) Sun Flower. Assuming this is your receptacle, and this is you placenta, the ovum is normally placed on the placenta but at the base of the ovary.
0.06) So, please, I know why this boy said that it looks like the marginal placentation. He said so because he feels that the ovum comes near the base. Not at the margin. Please, the ovum is not at the margin of the ovary but at the base of the ovary. So that is basal placentation.
T: The last one is Superficial placentation.
0.07) Who can tell me the meaning of the word Superficial? Hm, the meaning of the word Superficial. Not even one boy knows the meaning of Superficial in class five. The other classes told me the meaning. Okay, try.

P: Air.
T: No! The word superficial means on the surface. Something that is not deep inside but something near the surface or on the surface. So knowing this meaning now it means that in superficial placentation the ovule and the placenta are not deep-rooted inside the ovary but they are sort of, near the surface.
0.08) Let me give you the diagram. (draws). If you look up you will find out that this ovary can be divided into five chambers and in between these chambers we have the placenta. We find out that this placenta is not inside the chamber. Do you understand what I mean?
Ps: Yes ma.
0.09) T: The placenta is not found inside the chamber but it is outside on the surface near the chamber. But not inside the chamber. And the ovules are attached with this placenta. So the word Superficial means that the ovule and the placenta are arranged on the chambers of the ovary. They are outside on the surface not inside. Just like that tomatoes that I talked of with axile placentation. You see the ovule and the placenta inside the chamber but in superficial, we see them on the surface of the chamber. Is it clear?
Ps: Yes ma.
0.10)
0.11) T: (Writes). Example of superficial placentation is water lilly, just the common root but if I find or come across any common root that has a superficial placentation I will tell you some other time. Any question on placentation?
Ps: No.
T: We have talked of marginal placentation, parietal placentation, and axile, free-central, central, basal and superficial placentation. These are the types of placentation we have. Any question?
Ps: No.
T: If there is no question we go over to the topic that we should treat today which is pollination.
0.12) (Writes). You should not forget that our main topic is sexual reproduction in flowering plants. The process of sexual reproduction in flowering plants is sort of, complex. Before a flower shall be said to have undergone sexual reproduction it must have gone through so many processes, one of which is pollination. After pollination, fertilization occurs and it is only after fertilization that a fruit and its seeds will be developed.
0.13) And it is only then that we say that sexual reproduction is ... has taken place in a flowering plant. So, before we talk of this fertilization that leads to the production of the young plant you will talk of pollination. And pollination leads to fertilization. Without pollination, fertilization cannot take place. So, while we are talking of these different topics bear it in mind that there are two sets of sexual reproducation in flowering plants. You must have been taught of pollination in your primary schools in the intergrated science. So, who can try to define the term pollination?
P: It is the transfer of the pollen grains from the anthers to the stigma.
T: Is the transfer of a pollen grain from the anthers to the stigma.
0.14) You can still remember the structure of a flower! I know that the male reproductive organ is the androecium that consists of what and what? What makes up the male organ?
Ps: Pollen grains, anthers ... stamens.
T: Another word for the male reproductive organ is stamen. What and what make up the stamen?

Ps: Pollen grains, filament and anthers.

T: The filaments and anthers. And the pollen grains. I told you that the anther has two pollen sacs and inside this pollen sacs you have the pollen grains and I told you that the pollen grain is the male gamete. So pollination is the transfer of this pollen grain which is the male gamete from the anthers of a flower to the stigma.

0.15) So the definition of the word pollination can be the transference of pollen grains from the anthers to the stigma.

Ps: Stigma.

T: So now we have known the definition of the term pollination. We can go further to know the kinds or types of pollination that we have. There are two types of pollination. There is what we called self-pollination and cross-pollination.

0.16)Ps: Cross-pollination.

T: Self-pollination involves one parent. That is, one parent is involved in self-pollination but in cross-pollination two parents are involved. Let me explain what I mean and that would lead us to define these two types of pollination.

In self-pollination, the pollen grains from the anthers of a flower are transferred to the stigma of the same flower or another flower of the same plant. Assuming that this is the plant and here you have some branches from here you have your flowers.

0.17) Assuming you have one flower here, another one here, another one here, another one here and you know that each of these flowers will have both the anthers and the stigmas. Self-pollination is the transfer of the pollen grains from the anthers of this flower to the stigma of the same flower or the pollen grains of this ... the anthers of this flower to the stigma of another flower but on the same plant. I hope you get it!

Ps: Yes.

T: Assuming you have a hibiscus plant in front of a house where there are about twenty hibiscus flowers. If self-pollination occurs in that particular one (points to one sketch) it means that pollen grains from the anthers of one flower might fall on the stigma of another flower of the same plant. Or it can fall on the stigma of the same.

0.18) Do you understand that?

Ps: Yes.

T: So self-pollination can be defined as the transfer of pollen grains from the anthers of a flower to the stigma of the same flower or another flower in the same plant. So the word, one-parent comes from the fact that all the flowers involved in self-pollination comes from the same plant. But in cross-pollination, pollen grains from the anthers of a flower in a plant are transferred to the stigma of another flower in another plant but of the same species.

0.19) Assuming you have a hibiscus plant in front of the principal's house and you have another hibiscus plant in front of the biology lab., cross-pollination can occur between these two hibiscus plants in that the pollen grains from the anthers in the flower of the principal's house can be thrown to the stigma of the same hibiscus flower in front of the biology lab. You see, it now happens between two plants but these plants are of the same species. It cannot happen between the hibiscus flower and the crotalaria. I think you understand what I mean?

0.20)Ps: Yes.

T: So cross-pollination is the transferrence of pollen grain from the anthers of one flower to the stigma of another flower on a different plant of the same kind.

P: Yes! Once more.

T: Cross-pollination is the transferrence of the pollen grains from the anthers of one flower to the stigma of another of a different plant of the same kind. If it is hibiscus species it will be hibiscus species. If it is beans flowers it will be beans flower. There will be no cross-pollination between a bean flower and a hibiscus flower.

0.21) So now we have seen the two kinds of pollination. We will go further to discuss the characteristics we find in flowers that have each of these kinds of pollination.

(Pauses, and writes and reads):

T: The characteristics that favour cross-pollination.

0.22) There are three characteristics that favours cross-pollination and they are: 1) Dichogamy, 2) Unisexuality and 3) Self-sterility. Who can tell me the meaning of the word 'di-'? What does it mean?

P: Two

T: So the word - 'di' - means two. What of 'uni-'?

Ps: One.

T: So dichogamy is the process of ... okay let me explain it first. In dichogamy what you have in it is that the anthers of the flower and the stigma of that same flower don't mature at the same time.

0.23) Remember we are talking of cross-pollination. So if cross-pollination will take place in a bi-sexual flower ... what is a bi-sexual flower?

P: A bi-sexual flower is a flower ... (not very audible).

T: Eh? No. Okay, what is a perfect flower?

P: Bi-sexual flower is a flower that has male and female parts.

T: A bi-sexual flower is a flower that has both reproductive organs present in it. So dichogamy occurs in bi-sexual plants. And for dichogamy to take place the anthers of that flower and the stigma of the same flower don't mature at the same time.

0.24) Remember, we are talking of cross-pollination. Assuming you have a hibiscus plant in front of the lab, ... if that hibiscus plant has cross-pollination you will find out that the anthers of that plant ... of the flower would not mature at the same time with the stigma of that same flower. So since they don't mature at the same time, assuming the anthers mature before the stigma, these matured anthers would be taken to another flower where it looks for the mature stigma. It would not stay there to wait for its stigma to mature. Do you get what I am saying?

Ps: Yes.

T: So since two different terms, that is, since the anthers and stigma mature at different times, you say that dichogamy has taken place.

P: ... has taken place.

T: So dichogamy is when the anthers and the stigma of a flower mature at different times.

0.25) P: ... say it again

T: When the anthers and the stigma of the flower mature at different times. This dichogamy occurs in two ways. There is the one called protandry and there is another we call protogyny. Protandry and protogyny are the two ways in which dichogamy can take place. And protandry is when the anthers mature before the stigma. Remember that I say that dichogamy

0.26) is when the anthers and stigma mature at different times.

Assuming the anthers mature before the stigma you say it is protandry. So protandry is when the anthers mature before the stigma. If protandry is when the anthers mature before the stigma, what is protogyny?

P: Protogyny is when the stigma matures before the anthers.

T: Okay. So you find out that if in a flowering plant you have the stigma and the anthers, and they mature at different times, cross-pollination must take place in that flower. So dichogamy is one of the characteristics of cross-pollination. But the next one is unisexuality. Please when I am talking of dichogamy remember that it must occur only in bi-sexual flowers.

(0.27) When you say that a flower is uni-sexual, what does it mean?

P: It has only either the anthers or the stigma.

P: It has either the stamen or the pistil.

T: It has either the stamen or the pistil, that is either the male reproductive organ or the female reproductive organ. So most flowers that are uni-sexual have what we call cross-pollination. Remember, I told you the pawpaw trees. I talked of male pawpaw trees and female trees and I told you that male pawpaw trees never produce fruits from year to year.

(0.28) So since it is a uni-sexual plant, cross-pollination must take place.

Ps: Take place.

T: The anthers of the male pawpaw tree must be taken to the stigma of the female pawpaw tree. I think you understand what I mean? So, and if that takes place it means that cross-pollination has taken place.

Ps: ... Taken place.

T: So another characteristic that favours cross-pollination is the uni-sexuality of flowers. That is, most of the flowers that have cross-pollination are uni-sexual. The last one is what I called self-sterility. And this self-sterility occurs in pollen grains.

(0.29) Assuming a plant or a flower has anthers and stigma but the anthers of that particular flower are sterile ... . The word sterile means something that is infertile, that is something that is not fertile ..., something that is not alive ... something dead. So assuming the pollens of that particular flower are dead, you know that they cannot pollinate the stigma of that flower. You understand it?

Ps: Yes ma.

T: So where you have sterile pollen grains you find out that those pollen grains can never pollinate the stigma of that same flower. So there will be an opportunity for pollen grains that are alive from another flower to pollinate the stigma of that flower.

(0.30) I think you understand what I mean, eh?

Ps: Yes

T: So in a flower where the pollen grains are sterile, cross-pollination must take place. So these are the three characteristics that favour cross-pollination. Dichogamy which is when the two ... when the anthers and the stigma mature at different times. And I have told you that it occurs in two ways which are protandry and protogyny. Protandry is when the anthers mature before the stigma while protogyny is when the stigma mature before the anthers. Then I talked of uni-sexuality.

(0.31) I told you that if a flower must have cross-pollination, that flower ..., apart from bi-sexual flowers, that have dichogamy, such a flower must be a uni-sexual flower. And I used pawpaw flowers as example. Then I talked of self-sterility where the pollen grains from the anthers are sterile and therefore are unable to pollinate the stigma of that flower. So giving way for pollen grains from another flower to pollinate that stigma. That shows you that cross-pollination has taken place. Any questions?

P: Excuse me ma! Are the flowers from the same plant?

T: What is cross-pollination? They are on different plants of the same kind. Any other question?

0.32) P: (Non-verbal response)

P: What is an example of a bi-sexual flower?

T: Give me an example of a bi-sexual flower?

PS: Hibiscus

T: Hibiscus is a bi-sexual plant because it has the male and female reproductive organs. And it happens to be a flower that is pollinated by cross-pollination because the anthers of that flower don't mature at the same time with the stigma. You understand what I mean eh?

Ps: Yes.

T: Any other question? What is the time?

P: Fifteen minutes past one.

T: So since we have two minutes more I do not know if we can go into what I have, and that is, the advantages of cross-pollination. (Writes).

0.33) Cross-pollination has about five advantages. The first one is that, with the help of cross-pollination, we get healthy plants. that is, plants that ... or young plants that are produced as a result of cross-pollination are always healthier than plants produced from self-pollination.

0.34) So the off-spring of plants from cross-pollination are healthier than those of self-pollination. And cross-pollination leads to the production of many seeds. The first one is healthier off-springs. The second one is more abundant and viable seeds are produced by cross-pollination. The third one is that the seeds produced as a result of cross-pollination germinate better than those produced as a result of self-pollination. What is pollination?

0.35) P: I dont understand the number 2.

T: Number 2? You dont know the meaning of abundant? Many! And the word 'viable' means live. Plants that are alive. Not dead plants. So, seeds, which are produced as a result of cross-pollination germinate better than those produced as a result of self-pollination. So the off-spring has better germinating capacity. (Writes).

0.36) Then in cross-pollination, new varieties of plants are produced. Who can explain what I mean by this new varieties of plants? I think I talked of it long ago when we were discussing the differences in sexual and asexual. Who can tell us what variation means?

T: New varieties of plants.

P: Genes

T: No, not genes. Okay (appoints another pupil)

P: Different types of plants

T: Is it different types of plants? I want you to explain it well.

P: Plants which are different from their mothers.

T: Okay! Plants that have a little difference in their appearance.

0.37) Then the last one is that in cross-pollination, the plants produced are more resistant to disease. What do I mean by the word resistant? We say that the plant is resistant to certain diseases.

P: It does not contact the diseases easily

T: Okay! I want resistance put in a better way.

P: That is, the plant can withstand ...

T: Okay, the plant can withstand infections. So when a plant or an animal can withstand infections, we say that that particular organism is resistant to such diseases.
0.38) (Writes). So these are the five advantages of cross-pollination. Any question? If no question, I think we can stop. Next time we will start with disadvantages of cross-pollination and then we go over to self-pollination.
0.38.42) Thank you!

T4

Lesson: Biology
Class: 5 (in the Lab)
Time: 9.40-10.16 (33 mins)
No. of Pupils: 23 (boys)

Time: Topic: <u>The Organ of Sight (The Eye)</u>:

0.00) T: Today we shall talk of the sense organs. Last week we talked of the organ for hearing and balancing which is the ear. And we have seen how the pinnae collects the sound waves, channel it to the ... ossicles and from the ossicles to the cochlea.
0.01) And then we saw the organ of touching. Again, have we discussed the organ of touching?
Ps: Yes
T: This week let us look at the organ of sight. The organ of sight, (writes), which is what?
P: Eye.
T: The eye. Looking at ... looking at the diagram on the board, (Displays a drawn section of the mammalian eye).
0.02) Every individual has two eyes. Where is the eye situated?
P: Socket
T: In the eye socket. We either call it socket or the orbit. Now let us discuss what this eye look like. Let us discuss what this eye look like. What we have in one eye we also have in the other eye.
P: Eye
T: The structure of the eye. Now looking at it you see that the eye has a wall, three layered wall. The outermost layer is called the scleroid. The outermost layer of the eye is called the scleroid.
0.03) This scleroid is tough and it is opaque. Scleroid is tough and is opaque. What do I mean by being opaque?
P: Not transparent.
T: Not transparent. You can't see through it. Have you seen the scleroid; the outermost wall of the eye?
P: Yes
T: Are you seeing it?
P. Yes
T: Then in front it forms something. In front, the scleroid forms the cornea. Look at it. When you look at the scleroid, coming in front it form, it forms the cornea.
0.04) This cornea is now transparent. Remember, behind it is opaque, but in front it forms the cornea which is transparent.
P: Transparent
T: The second layer is the choroid.
P: Choroid

T: This choroid is made up of pigment - melanin. And as such it is dark. (Writes this point on the board). I said the second layer is the choroid, which is dark in colour because of the presence of this pigment, melanin. I think we've met this before?

Ps: Yes.

0.05) T: When we treated what?

Ps: Skin.

T: When we treated the skin. In front again it forms something; the second layer, choroid. In front -, it doesn't form the choroid again; it forms another thing. And that thing is what? The iris.

P: Iris.

T: Do you see it?

Ps: Yes.

T: The iris in front. Remember, the scleroid forms cornea in front. The choroid forms iris in front. Then the third layer is retina. Do you see the retina? This retina is the inner-most and most delicate part. It has light sensitive cells. Light sensitive cells called the rods (writes) and...

P: Cones.

0.06) T: Cones. The retina has light sensitive cells called the rods and cones. At a point, at the spot just opposite the lens in the retina, we have the yellow spot or fovea, which has more cones than the rods. The fovea has more cones than rods. But before we go on, let me tell you that the rods are sensitive to low light, while the cones are sensitive to ...

Ps: Bright light.

T: The rods are sensitive to low light while the cones are sensitive to bright light intensity.

0.07) While at this point (points to diagram) we have more cones than the rods where we call the fovea or the yellow spot. Because it has more cones than rods it gives the clearest vision. Leaving the fovea down are the point where the optic nerve leave the eye. Do you see the optic nerve?

P: Yes.

T: At this point (points to diagram) where it leaves the eye we have the blind spot. Why is this called the blind spot? It has no sensitive cells at all. It has no rod, it has no cone. These are the cells that are sensitive to light. That is why we say that retina is sensitive to light because rods and cones are scattered in the retina.

0.08) But at one point we have more cones which are sensitive to high light intensity or just light than rods. Leaving that one we have the blind spot which has no sensitive cells at all. Neither the rods nor the cones, none of them is present. So it is insensitive to light.

P: Which one is insensitive?

T: The blind spot. Are you following?

Ps: Yes.

T: Then inside we see the lens. What is the shape of this lesn?

Ps: Round, Oval (chorus).

T: If you know it tell me, physics students. Yes!

P: It is more or less spherical.

T: It is spherical.

0.09) But to be more specific, it is biconvex (writes). The lens, ... and this lens do you see the position? It divides this eye into two chambers. One greater than the other. In front we have the aqueous humour and behind we have the vitreous humour.

Ps: Humour.

T: What is inside this aqueous and vitreous humour? Water substance containing sugar and protein (writes). To supply the lens with sugar and protein.
Ps: Protein.
T: And also to protect it, make it watery.
(0.10) And then what is another function of this aqueous and vitreous humour which we say is watery substance containing sugar and protein? Supply these things to the Lens and then make the lens watery. It also gives the eye its shape. Because if they are not contained here the walls may collapse. Do you understand me?
Ps: Yes.
T: Let's take for instance the balloon (draws). When you inflate this ballon with air, it has the shape. And then you open at one end to deflate it the wall tends to come together, losing that shape. The same applies to the eye. If this watery substance are not there they will tend to lose the shape. Do you understand this now?
Ps: Yes.
(0.11) T: So their presence gives the eye its shape. Look at the ..., now is the lens hanging in the air?
Ps: No.
T: It is held in position by the suspensory ligament.
Ps: Suspensory ligament.
T: The lens is held in position by the suspensory ligament, which is an outgrowth from the ciliary muscle. The ciliary muscle. The gap between this iris ..., you know we have mentioned iris before ..., the gap between the iris is called the pupil. Iris is formed in front from the choroid. Do you remember?
Ps: Yes.
T: And the gap between this iris is called the pupil. So we now
(0.12) the parts of the eye; the structure. The cornea in front formed from the scleroid is the first layer of the eye. And then the second layer, the choroid forms the iris in front. And the lens divides the eye into two chambers; the vitreous ..., the aqueous humour in front and the vitreous humour behind ... .
P: Behind.
T: ... both containing sugar and protein, and they supply this to the lens. Also gives the shape to the eye. Now another function of this aqueous and vitreous humour is to refract light when it enters the eye. Now that you have known the structure of the eye you will not stop one day to think about how you see!
(0.13) You know, when we were starting this sense organ you said they help us to know more about our environment. And if you see things around you, you know them better. Can you think of how you see? Since you were born you started growing, you see things around you. But there are people blind. How do you manage to see? How are you very lucky to see? That we shall discuss under the formation of ...
P: Images.
T: ... images (writes: Formation of Images). Now we know that light travels in a straight line. Is that correct?
(0.14) Ps: Yes.
T: Here is a human being standing (Draws on the board to illustrate) behind ... . You know, we are discussing one eye. What happens in one eye also obtains in the other eye. So we shall be taking one eye at all times. What is this now?
Ps: Lens.
T: This? (points).

Ps: Pupil, cornea.
T: The cornea. Here? (points).
Ps: Aqueous humour.
T: Here? (points).
Ps: Vitreous humour.
T: Vitreous humour. And here? (points).
Ps: Optic nerve.
T: Where is this optic nerve going to?
Ps: To the central nervous system.
T: Now listen. All images are formed in the eye. This is the ... the light rays coming from that human being.
(0.15) On getting to the cornea ..., remember when light travels from one medium to another, it ...
Ps: Refracts.
T: ... It refracts. Entering the cornea it will refract or bend. Because its a different media from the atmosphere. (writes) And getting to the lens, what will happen too?
Ps: It will refract.
T: It will also refract. Then remember it is carrying that image of the object to focus where?
Ps: On the fovea, retina.
T: On the retina. Now look at that human being here. What of the position of this human being that the image is being focussed on the retina?
(0.16) Ps: It is formed upside down.
T: It is formed upside down. What about the size?
P: Smaller.
P: Diminished.
T: The size is getting smaller. And when the image is formed on the retina, ... you know that the retina has the light sensitive cells, the rods and cones. ... They are now stimulated. Changing this light sensitivity into nervous impulse. Do you remember?
Ps: (No response)
T: And then this impulse, does it stop there to show you your teacher standing in front of you with the head on the floor and the feet up?
P: No.
T: Are you seeing me like that?
Ps: No.
T: You are seeing me standing on my feet. What do you think has happened?
(0.17) P: (In audible. Fails to be clear and teacher continues)
T: This nervous impulse set up in the rods and cones in the retina has been transmitted through the optic nerve to the brain.
Ps: Brain.
T: For what?
Ps: For interpretation.
T: For interpretation and correction. It will turn this to appear erect. You see that object as being erect. What part of the brain does this work?
P: Frontal part of the brain.
P: Cerebellum.
P: Central part of the brain.
P: Cerebrum.
T: Now, when we discussed the brain, you know, we had the fore-brain - the mid-brain and the hind-brain.
(0.18) And in the fore-brain, we mentioned that the centre ..., the motor centre association, accessories centre are located in the fore-brain. And in fact, the specific area is at the

cerebral cortex, cerebral hemisphere. So when this impulse is carried by the optic nerve to the cerebral cortex it interprets it. This image being focussed on the retina will make you see the actual size. Make you see the object as erect, upright. And then give you the feedback; this is a human being not a tree. Is standing on her feet. And the actual height of the person. That is the function of the cerebral cortex.

(0.19) Interpreting the impulse being sent by the optic nerve. That impulse previously was light rays (writes), and falling on the retina and the rods and cones are stimulated. That stimulation is being transformed into nervous impulse by the light sensitive cells, and carried by the optic nerve to the cerebral cortex of the brain, and the feedback is being seen as real image and you see the person.

P: Excuse me!

T: Yes.

P: Supposing these things are not taking place in the human being what will happen?

T: What things?

P: This ...

P: You are blind.

T: If you are looking and you don't see, what do you think is happening to you?

Ps: Oh o! You are blind.

T: You are blind. And that may ... now listen, that may come from the damages of the retina.

(0.20) If you are not blind from birth then there must be some damages in this organ for sight, which is the eye. And in short, probably you don't have rods and cones on the retina, or they are damaged. You know I mentioned they are very delicate.

Ps: (Two pupils try to ask questions)

T: One after the other, yes!

P: Does it affect all?

T: That is what I mean by damage. When this diseases come to your eyes, first they start by reddening the eyes. And then if not well treated they may damage these delicate organs in the eye. Any other question? Yes!

P: What exactly is in our eyes that make our eyes to become red?

(0.21) T: When you have infection, it will make your eyes red. When you have foreign body in your eye, it will redden the eye.

P: But what makes it to be red? What is inside our bodies that makes it to be red?

T: Do you know that you have supply of blood to every part of your body? And when you have foreign bodies in your eye you tend to scratch and then these things will be coloured and get reddened. At times when you bend down ..., even babies when their heads turn upside down, you see inflow of blood come more to the head and they are shown in the eyes. They colour the eyes. Yes!

P: After operation can one have his sight back?

T: After ...?

(0.22) P: Operation ...

T: Can one have ...?

P: His sight?

T: If it is what we call the catarract, a covering on your eye ..., you see in some students when you look at their eyes you see some white substance covering the eye. If you go to remove that entirely then they will start to see. That thing is just blocking the light rays entering the eyes. You know that this cornea is now transparent and all these things here, (points to diagram) with the help of this gap, the pupil, light can travel from the atmosphere to the cornea, aqueous humour through the pupil, enter the lens, the vitreous humour and focus on the retina. You see this is not there.

0.23) If something comes to cover the cornea, it is blocking your view; light can not penetrate again. And when that is removed ..., operations are done mainly for removing such ... such types that cover the passage of em. light rays into your eyes. When they are removed then you will get your sight.

P: Madam, I believe when those things are removed the person will not see full; he will see partial.

T: Has it occurred to you before?

Ps: (Laugh)

P: Excuse ma!

T: Yes!

P: Why is it that somebody in a complete dark place and unfortunately there is bright light, it will dazzle his eyes?

T: That is what we mean by ... this, you know that the eye needs adequate light. These cells here if care is not taken high sensitive ... high light destroys the cells. And immediately like last night, the light went off. All of a sudden it came back, you noticed some adjustment in your eye.

0.24) The pupil ... the iris will now come closer together making that passage, the pupil, small to allow only the adequate amount of light you need into your eyes. So since it is so sudden you get that quantity of light entering your eye you tend to ... your eye, your eye tend to adjust to allow in only the quantity you need. That is why. Yes!

P: Sometimes when you come into a place from outside you don't use to see well for sometime, why is it so?

T: Because the intensity differs. In the bright light, your eye tend to ...

P: Contract.

T: ... the iris tend to close up making little ... leaving only a little space here (points to diagram), making the pupil small in size to allow only small amount of light.

0.25) Now when you come in going from one em ... em ...

P: Bright light.

T: ... illumination to the other, bright light to dim light, you tend to adjust. During that period of adjustment it tends to be shady. Yes!

P: What will happen to the eye if there is lack of sugar-and-protein in the aqueous and vitreous humour?

T: Do you know that the eye is functioning constantly? And it needs energy, do you know?

Ps: Yes.

T: That is what ..., why it is being supplied with it.

P: What of ... (teacher interrupts)

T: And to be deficient of sugar and protein and you know em ... the result of food deficiency.

P: The eye will spin.

P: Ma, excuse me!

T: Yes.

P: At times when somebody will give you a very hard slap around here, (touches side of face), you will see blue stars going round, round and round.

0.26) Blue red stars just going round.

P: And black (and laughs).

T: Now listen, that has to do with balance in the ear. And all these things are connected. They are ... they are going to the brain. There is a sort of accident, let me put it that way. When you are given a big slap around the ear then the fluid, the fluid, the perilymph inside the semi-circular canal, they are disturbed. And they control your balance. And since all these things are connected to the brain, you see stars really. Because if the slap is very hard you, you stagger before you regain yourself.

P: Why do some people have different colour of eyes? Some have blue, brown and black?

T: That has ..., now that has to do with gene.

0.27) The chromosomes that come together to form you from your parents. From both male and female, from husband and wife; what they have is what they give you. You either take to your father or to your mother.

P: Excuse me, if you look at em ... some people's eyes, now if I am looking at you, my eye, I am looking at you but the eye is this way (guestures directions of eye with hands).

Ps: (Laughter).

P: Is called "4.O'clock eyes."

Ps: (Laughter).

T: That is what we call ..., is not 4, O'clock. They call it squint. The eyes are squinted ... (writes: Squint).

Ps: Squinted.

T: ... to one side. You are looking one side, but your eyes are pointing to the other side. (A lot of excitment in class).

P: Does it mean that if the light intensity is low, the pupil expands?

0.28) T: Yes. If there is low illumination then, this, (points at diagram) pupil, this iris will recede, go back a bit. Mainly for the pupil to be bigger in size and then allowing more light into your eyes, and then you see clear.

P: Excuse me.

T: Yes.

P: As we have seen now, rats and cockroaches don't move at the day. They move at night, when the place is dark. Does it mean that they see clearly in the dark? Or they just go about?

P: No.

T: They have other sensitive areas, like the cockroach has the antennae which enable it in discovering. You know, the cockroach has the compound eye.

P: What about the colour of the eye?

T: Yes, both the colour and the make-up. It is what I have I will give to my children. What myself and my husband bring together that the children have.

P: Eh e! From that point, the father and the mother may not have red eyes and the child may not have their eyes.

0.29) P: The child may not have their eyes!

T: Now, there are dominant genes and recessive genes. They may manifest in another generation. You see your child, they won't look like you or your wife's they look like your great grandfather. That gene has now manifested in that child. Because; since, they have been kept in the people between your great grandfather and you. Now it has brought out itself.

P: Ma, that is reincarnation of the eye.

P: Could it be it is due to the food you eat?

0.30) T: No never. Do you remember digestion and then respiration, tissue respiration? Where those things are being carried through blood capillaries to all part of the body. Now your eye is one of the parts of your body. They must be carried to that place. Yes!

P: Why is it that new born babies don't see as soon as they are born?

T: Not that they don't see. They don't ..., by that time everything is growing gradually. Why don't they walk immediately they are born? Or start to talk? Sensitivity moves with all these things. Then after a time ..., not that they are not seeing. They don't know that they will ..., what you are bringing near their eye will hurt their eye. So if you are doing like this, (moves - dangles fingers to demonstrate) they will just keep their eyes open. After two days when you bring something near the eye, you see them blink.

0.31) Because not they are wanting to ... they have started to know that that thing will hurt their eyes. And blinking is a way of protecting the eye. So they blink.

P: Is very interesting.

T: Now from this em formation of images, what and what do refract light rays when they enter before it is being focussed on the retina? If no ..., let me state it again. What and what in the eyes tries to refract light rays before it is being focussed on the retina?

Ps: The cornea and lens.

T: One after the other, when you stand up ... Sotonye Jack?

P: The image.

Ps: Out of point.

T: Sunday?

P: The cornea.

T: The cornea.

0.32) Let me name it: the cornea, the aqueous humour, the lens, the vitreous humour and then it finally falls on the retina. And what about the image formed?

Ps: Upside down.

T: It is inverted.

P: It is visual object.

T: It is not visual object; it is real object. And then dimished. (Summarises lesson - writes). Now what carries the impulse to the brain?

Ps: Optic nerve.

T: The optic nerve. To what part of the brain?

Ps: To the cortex.

T: To the cerebral cortex. So, in our next lesson we shall discuss how the eye focus far and near objects. Also, the eye defects. That is for next lesson.

Ps: Very very interesting.

0.33) P: I enjoyed this topic oh.

T6

Lesson: Chemistry
Class: 4 (in the Lab.)
Time: 11.47-12.16 (29 mins.)
No. of pupils 40 (all girls)

Time: Topic: Water - Properties and its uses as solvent

(0.00) T. Chalk - (pupils settling down)
(00.1) T. Where is the chalk? What did we do in our last lesson? Who remembers? I remember we prepared a salt. What type of salt did we prepare?
(0.02) Who remembers the name?
P. Sodium chloride.
T. Sodium chloride. Who remembers how we prepared Sodium Chloride? Yes!
P. We reacted hydrochloric acid through neutralizing with a base like Sodium hydroxide.
T. Then we know that a sodium chloride is a soluble salt and for soluble salt we know we prepare them with methods that involves crystallization.
(0.03) Ps. Crystallization.
T. So, when we got our hydrochloric acid and sodium hydroxide we poured the acid in to the base and we have the salt in solution. So the method through which we could bring out the salt to ---- to ---- evaporate the solution to dryness. And the solid that was left behind for us was our salt, sodium chloride.
P. Chloride
T. Today, we are going to talk about another thing.
(0.04) We are going to talk about a simple substance that we use almost everytime of our lives --- and that substance is -----. Who knows what that means?
P. Water
T. I am saying that water is a substance that we use almost everytime in our lives. What do we use it for?
Ps. For cooking.
T. We use water for cooking.
P. Drinking
T. Drinking
(0.05) P. For washing ...
T. For washing what?
P. Our clothes
T. Yes
P. ... our clothes
T. Yes!
P. Bathing
T. For ?
P. Cooling industrial instruments
T. For cooling instruments etc. Yes, cleaning dirty places. Okay, from what you have told me, we all have seen that we use water for
(0.006) so many purposes, and can we live without it?
P. No
T. So, without water we cannot live.

Okay, these uses we can say are domestic uses of water. Now, like our friend told us that water is also used in the industry ..., In the industries, what do we use this water for?

P. Cooling of industrial instruments

T. Cooling of instruments. Now, even in the industry there are so many uses we make use of water, and one major use of water we are going to talk about today is using water to dissolve certain

(0.007) things. So we are going to say, we have water, the major use of this water and its uses in dissolving things. Now, may be later we will give it another name. We have a test tube here ... and we have a substance here ... a substance that is very common to us. What is it?

P. Sugar

T. Sugar. Now the test tube is so small that it cannot take it as it is.

(0.08) So I am going to break it. Now look at what I am going to do. I have put the sugar into the water. Now, what I want you to do is to observe it, look at it and see whether you can notice anything. Do you notice anything?

P. Yes

T. What is it?

P. It has dissolved in water

T. If I were you I will say the sugar is reducing its size. And as it is reducing its size, is it going away?

P. No

T. Is it moving out of the water?

P. No

T. Moving out of the test tube?

P. No

T. Okay, it is just disappearing into the water and this process we say ... we call it 'dissolving'

(0.09) P. Dissolving.

T. Now if I want it to dissolve quicker ... if I want it to dissolve quicker what will I do to the test tube?

P. You will shake it

T. I will shake the test tube or I can use any substance to stir it. When you drink your tea, what do you normally do?

P. We stir it before drinking

T. So, I can even do this by using this glass rod to stir it (teacher stirs). Do we see any particles of sugar any more?

P. No

T. So, it has all gone into the water. So we can say, water plus

(0.10) sugar ... we have liquid water, we have solid sugar. Now, when we put them together we are now seeing only liquid ... we are seeing the water ---. Looking at it, we are seeing the water

Ps. Water

T. Looking at it alone we will not be able to see whether it contains anything or not. But if we should taste it what will we discover?

Ps. We will taste it

T. We will discover that the sugar is in the water. So we can say the water and the sugar have now given us .....

Ps. Sugar solution

(0.11) T. Sugar or a mixture of sugar and water . A mixture of sugar and water. But one thing we have to note is that this mixture is so uniform. By saying that I mean the particles of water and the particles of sugar are so well mixed together that we cannot be able to say this one is the particle of water and this is that of the sugar. The particles of the sugar and those of the water are so well mixed together. So we will call this now a uniform mixture of sugar and water

Ps. Sugar and water

(0.12) T. Now, because this mixture is so uniform, we can call it a solution. There is one other name we can attach to it but we will mention that name later. So we have got a uniform mixture of sugar and water, and this uniform mixture of sugar and water we can call it a solution. So the water plus sugar is giving us a solution. Remember, the reason I gave you. Remember the reason I say we are calling this a solution. It is a uniform solution because the particles of sugar and the particles of water are so well mixed together. You can not point out this is the particle of sugar or this is the particle of water

Ps. Water

(0.13) T. Any part of this solution that you taste will give you the same taste. Now, as we said before, if you are dissolving the solid and you want to dissolve quicker, you can shake the test tube or stir it. Again, there is another method. If you want the sugar to dissolve quicker there is one more thing ..., there is something you can do to the sugar before adding it ot the water. What is thing thing? Yes!

P. By grinding it.

T. Yes, by grinding the sugar - making it to appear in smaller particles. Now you will observe this as you take your morning tea. If you use cube sugar, and granulated sugar to drink your tea, which of them dissolves quicker? Is it the .... granulated sugar.

Ps. Its the granulated again.

T. Again, in connection with tea there is one more thing we can say. There is one more way that we can make the sugar dissolve quicker. You know when drinking tea, the tea could be hot or cold. In which of these cases does the sugar dissolve quicker? You!

(0.14) P. In the hot tea

T. In the hot tea. The sugar can be made to dissolve quicker by grinding it to smaller particular and by using hot water

Ps. Hot water

T. Now, as a scientist when you say hot water, what strikes you at the back? What is that main thing that is there? Yes, when you say hot water, what are you really talking about?

P. Very hot water

T. What about water?

P. The temperature of the water

(0.15) T. Is the degree of hotness of that water which we normally call it the temperature of that water. So you can make something to dissolve quicker by making it to be in smaller particles or by increasing the temperature of it. By grinding it or increasing the temperature.

Ps. Temperature

T. Now, let us now go back to our board. We have liquid water, we have solid sugar. Put them together and it gives us a solution. There are some other names we can use for these. As we are talking about that, in this case let us say mixture of (writes) sugar and water. Now, this water we use in dissolving the sugar we can call it solvent. The water we use in dissolving the sugar we can call it solvent. So a solvent is something ... a substance we use in dissolving another thing or another substance. Solvent plus solid sugar. Now this solid sugar that dissolves in our liquid water, we can call it a solute, We can call it what?

(0.16) Ps. A solute

T. So from what we have got now a solute is ... a solute is what? A solid or a substance that dissolve in a solvent. We use a solvent to dissolve a solute. So from what we have on the board, solvent plus solute is now giving us solution

(0.17) P. Solution

T. Now, do you think all solids will dissolve in water as sugar has done?

Ps. No

T. No! Okay let us try one ... let us try a solid in another test tube and see whether our 'No' is true. I want somebody to get some quantity of sand - there (points). Just a small quantity of sand. We have performed this experiment when you were in Form II. Is it one or two?

(0.18) Ps. Two

T. Now, what do you see?

Ps. A solution of sand and water

T. What I want you to tell me is what you are seeing inside this test tube

P. The water is dirty

T. One person at a time. Tonye, we are listening to you. We are listening to Tonye.

P. The solution is a dirty one

T. Remember, I told you why we called the other one a solution. Yes.

P. It can't be called a solution because ...

T. I am not asking you whether it can be called a solution or not. All I am asking from you is what are you seeing?

P. The sand is at the bottom while the water is at the top of the sand

T. Now I shake it again

(0.19) P. It is still the same

T. It is still the same. So this one is not happening like the case of the sugar. Now even if after shaking ... , I am now shaking and shaking and shaking till I am even tired. But what is happening? The sand has refused to go into the water

Ps. Water

T. What it is doing is just settling at the bottom of the test tube, leaving us with dirty water on top. But if we allow this to rest for sometime, what do you think will happen to the dirty water?

P. It will clear

T. It will be clear, because gradually the particles of the sand will settle to the bottom of the test tube

P. Test tube

T. Right now, if you look at it you will see large particles of the sand at the bottom of the test tube while you see fine particles, that is, smaller particles of the sand still moving in the water

(0.20) Ps. Water

T. They are suspended in the water
P. Water
T. So in this case can we call it a solution ... a uniform solution
P. No
T. We cannot call it a uniform solution because we can make out the water from the sand
P. Sand
T. So instead of solution, we call this a suspension. We call it what?
P. A suspension
T. So in the second case we have water again plus sand and it has given us a mixture of sand and water
P. Sand and water
T. But we have to decide how the sand and the water are in the test
(0.21) tube. We have the large particles of sand right below followed by smaller particles. And some very very small particles still in the water moving to all directions. So we now call this one a suspension. We call it what?
Ps. A suspension.
T. Now what names will you give to this water?
Will it be a solvent?
P. Yes.
T. It is a ..?
P. A solvent.
T. Okay, so we can now call this water, solvent.
We call this one a solute.
P. Solute.
T. Then what is our result?
Ps. Suspension.
T. The result is a suspension. Can we think of other cases where we can mix two things, a solvent and a solute together and it gives us a uniform solution? Who can think of one? Yes!
(0.22) P. Common salt.
T. Common salt. I will like you to mention its chemical name since we are in the lab.
P. Sodium chloride.
T. So if we take another test tube, and add come sodium chloride ---, you see something happening already. Is n't it? You see something happening already - is n't it?
Ps. Yes.
T. What is that?
Ps. The salt is disappearing.
T. The salt disappearing into the water. So it is now giving us a solution.
Ps. A solution.
T. What type of solution?
Ps. Uniform solution.
T. Uniform solution. Okay, can we now think of another thing where
(0.23) we can mix a solvent and a solute, and it produces a suspension of us? Yes!
P. Water with iron filings.
T. Water with iron filings. Do you know what iron filings are?
Ps. Yes.

T. We use it when we are trying to separate mixtures. You remenber it?

Ps. Yes.

T. So if we put iron filings into water it will give us a suspension. Now I, gave you a very easy one. Is --- one that we see it almost every morning. Yes!

P. Chalk.

T. Is it chalk? Amost every morning. How many of you know how to drink akamu? Okay when you prepare the akamu how does it look (0.24) like? You put the solid akamu into your water, in that case the water is the solvent, the akamu is the solute. When you put them together and stir, what happens?

Ps. It dissolves.

T. I want one person to answer. Yes, one person who knows how to drink akamu. Yes.

P. It mixes with water.

T. Initially, you see it, it mixes into the water. Then when you allow it to stand for some time, what do you see?

P. It starts settling down.

T. The akamu will now start settling at the bottom of the containing vessels. So we cannot call that a true solution, or a uniform solution. But we can call it a suspension.

P. Suspension.

HOMEWORK

T. Now, I will like you to do this at home. You know that em... em substance we call... Blue .. you use it for your white, Is n't it?

P. Yes.

T. I want you to put some blue into the container containing some (0.25) water. Shake it up and allow to stand. On the other side, take a common salt and put into water. Shake it if it does not dissolve at once and observe what happens in the two cases. I would like to see the results..., your observations from your experiments on Monday. Is n't it or Tuesday? Then from the two activities you will be able to tell us which one among them is a uniform solution and which one among them is a suspension.
Okay, let me give you something that will stop you from murmuring. I want somebody to define a solvent for us. What substance will (0.26) you call a solvent? What is a solvent? Yes!

P. A solvent is a substance which can dissolve a solute.

T. A substance is a... a solvent is a substance which can dissolve a solute. Okay, we will like to hear from Tonye. What a solute is?

P. A solute is a substance which can dissolve in a solvent.

T. Which can be ...?

P. Which can dissolve in a solvent.

(0.27) T. Okay, what will you say about a solution?

P. A solution is a ... (interrupted by teacher)

T. Did I say a uniform solution?

P. A uniform solution is a ... it is when eh.. when eh..

T. Since, you have been laughing ... you do not know what a uniform solution is!

P. A uniform solution is formed when solvent and solute are mixed together?

T. When?

P. Solvent and solute.
T. And something happens, what is that thing?
P. The solute enters the solvent.
T. Okay the solute enters into the solvent completely. What can we
(0.28) say about a suspension?
Nefiema are you ready?
P. A suspension is when the solute enters the solvent and it does not dissolve.
T. How long does it stay?
P. After a short period of time the solvent will settle at the bottom of the vessel.
T. The solvent?
P. The solute will settle at the bottom.
T. Will settle at the bottom of the containing vessel. Okay!
(0.29)

T7

Lesson: Chemistry
Class: 5 (In the lab.)
Time: 45 mins. (11.50-12.41)
No. of pupils: 25 (All girls)

Topic: Halogens - Chlorine, its preparation and its characteristics

Time:

(0.00) T Last week we started treating chlorine and I mentioned to you that chlorine is one of the four members of the halogen family. And that halogen means salt-producers since the halogens or members of the halogen family combine with most metals to form
(0.01) salt-like substances. Then I told you that chlorine is made or is prepared by the oxidation of hydrochloric acid (writes) Hydrochloric acid when oxidized gives you water plus chlorine. So this is a very common way of preparing chlorine. Then we started the lab. preparation of chlorine.
This lab. preparation we are going to talk about now uses heat. There is another method we will discuss later. That method
(0.02) involves no heat. (writes). So in a round bottom flask or in a flask like this you put your manganese (iv) oxide. Then through a thistle funnel you pour hydrochloric acid. Then you heat. But before heating, after pouring your hydrochloric acid, you shake the flask. After shaking the flask then you connect the flask to
(0.03) the other .... , to the wash bottle which contains water. That wash bottle contains water to remove hydrogen chloride gas. Then the rest of the gas passes through the next delivery tube into the second wash-bottle. This second wash-bottle contains sulphuric acid which serves as a drying agent to the gas. Then the dried gas now moves into another delivery tube and passes into the collecting jar. That is, ga jar. That is a rough
(0.04) sketch of the apparatus. (Draws). That is what the apparatus looks like.

T. Then the equation for the reaction: (writes). Manganese (iv) oxide plus hydrochloric acid which will give manganese chloride, plus water plus chlorine (MnO2+4HCL - MnCL2+2H2O+2CL2.) This is one of the methods of preparing chlorine.
(0.05) The next method is one in which you collect chlorine over brine. Brine is sodium hydroxide. In this method you use potassium tetraoxomanganate. Here you need not heat the mixture before your chlorine is ev lved. All you have to do here is just pour in your hydrochloric acid .... , concentrated hydrochloric acid there and your greenish yellow gas will be evolved which will be collected over brine and you see your greenish-yellow gas in the gas jar. The equation for the second reaction is ..... , remember that heat is necessary here in the first reation .... , first
(0.06) method of preparing chlorine. In the second method, no heating is needed (writes). So all these are the products of the reaction between potassium tetraoxomanganate and concentrated hydrochloric acid where no heat is needed. And you need not

(0·07) perform the preparation in a fume chamber. All you have to do is just connect your apparatus so that you collect your gas through brine.
Now we will look at the properties of chlorine. What are the properties of chlorine?
Yes!

P. It has .... it is green-yellow gas
T. Is it green - yellow you say?
Ps. It is a greenish-yellow gas.
T. It is a greenish-yellow gas. What other properties do you know?
P. It has a choking and an irritating smell.
(0.08) T. Louder please!
P. It has a choking and irritating smell
T. Okay, it has a choking, irritating or unpleasant smell. What other properties?
P. ..... (inaudible)
T. Yes, Okay
P. It is soluble in water
T. Is it soluble in water? It is. I only wanted to test or confuse you a little bit. Yes!
P. It turns blue titmus red
T. Okay, it is an acidic gas. Anymore?
P. ..... (inaudible)
(0.09) T. Why do you say so? (Silence). Can anybody try?
P. Yes!
T. Yes
P. If you breathe it, it is poisonous
T. Yes. It is a poisonous gas if you breathe it in. Yes, do you want to add anything? Is that what you wanted to say?
P. Yes
T. You have not said that it bleaches colour off all substances. So that is one of the properties. It is a bleaching agent. So the ..... , and the chlorine does not go bleaching dry clothes. So the clothes have to be damp before the chlorine can bleach them.
(0.10) Just like your filter paper, if you just put the dried fileter paper or litmus paper into a container of chlorine, nothing will happen. So you have to dip it into water before the bleaching action can start at all. Who knows why it should be dipped into water first?
P. So that it can react with the water
T. So that what can react with what?
P. Water with chlorine
(0.11) T. Yes. So the bleaching action ... the bleaching action of chlorine is brought about ... by the formation ..... by the formation of hypochlorous acid. By the formation of hypochlorous acid or Oxochlorate. So the chlorine reacts with that water to form your oxochloride. And this oxochlorate is actually the reactive agent in the bleaching action ... in the bleaching action of chlorine. That is why chlorine cannot start bleaching anything just like
(0.12) that. So it has to react with water to form this oxochlorate or hypochlorous acid. Then this hypochlorous acid will give its oxygen to the dye ... to the colour of the material before the dye will be bleached. So the oxochlorate is the reactive substance. So when you have the dye and you add this

oxochlorate, what you have is due plus oxochlorate .... dye plus the oxygen of this oxochlorate. Then you have your hydrochloric acid. So each dye is coloured. So the dye plus oxygen is colourless.

(0.13) That's how the chlorine bleaches anything even including litmus paper. So your chlorine will first of all act with the water in which you dipped your litmus paper to form this oxochlorate. Then the oxochlorate will give its oxygen to the colour of that litmus paper before it bleaches it into colourless. But first of all, being an acid gas, the colour of the blue litmus paper will first of all change to red before changing to colourless. Is it clear?

Ps. Yes.

T. So if you want to test for chlorine you just get a blue litmus
(0.14) paper, dip it in water and put it in a gas jar containing chlorine. Before changing to colourless your blue litmus paper will first of all change to red before changing to colourless. And it changes to red because chlorine is an acidic gas. Any questions? Is there anybody that does not understand chlorine so far? Yes!

P. You said that types of chlorine ...

T. Types of chlorine? You don't understand it or you didn't hear what I said?

P. I didn't hear ....

T. .... What I said? I said that if you want to test for chlorine, there is a very simple property of chlorine you can use without
(0.15) referring to this ...., without referring to action to Litmus paper. You can use the colour one. Colour of chlorine being a greenish-yellow gas you can use the colour of it to identify it. You can also use the smell---the odour of chlorine you can use it to identify chlorine. That is the second test. Then the third test is this action to .... with litmus paper. If you were asked to use litmus paper to identify chlorine, your first step is to dampen that litmus paper, that is, you should dip it in water. Because its only with water on the litmus paper that the chlorine will act on it. So the chlorine first of all act with the water to form hypochlorous
(0.16) acid. After forming this hypochlorous acid, it is this hypochlorous that will give its oxygen. The oxygen here will be given to the dye. That is, the colour of the litmus paper before it changes it to colourless. That is, dye plus oxygen here is colourless but this due here is coloured. But by the time the oxochlorate will have acted on it, it will become dye and oxygen, and this dye and oxygen is colourless. Is that clear?

Ps. Yes Ma.

T. So, now we are going to take hydrogen chloride gas. Hydrogen
(0.17) chloride gas: (writes). Chlorine has an affinity for hydrogen whenever hydrogen is free or in combined state. So if you have hydrogen in a compound, say hydrogen sulphide, chlorine will act .... , will displace its sulphur to attach itself to hydrogen. Even if you have hydrogen in form of water, the chlorine will displace any other thing you have attaching itself to hydrogen, to attach itself here. That means that it has a very strong attraction for hydrogen. Because of that even free hydrogen can

be attached .... or even free hydrogen can be attached --- or
(0.18) even free hydrogen can form compounds with chlorine because of that strong affinity that chlorine has for it. So chlorine can react with water to form this type of compound first. Then after that it will lose the oxygen to form hydrogen chloride gas. Have you written that chlorine has a strong affinity for hydrogen?

Ps. Yes

T. So chlorine plus water gives you your hydrogen chloride gas plus
(0.19) oxygen (write). This reaction occurs in two stages. This reaction between chlorine and water to give your hydrogen chloride gas plus oxygen occurs in two stages. So the first molecule of water plus one molecule of chlorine will give you the hypochlorous acid or oxochlorate plus HCL. Then the second --- second molecule of water will undergo this type of reaction
(0.20) also to give you another molecule of oxochlorate and HCL. But two mol ecules of oxochlorate gives you two molecules of hydrogenchloride gas plus water. What type of reaction is this?

P. Displacement

T. Displacement?

P. Decomposition

T. What?

P. Decomposition.

T. How is it decomposition? If it is decomposition, how? You are not sure. That's what you think. If you are sure you should be able to tell me how this reaction is decomposition? You don't
(0.21) know why it is decomposition? Is a shame! Didn't I teach you that in decomposition its an already formed compound that decomposes into simpler substances. I said that much, didn't I?

Ps. Yes

T. So, why can't you say it again when you are asked to say it? It seems as if you are not taught. So one molecule of water plus one molecule of chlorine reacts to give your hypochlorous acid plus HCL. Then, the next molecule of water ----, notice that there are two here. This is only one. One undergo es this type of reaction. The second one undergoes this type of reaction
(0.22) again. That is how we came about this two here. So this two will undergo decomposition to give you your HCL gas plus oxygen. That is, preparation of hydrogen chloride gas using chlorine and water. You can also prepare hydrogen chloride gas using chlorine and hydrogen sulphide. Here, it is only one molecule of chlorine that you use. This gives you your two molecules of hydrogen chlordie plus sulphur. You can also use three hydrogen plus three chlorine since I told you that chlorine has a strong affinity for hydrogen. It does not find it difficult attaching itself to the hydrogen at all.
(0.23) Any questions so far? Any questions? Did you understand it?

Ps. Yes ma

T. Properties of hydrogenchloride gas. Hydrogen chloride gas has a choking, irritating smell. Why? Why does it have a choking, irritating smell? You don't know?

(0.24) P. Because of the chlorine.

T. Yes. When treating the properties of chlorine we mentioned the smell of chlorine and this is another gas that has chlorine in it. And because of that chlorine, the gas here too also has the same type of smell.
It is an acid gas, why?

P. Because of the presence of chlorine.

T. Yes. The acqueous solution .... No, we should say this first. That the hydrogen chloride gas is soluble in water. And the acqueous solution of the gas gives on acid.

(0.25) The aqueous solution of hydrogen chloride gas gives an acid which is almost completely ionised in water. Hydrogen chloride gas does not support combustion. Hydrogen chloride gas reacts with metals like aluminium, zinc and iron to give anhydrous chloride.

(0.26) What is anhydrous chloride? Yes!

P. Anhydrous is something without water.

T. Yes, without water. Say it properly. Say it in another way. Something without water, is it not dry? Yes! So anhydrous chloride, that is, a dry chloride.
Hydrochloric acid: Hydrochloric acid. In the lab. hydrochloric

(0.27) acid is prepared by dissolving hydrogen chloride gas in water.
In the lab. hydrochloric acid is prepared by dissolving hydrogen chloride gas in water, using an inverted funnel to prevent sucking-back due to the high solubility of the gas.
Properties of hydrochloric acid:

P. Ma --- due to the ....

T. Due to the high solubility of the gas. Properties of hydrochloric acid: properties of hydrochloric acid. What are the properties of hydrochloric acid? Yes!

(0.28) P. It reacts with ..... It reacts with bases and acids to form salt and water.

T. Okay! Come and show us. Come and show us. Can anybody come and show us how it forms salt and water? Yes! It is only very few people that are answering questions in class. Are they not your class mates? Or are they taught differently by other teachers except me?

(0.29) P. (Writes equation on the board). $(HCL + KOH \rightarrow KCL + H_2O)$

T. Yes, very good. Show us now ..., what did you say ... You say it is?

P. Forms salt and water

T. Okay. It reacts with what and what?

P. Alkaline metal with acid

T. She has written one, come and write the other one. You don't

(0.30) know it? what do you mean by alkaline? No idea! Does anybody know? Do you know what alkaline metals are? You don't know? So you don't know too what alkaline are! You don't know? Yes, yes, what are alkaline metals?

P. They are ones that are soluble in water.

T. What are they? I am not asking you their properties. Don't you

(0.31) think this is an alkaline? This is an alkaline metal. You don't know? Hm, Iam telling you that this is one of them. Yes!

P. An alkaline is a basic hydroxide which is soluble in water.

T. Like which one and which one?

P. Sodium chloride.

T. Is an alkaline?

P. Po assium hydroxide.
T. Yes, potassium hydroxide is an alkaline ... is a base. Okay. What are the other properties of hydrogen ...., hydrochloric acid?
(0.32) P. It reacts with metals to produce hydrogen.
T. Yes. It reacts with metals to produce hydrogen. Somebody should come and give us an example of the reaction. You! Yes! An example of the reaction between hydrochloric acid and the metal to give hydrogen.
P. I don't know.
T. You don't know! Yes
P. (Writes on the board)
T. What are the other properties of hydrochloric acid?
P. It turns blue litmus red.
(0.33) T. It turns blue litmus red. Yes. Any more? Hm, where is the hydrogen produced now? You have only written the action of hydrochloric acid on a base to produce salt and water. What we wanted now was the action of hydrochloric acid on a metal to give hydrogen. Yes.
P. I don't know
T. You don't know? Only very few people are participating in class. Yes, you!
P. It displaces Carbondioxide from carborates.
(0.34) T. Okay, it displaces carbondioxide from carbonates. We want somebody to come and write the reaction between hydrochloric acid and a metal to give hydrogen. Yes.
P. (Volunteers and writes)
T. Balance the equation. Is it correct?
P. No
(0.35) T. No? Are you coming to correct this one? Yes, okay. You are not seeing it. She has written two molecules of hydrochloric acid plus one iron to give iron chloride and hydrogen. Is it correct?
P. Yes
T. She thinks she is not correct. Come and tell us why it is not correct.
P. There should be 2 there
T. What?
P. There should be 2 there
(0.36) T. Why? Why should 2 be there? Have you not heard of iron II, iron (III)? Haven't you heard of ferrous and ferric irons?
P. We have ......
T. Yes. There is a difference between them This is iron (II) chloride. Is that all you can offer? Somebody said it displaces carbondioxide from carbonates. We want the reaction. You! It seems most of you are not interested in this lesson. I wonder why you come at all if you are not interested. You just sit down, you don't participate in the class. You make the class dull.
(0.37) So who can give us the reaction? Yes!
P. (Writes on the board)
2HCL + Na2 CO3 - 2NaCL + CO2 + H2O
T. Hydrochloric acid and carbonate to give carbondioxide and something else and something else. What is this here? Is it a mistake or you purposely left it?
P. (Corrects error)

(0.38) T. That's alright. So our sodium carbonate or sodium trioxocarbonate plus hydro-chloric acid - 2 molecules of it gives you two molecules of sodium chloride, one molecule of carbondioxide and water. This is a reaction between trioxocarbonate and hydrochloric acid to displace or liberate carbondioxide. Do you have any questions? It is clear so far what we have done today?

Ps. Yes

(0.39) T. Okay, if it is clear, how does chlorine bleach litmus paper? How does chlorine bleach litmus paper? Yes! How does chlorine bleach litmus paper?

P. I did not hear what you said about it.

T. What?

P. I did not understand

T. So ... and I a ed the class whether it was clear!

P. I don't know what you said

T. So what are you trying to say? Is it that you did not hear what I said about it?

P. Yes

T. So who heard what I said about how chlorine bleaches litmus paper? Yes!

P. You said that the chlorine reacts with the water to give the acid

(0.40) and changes blue litmus to the colourless .... .

T. Yes, it reacts with the water to give what? Yes, help out.

P. Hypochlorous acid

T. Yes! Then what happens to the hypochlorous acid?

P. It changes to chloride

T. No. Does anybody know? Yes, what happens to the oxochlorous acid?

P. It reacts with the dye and change to the dye and oxygen.

T. Yes! Its even on the board here. It reacts with the colour .... the colouring material and changes that colour into colour or dye plus oxygen. It is not the same thing as ordinary dye giving you

(0.41) your colourless material. Okay, I said that chlorine has a strong affinity for hydrogen and I said that it can combine with hydrogen whether hydrogen is dash or dash. Whether hydrogen is what or what?

P. Free.

T. Or?

P. Or combined state.

T. Yes! And eh ... and, eh ... hydrochloric acid, we said it can be prepared by what method? How can it be prepared?

(0.42) P. Titration.

T. How do you prepare hydrochloric acid in the Lab? Who has not answered any question today? The next person to you. Yes! How do you prepare hydrochloric acid in the Laboratory? Yes. You.

P. By hydrogen and two molecules of chlorine.

T. Is that how you prepare it in the lab? That is one method of

(0.43) preparing it but I want the particular one used in the lab. Yes!

P. Add sulphuric acid to common salt in round bottom flask ....

T. Hm, to give you what and what?

P. To give you .... em .... sodium chloride.

T. What is common salt? Is it not sodium chloride?

Ps. Yes.
T. So when you want to react hydrochloric acid with sodium chloride what do you think you will get? Yes!
P. Sodium hydroxide
(0.44) T. Sodium hydroxide? Didn't I tell you in this class that you prepare hydrochloric acid in the laboratory by dissolving hydrogen chloride gas in water? What is it you are talking about now? Then I mentioned that you use an inverted funnel for it so that the gas is not sucked back. Because the gas is very soluble. So you are not listening. So shall we continue?
Ps. Yes ma.
T. Chlorides:
(0.45) There are three main types of chlorides. You have the soluble chlorides, the insoluble chlorides and the anhydrous chlorides.

Tape ends

T8

Lesson: Chemistry
Class: 3 (in the Lab)
Time: 10.20-10.53 (37 mins)
No. of Pupils: 35 (all girls)

Time: (0.00) Topic: Separation of components of mixtures using various techniques:

T: (Writes topic on the board).
(0.01) Today, we are going to treat the separation of components of mixtures using various techniques. Last time, we discussed em ... the properties or the characteristics of a mixture and compound.
(0.02) In fact we treated elements, compounds and mixtures. So at least you know what a mixture is. Isn't it?
Ps: Yes.
T: If you are given a substance you should be able to know if its a mixture or a compound. And if you know what a mixture is then we will go on to the next stage which is the separation of components of mixtures using various techniques. As you well know ..., okay, you know what a mixture is! Can someone now tell me in her own simple way what a mixture is?
P: A mixture is that which can be separated ...
T: By physical means.
P: ... by physical means.
T: So we are not chemically ... the components are not chemically combined together.
(0.03) So if the components are not chemically combined together we shall see how we can separate these various components. Now here I have a few things. Well, I know you are going to identify them. The simplest ..., one of the simplest techniques we are going to apply now ... we are going to use is (talks and writes) dissolution, filtration, washing and then evaporation.
(0.04) I will regard all these as a process - dissolution, filtration, washing and evaporation. Look up! I want to prepare a mixture. Here I have sodium chloride, the

Common salt used in the kitchen. Can you see it?
Ps: Yes.
T: I also have sand in this beaker. You all know what sand is. Now, I am going to take, may be, two spoonful ... two spoonsful of sand and some quantity of salt.
(0.05) Let's see if I have enough of this. (Demonstrates as she talks along). I am going to make the sand three so let me add one more spoon. I am mixing it.
(0.06) Look at it, if you can pick out the sand from the salt. (Pupils observe mixture which is being passed round).
(0.07) Alright, we have seen the mixture of salt and sand. So, this is a mixture of sand and salt. We want to see how we can separate mainly salt from sand. So, I am going to pour this mixture into the beaker. Let me have the ... that container. Yes the distilled water ... the distilled water ... the ... yes! Is there any water in it?
P: A little.
T: A bit. Is there no other one containing water? In front of you!
(0.08) P: Yes (after lifting a few water bottles).
T: Does it contain water? Bring it. I hope the water in it will do. ((sign of unpreparedness) (pours water into the mixture and then clamps up funnel for filtration)). Pẹpẹyẹ go and place it on the tripod. So, while that is heating I have added water to the mixture and put on the tripod. Place it on it, okay. (asks pupil).
(0.09) Okay, this is the filter paper. See it! See how I am going to make a funnel out of it. I have divided it two ... folded it into two halves. Are you seeing it?
(0.10) Ps: Yes.
T: And this half is folded again into another half. Now I will open up this. And now I have a funnel-like thing, isn't it?
Ps: Yes.
T: So I am going to place it here in the funnel. It takes the shape of the funnel. Can you see it?
Ps: Yes.
T: I am sure by now that thing is hot enough; it has dissolved. Now, what we are doing ..., we will be making use of the different ..., difference in the solubility of the substances. We have sand and salt.
Ps: Salt.
(0.11) T: One dissolves in water; the other one does not dissolve. So, we want to separate one from the other. So I am pouring the whole mixture and the water into the filter ..., into the funnel containing the filter paper. So, now, we can see the solution dropping into the beaker. Isn't it?
Ps: Yes.
T: When I added the water to the mixture the salt dissolved leaving the sand.
(0.12) And I want to separate the sand from the salt.
Ps: Salt.
T: So, in effect, what I am doing is to be able to remove the sand from the solution. In the solution we have water ... I mean sorry, we have salt. In this solution we have salt dissolved. So as you are seeing, we are getting this. This is called the filtrate. Is that clear?
Ps: Yes.
T: This one that is passing through the filter paper into the beaker is what we call the filtrate. Now as soon as the filtration ends we ... we are are going to get the sand. That is, wash it up from the solution and wash up every thing. That is the salt that will still be in it and then dry it.

And we can get back our sand.

O.13) That is the sand I am talking about. And then the filtrate, we are going to put on that (points to the burner) and start heating. We will heat ..., if we have enough gas, we will heat it until we see the salt crystallizing out ... coming out. The water vapour, I mean the water will be boiling off in the form of vapour.

Ps: Vapour.

T: So that is one other method of separating components of mixture. Look at it, first of all dissolve it to filter it. Later we wash off one of the components and then evaporate to get the other component. In this case, we are making use of difference in the solubility of the two components. In the first place, salt dissolves in water but sand does not dissolve in water.

Ps: Water.

O.14) T: So here we are making use of that property. Then ..., of course, we might not have time to go through all the processes. But eventually you will see that ..., you will see that em ... the solution will be left on the tripod stand that place ... you saw it, where ..., you saw where I kept the beaker ... where I kept the beaker when the burner was on. And as it is being heat the solution ..., as we are heating it, the water vapour will ..., I mean the water will be going up in the form of vapour.

Ps: Vapour.

T: So there will be a time when the whole water will go off and you have the salt crystallizing out.

O.15) That is what is called crystallization. Is that clear?

Ps: Yes.

T: So this is our solution; we can send down here to heat. While we are watching ..., waiting for the sand to get dry we will go on to the next technique. And that is distillation. (Writes: Distillation).

O.16) You all know what ink is, isn't it?

Ps: Yes ma.

T: You have seen ink?

Ps: Yes.

T: We don't have any with us here. Supposing, you know, you bring a bottle of ink and then you pour water into it. You want to get back your ink. Because if you pour water into it you will not be able to get back from the water ..., from it directly. Can you?

P: No.

T: Can you filter it up? Is not possible to get the water. So in that case, you know, it is difficult to use the method of filtration.

O.17) So here the property we are going to use is the boiling point of the two components. We will see that (talks and writes) ink and water, have two different boiling points. If you have your textbooks, please open to page 11. you will see a simple apparatus. If you have, open to page 11. you will see a simple apparatus for distillation (writes: Apparatus for distillation).

O.18) So have you seen the apparatus, and diagram of the apparatus?

Ps: Yes.

T: You have a conical flask on a tripod stand. And then you have a tube ... a delivery tube from the conical flask emptying into a small testtube. And then you have a testtube in a beaker ..., look at it ... the beaker contains cold water. You have a testtube in it ... in the cold water. Okay, now

O.19) you have a ink and the water in the conical flask.

And of course, there is a thermometer. Please, can you see that? (Describes apparatus in book).

Ps: Yes ma.

T: It's just a simple em ... (Draws a sketch of the diagram found in the book). Okay.

0.20) Now the ink, that is the mixture of the ink and water is put into the conical flask and you apply heat. We start heating the conical flask containing the mixture. At a certain temperature the boiling point of one of the components that is the water or the ink will be reached. And at that temperature, it will em ..., you have the vapour of it coming out. Is that clear? Look at it. Look at the diagram. You will see ... see what I have on the rough diagram on the board.

0.21) You have the ink and water here (points to conical flask). So there will be a time when one of the components will boil because there are two different boiling points. And in this case the water will boil before the ink. So, at that temperature ..., and that is the boiling point of water ..., you have vapour ... water vapour coming up. Is that clear?

Ps: Yes ma.

T: When in ... in that state ... in the vapour state, it comes up above the solution or above the liquid. So it has an outlet. Look at it. Can you see the tube ..., the delivery tube?

Ps: Yes.

T: An outlet, ... So since its the only outlet, the vapour follows this direction and comes down into the ... into the testtube. You have the testtube in a cold water. So the vapour condenses to form water. Is that clear?

Ps: Yes.

0.22) T: So that as you are heating it, the water continues to leave the mixture. And there will be a time when the boiling point of the ink will reach; by which time you have, you know, got all your water. And you remove this thing, and you are able to separate the ink from the water. So in this second case where we used distillation ... the process of distillation, you are making use of the property ..., you know, I mean, the difference in their boiling point.

P: Point.

T: Is that clear?

P: Yes.

T: There is still another method you can use or technique you can use to separate components from the mixtures. For example, you have ... em ... iodine and common salt. We are suppose to carry out this experiment with fume cupboard and em we don't have one here. But iodine is in a solid state.

0.23) Iodine is in a solid state and also you have the salt, the sodium chloride. Just like you have the sand, you can mix up the two. You can have the two mixed up. You know, when you get them mixed up as we did in the case of salt and sand you place it or put the mixture in a beaker and then apply heat. This is going to be carried out in your fume cupboard. As you heat the mixture a time will reach when you will see vapour ... violet coloured vapour coming out.

0.24) You know that is the gaseous state of iodine. I mean, vapour. Now when you combine to heat it, the vapour will be going up leaving the beaker. A time will reach when you will not have any of the iodine in ..., you know, at the bottom. You will only be left with the colourless substance which is the ... is the common salt.

Ps: Common salt.

T: Now, ... em ... if you look at it, because, ... I mean, when you are heating the beaker or anything or I mean ... sorry, the testtube or whatever, you will notice that the top ..., at least it is common knowledge ..., if you are heating it, the temperature at the top will be different from the temperature at the bottom. That is, in otherwords, here (holds up a beaker and points) is hotter. The bottom will be hotter than the top.

0.25) So that when the iodine vapour comes up, there is the possibility of some of them condensing at the tip ..., at the top. Is that clear? So you get back the solid, the solid iodine at the top. Now, at the bottom you have the salt which will not, at that time will not change into the vapour state.

Ps: State.

T: So, you see, you are able to separate or remove the iodine from the sodium chloride. Is that clear? You are able to remove the iodine from the sodium chloride. That process the process of a solid moving straight to the gaseous state without passing through the liquid phase is what we call 'Sublimation'. Is that clear? Sublimation. (Writes: Sublimation) sublime. The iodine sublime.

0.26) It went from the solid state. As you are heating it, at a point ... at a point, you never ... you didn't have a solid again; you have em a gaseous state. That is, the vapour. It moved from solid state to vapour or gaseous state. Now we call it, sublimation. So sublimation is one other method ... physical method of separating components of a mixture. Is that clear?

Ps: (Silence).

0.27) T: Then of course, there is this method. But I will just talk briefly about it. It's the last method, and I know you will not ... you know, understand it well. So I will even not go into details. All what I will tell you is that there is still another method. Say, the 5th method of separating em components of a mixture. That technique or that method is what we call 'chromatography'. Some of you are looking at me as if I have said what should not be said. As I said, I am not going to bother you with the details. But all what I want you to know is that there is another method we can use to separate components of a mixture.

0.28) And that method is called chromatography. As you go on with your chemistry ... as you go higher and higher you will come to know a little more or more about chromatography. Is that clear?

Ps: Yes.

T: So, from what I have said so far ... forget about the last method I have just told you ..., the methods we have known so far, can somebody tell me how she can ..., what, you know, technique she will use to separate sugar from sand? I am only seeing two hands up. Only two people can tell me how they can separate sugar from sand? Yes, okay, Iyaye!

0.29) Sugar from sand!

P: When we want to separate sugar from sand, you will first of all, put sugar and sand and mix them. Then you will add water. Then one of them will dissolve, then you filter, then you evaporate and you get back your sugar.

T: Then you get back your sugar. That's beautiful. That's nice. So we now know that if we want to separate sugar, I mean granulated sugar from sand, you know what to do. Is that clear?

Ps: Yes.

T: Okay.

(0.30) Now em, if for example you have a mixture of oil ... palm oil ... the oil you use at home for cooking ... if you have a mixture of palm oil and em, kerosine, what method do you think you should use? What technique will you use? Palm oil with kerosine! I want you to tell me what method you will like to use to separate the two components out from the mixture? You have an idea. Think of it. I want you to give me a sound answer. Yes!

P: You will use the ... the method of distillation.

T: Why do you want to use the method of distillation?

(0.31) In your distillation, what are you making use of? You know, in the case of em ... the solids, ... I mean, the sugar and the sand, they made use of their ..., the solubility of the substances. One does not dissolve in water, the other one dissolves. Isn't it?

Ps: Yes.

T: Like in this case now, like palm oil and kerosine, you all know kerosine, you all know palm oil. Em ... you said you are going to use the method of distillation, you are right. But why do you want to use the method of distillation?

P: Yes, I want to use the method of distillation because, for palm oil and kerosine, I want to know which one will evaporate first.

(0.32) T: Very good! You are making use of the differences in their boiling point. Is that clear? You are right by saying you are going to use the method of distillation. Then you must know the principle ... the underlying principle why we should use the method of distillation. This is what I want you to grasp. Is that clear? Don't just cram up anything or when you read the book and you don't know. You must know why you are using a particular method. So in the case of distillation you are making use of the differences in their boiling point. One would boil before the other. That is, one would start evaporating before the other. So that, if the other, ... the one evaporates as soon as you know the second one would start to evaporate you stop the whole thing. You remove the other. So you have separated them. Is that clear?

Ps: Yes.

T: Okay. That's nice. Em ... there are a lot I mean, there are so many I mean, different types of mixtures that you will need different techniques.

(0.33) There are em ..., like I told you, ... when we had a mixture of iodine and common salt, we made use of a property. One changed from solid to gas. From the solid state to the gaseous state. And that was iodine. There are a few other substances that sublime. That is, change from the solid to the gaseous state. And I want to give you the names of these other substances. You will come to know them much ... as you go on with your chemistry. Em ... I dont know if you have ever heard of this substance; Aluminuim Chloride ($ALCL_3$). It's a chemical used here in the laboratory. It also sublimes.

(0.34) Then em, that anhydrous Aluminium Chloride that's powdery; there is no water of crystallization in it. You remember my last ..., the last ... that, my first lesson with you I showed you the difference between a crystalline substance and anhydrous substance. I mean, I showed you two substances or ... . You remember when I used copper sulphate ... copper II sulphate? You remember?

Ps: Yes.

T: What was the other substance I used? You know the difference, I used to show the difference. Can you remember? Yes!
P: The permanganate.
T: No. It is in the appearance. Copper Sulphate and ...
P: Oh yes, it is when we ... (not audible)
T: Is alright, is alright.
(0.35) I told you that if a substance is in a crystalline form, it has a peculiar appearance; a shin y small, you know, granular form. But if you have ... you know, you all know powder. Don't you use powder? It doesn't contain water of crystallization. So it's different from the copper sulphate ... Copper II Sulphate crystal or even the sodium chloride we mentioned. So anhydrous ..., when you hear of anhydrous substance, it means it does not contain water of crystallization. Is that clear? So one of the substances that can sublime is anhydrous aluminium chloride ($ALCL_3$). There is also another one; anhydrous Iron III Chloride ($FeCL_3$). Just like iodine, if you heat it, it moves from the solid state to the gaseous state without passing through the liquid phase.
(0.36) Is that clear?
Ps: Yes.
T: And also, Ammonium Chloride (NH_4CL). You will come to see them and even know these chemicals. The other one ... I don't want to bother your head ... is benzoic acid. Don't bother your head. But know these, $ALCL_3$ $FeCL_3$ and NH_4CL because you will come across them sooner or later. Is that clear? (Writes names of substances on the board).
(0.37) Okay, so, so far we have known what an element is. You now know a compound ...

END

T35

Lesson: Integrated Science
Class: 1B
Time: 12.00-12.28 (28 mins)
No. of Pupils: 65(mixed)

Time Topic: <u>Cells (Animal and Plant)</u>:

(0.00) T: (Writes) Cells (and draws a plant cell). Last lesson I asked you to find out what living things are made up of. Now what are you made up of? Yes!
P: Skin.
T: Yes.
P: Cell.
T: Cells, yes! (writes): Cells.
P: Nose.
T: Nose, yes!
P: Teeth.
T: Teeth (writes): Teeth.
P: Mouth.
(0.01) P: Blood.
T: Now, what are plants made of? Yes!
P: Root.
T: Roots.
P: Stem.
T: Stem (writes): Stem.

P: Leaves.
T: Leaves (writes): Leaves. Now, some of you said a plant is made up of roots, leaves and stems. Now, if we look ..., apart from the fact that they have roots, leaves and stem ... if you look at ... at these things closely you will find out that they ... they are made up of ... more than just roots, flowers and stems.
(0.02) So we are going to look at a prepared slide that I have here. This is just a piece of skin from an onion. The aim of this is for you to know what an onion leaf is made up of. (Writes aim as stated). So I want you to come out three ... three students to come out starting from this row ... to see what ... the onion the onion leaf is made up of. Look at the ... look at the slide there so that at the end - or at the end, you tell me what you've seen. Is not just coming out, put your eye on the eye-piece without seeing anything.
(0.03) You have to see something. At the end you tell me what you've seen. Next ..., the next 3 students. (At this point pupils come out in 3's to the 3 microscopes on which the onion skin slides have been mounted). Take note of what you've seen. Next. (Pupils set out to the microscope). Next three students. (Pupils set out).
(0.04) Next (Pupils set out). Next three (Pupils set out to the microscope). Don't just place your eye on the eye-piece without noting what you've seen. Then you can go to your seat ... . Next 3 students ... (Pupils set out). Next.
(0.05) (Pupils set out to the microscope). Next (Pupils set out). Next ... next 3 students. (Pupils set out). The next 3 students ... (Pupils set out). Okay, next 3 students ... .
(0.06) (Pupils set out). Next. Those of you who have seen the slides, get ready to say something. Is not when I call your name you start looking at me. Next... you go and sit down. Next ... .
(0.07) Make sure you dont cover the light. Next 3 students. Are you seeing anything there?
P: Yes.
T: Okay go and sit down.
(0.08) Next three ... . Now, you've all seen the fresh slides. Now, I want you to tell me what you have seen? And I expect everybody to talk because all of you saw the slides. Yes!
P: Onion leaves.
T: Yes. What you saw there, not the diagram on the board.
P: Something like yam.
T: Something like ...?
P: Yam.
T: Yes!
P: Some white things and some ... there are some parts that are black ... and looks like a cell.
T: Yes!
(0.09) P: I see something ...
T: I saw ... (corrects pupil's language).
P: I saw something like thin leaves ...
P: I saw something like net.
T: Net, you saw something like a net. Hm Cookie!
P: (not audible)
T: Kosuowei.
P: I saw something like blocks.
T: You saw something like blocks. Somebody saw something like net and you say you saw something like blocks.
(0.10) If you ... if you had looked at the slide, you would have seen that there are many spaces that look like blocks, like that boy said. (Points at boy). Now these spaces that look like

blocks are called cells. These are the cells of the leaf of an onion. These holes ..., little spaces are joined together by cell wall. They are called cells. What are they called?

Ps: Cell.

T: They are called cells. All these that are net-like structures are called cells.

Ps: Cells.

T: So that brings us to the topic we have for today - The structure of a plant cell.

Ps: Plant cell.

0.11) T: And we now know that living things are made up of block-like structures called cells. What are these block-like structures called?

Ps: Cells.

T: They are called cells. So we are now going to look at the structure of the plant cell. Now the plant cell is surrounded or enclosed by an outer wall. And this outer wall is called a cell-wall. What is it called?

Ps: A cell wall.

T: A cell wall. And this cell wall is very tough and is made up of a substance called cellulose. What is the name of the substance?

Ps: Cellulose.

T: Cellulose. That is why the cell wall is called a cellulose cell wall.

0.12) (Writes) A cellulose cell wall: Because the wall is made up of what?

Ps: Cellulose.

T: Cellulose. The wall is made up of that substance called cellulose. So we refer to this wall, ... this outer wall as a cellulose cell wall (Points to cardboard drawing mounted on the wall). Now, apart from the fact that the cell wall encloses the cell ... the inner part of the cell, it also gives the cell a shape. That is one of the functions the cell wall... the cell wall performs. It encloses the inner part of the cell. At the same time it gives a shape to the cell. Now, the next layer is ... is a jelly-like layer.

0.13) This jelly-like layer is called protoplasm. What is it called?

Ps: Protoplasm.

T: That area, protoplasm is the living part of the cell. When we say something is living I hope you know the characteristics of living things. So that part is the living part of the cell and it is jelly-like in appearance. How many of you have seen a raw-egg before? A raw egg. An uncooked egg?

P: (Almost all pupils raise hand).

T: You've all seen it?

Ps: Yes.

T: Now, that white ..., that colourless part of it ..., I don't mean the yellowish part ..., the yellowish part is called the yolk. While the colourless part is called the albumen. Now that colourless part is jelly-like. If you have seen it before you will now know how the protoplasm looks like.

0.14) Is jelly-like in appearance and it is the living part of the cell. Now there are some structures present in the protoplasm which is the living part. Now, one of the structures present is a ball-like structure called the nucleus. What is this ball-like structure called?

Ps: The nucleus.

T: The nucleus. This nucleus controls the activities of the cell. So it is regarded as the power-house of the cell because it is the duty of the nucleus to control any activity that is taking place inside the cell. So it is called the power-house of the cell. What is it called?

Ps: The power-house of the cell.

T: The power-house of the cell.

0.15) This is due to the fact that it controls all the activities inside the cell. Now, if you look at ... if you look at the diagram you find out that there are other roundish structures inside the protoplasm. Now these roundish structures are called chloroplasts. What are they called?

Ps: Chloroplasts.

T: Chloroplasts. A chloroplast contains chlorophyll (writes) Chlorophyll is the ..., you've known what the chlorophyll is.

Ps: Yes.

T: Is the green pigment which is responsible for the greenish appearance of the plant. The chlorophyll is an important substance because it is used during photosynthesis. And you know what photosynthesis means.

0.16) Is the process whereby plants manufacture their food in the presence of light energy (writes). Towards the inner part of the cell is a space known as a vacuole. What is this space called?

Ps: A vacuole.

T: A vacuole. Now this vacuole contains a liquid. And this liquid is called a cell sap (writes): For our next part, let's look at the diagram again and look at the structures present inside the cell. Now the outermost layer of the cell ... the outermost layer of the cell is the cell wall.

0.17) And this cell wall contains an important substance. What is this substance called? Yes!

P: It is called cellulose.

T: Cellulose. That is why we call the cell wall a ...

Ps: Cellulose ...

T. ... a cellulose cell wall.

Ps: Cell wall.

T. Apart from the fact that this cell wall contains an important substance called cellulose, it performs two functions. What are the two functions? What are the two functions? Yes.

P: The cell wall encloses the inner part of the cell.

T: That is the cell wall encloses the inner part of the cell. This is the inner part of the cell. It surrounds or - sort of covers the inner part of the cell.

0.18) And it gives the cell a shape. So take note of the functions. How many function did I mention?

Ps: Two.

T: And what are the functions? Yes!

P: Number 1, it covers the inner part of the cell.

T: Yes, it encloses the inner part of the cell. Then what is the second function? Yes.

P: It gives the cell a shape.

T: Yes. Now let's move to the second layer. What is the second layer called? Yes (writes: Protoplasm).

P: Protoplasm.

T: Protoplasm. It's that part that is referred to as the living part. Is it the non-living part of the cell? Is it the living part or the non-living part of the cell? Yes.

P: The living part of the cell.

T: It is the living part of the cell.

0.19) What are the structures present in the protoplasm? Look at the diagram and tell me the structures that are present in the protoplasm. What is this structure called? (Points at the nucleus) Yes!

P: Nu ... nuk ... . (Pupil unable to pronounce part).
T: Its called what? What is it called? Yes (invites another pupil).
P: Nucleus.
T: Open your mouth!
P: It is called the nucleus.
T: Is called the nucleus. I want the function of the nucleus! I want many hands up ...
Ps: (Pupils raise hands).
T: What is the function of the nucleus? Yes.
P: Is the place that life is. Without it ... the nucleus it will not be alive ... it will be dead.
T: Any other person? Yes.
(0.20) P: It is where the cell have life.
T: What is the function? If this whole part is the living part then what's the function of the nucleus? What did I say about the power-house of the cell? Hm?
P: It controls the activities.
T: It controls all the activities of the
Ps: Cell.
T: ... of the cell. So without the nucleus all the activities we have talked about would not have ... it would not control all the activities. Now, apart from the nucleus which other structure is present in the protoplasm? Look at the ..., the diagram is in front of you.
(0.21) So don't ... don't crack your ..., look at the diagram there. You can make use of your eyes. Look at the diagram and tell me the other structures present in the ... in the cell. Yes!
P: Chloroplast.
T: Chloroplat. The chloroplasts contain what? What do they contain? Yes!
P: Chlorophyll.
T: They contain chlorophyll.
Ps: Chlorophyll.
T: And why is the chlorophyll thought ... or referred to as an important substance? Yes!
P: It's because all the green leaves contain chlorophyll.
T: Yes, it contains chlorophyll. Is that why its an important substance?
(0.22) Tell me why it's an important substance? Yes!
P: Because it has chlorophyll that is used by the photosynthesis to manufacture food.
T: You don't ...
P: ... To manufacture food.
T: That is, the chlorophyll uses energy from the sun during photosynthesis which is the process where plants manufacture their food. (writes use of chlorophyll).
Ps: Food.
T: Now the innermost part of the cell is made up of a space known as the vacuole.
(0.23) What is contained in this space? This space contains a liquid. What is the name of the liquid? Yes!
P: A cell sap.
T: Yes, cell sap. (writes: cell sap). If you have questions you are free don't be shy. Ask questions. If you want to ask questions about the plant cell you are free to do that.
P: My question is: from which part of the plant cell does the cell ... the cell have its food?
(0.24) T: Now the ... the plant ..., you know that the plant contains chlorophyll. You can see that ... you can still see it from the diagram. The chlorophyll are inside the protoplasm and

with this chlorophyll, the plants are able to make use of energy ... energy from the sun and produce food. It's this food produced during photosynthesis that the ... em ... that the plant take in. That is why I told you that the protoplasm is the living part of the cell. And if you look at the protoplasm you find the chloroplasts containing chlorophyll.

(0.25) And the plants use the chlorophyll during photosynthesis to manufacture food - which is taken in. You know all the characteristics of living things and includes feeding, respiration, movement ... what else?

Ps: Response to stimuli.
T: Response to stimuli. What else?
P: Movement.
T: Movement, ...
P: Growth.
T: Growth. All these activities take place in protoplasm. You can differentiate between the cell wall which is the non-living part and the living part. So feeding is one of the characteristics of living things. And with the chlorophyll present in the protoplasm food is manufactured during photosynthesis. So it is this food that it takes into its protoplasm. Any other question? Yes!

(0.26) P: What use is the vacuole?
T: Now the vacuole is just an empty space that contains the cell sap. You can call it a store ... a store ... store house because the cell sap released from the cells is stored inside the vacuole. So you can just call it a store house because it stores cell sap. We have done the function of the ... of the cell wall, the protoplasm that is the site of all living activities.

(0.27) Then the function of the nucleus. What is the function of the nucleus? The function of the nucleus? Yes! I want many hands up. Yes. Kosuowei.

P: It's the life of the plant cell.
T: Yes! (appoints another pupil).
P: Is the power house of the cell.
T: It's the power house of the cell. Yes!
P: It powers the activities of cell.
T: It controls. Not power, it controls. You can refer to it as the controller of the cell.

(0.28) If you dont have any other question, for your assignment, I want you to draw the diagram of the structure of a plant cell and label all the parts. (writes the assignment on the board). So that's the assignment against the next lesson. Draw the structure of a plant cell and label all the parts. Good afternoon students.

Ps: Good afternoon.