CHAPTER ONE

BASIC CONCEPTS IN INSTRUCTIONAL STRATEGIES IN SCIENCE, TECHNOLOGY AND MATHEMATICS

Introduction

The method of instruction refers to the method by which a teacher conveys stimuli to the learners. It refers to the method by which the teacher communicates the contents of instruction so as to achieve the goals of learning. It is the process of impartation of learning, knowledge, skills to the learners.

There are various methods of instruction; the particular method deployed by a teacher at a given time depends on the prevailing situation, available resources and student's response to the lesson. A teacher may switch to another method when he sees that the students are not responding favourably and vice versa. The number of students and the nature of the course also determine the method a teacher will decide to use

The following concepts in science, technology and mathematics teaching are explained: The nature of science and mathematics, the nature of teaching, major areas in science and mathematics teaching, General principles of teaching, the maxims of teaching, the teaching of concepts in science and mathematics, the teaching profession, the teacher, and basic teaching methods.

MATHEMATICS, SCIENCE AND TECHNOLOGY

Because of its abstractness, mathematics is universal in a sense that other fields of human thought are not. It finds useful applications in business, industry, music, historical scholarship,

politics, sports, medicine, agriculture, engineering, and the social and natural sciences. The relationship between mathematics and the other fields of basic and applied science is especially strong. This is so for several reasons, including the following:

- The alliance between science and mathematics has a long history, dating back many centuries. Science provides mathematics with interesting problems to investigate, and mathematics provides science with powerful tools to use in analyzing data. Often, abstract patterns that have been studied for their own sake by mathematicians have turned out much later to be very useful in science. Science and mathematics are both trying to discover general patterns and relationships, and in this sense they are part of the same endeavour.

- Mathematics is the chief language of science. The symbolic language of mathematics has turned out to be extremely valuable for expressing scientific ideas unambiguously. The statement that $a=F/m$ is not simply a shorthand way of saying that the acceleration of an object depends on the force applied to it and its mass; rather, it is a precise statement of the quantitative relationship among those variables. More important, mathematics provides the grammar of science - the rules for analyzing scientific ideas and data rigorously.

- Mathematics and science have many features in common. These include a belief in understandable order; an interplay of imagination and rigorous logic; ideals of honesty and openness; the critical importance of peer criticism; the value placed on being the first to make a key discovery; being international in scope; and even, with the development of

powerful electronic computers, being able to use technology to open up new fields of investigation.

- Mathematics and technology have also developed a fruitful relationship with each other. The mathematics of connections and logical chains, for example, has contributed greatly to the design of computer hardware and programming techniques. Mathematics also contributes more generally to engineering, as in describing complex systems whose behaviour can then be simulated by computer. In those simulations, design features and operating conditions can be varied as a means of finding optimum designs. For its part, computer technology has opened up whole new areas in mathematics, even in the very nature of proof, and it also continues to help solve previously daunting problems. C:\Users\commy\Downloads\chap2.htm - top

THE NATURE OF SCIENCE AND MATHEMATICS

Science and mathematics teaching involve a systematic attempt to define and investigate the problems involved in learning and instruction in science and mathematics (White & Gunstone, 1992). Any problem in science and mathematics seeks for solution by an organized method of formulating a hypothesis, experimentation, analysis, prediction, inference and conclusion. The nature of scientific truth is that it is never absolute i.e. there is the lack of closure. The truth is tentative; hence, all results must be tested. There is always a need to find out or investigate a scientific truth. The concern of scientists and mathematicians recently is that, despite the immense human and material resources allocated to the teaching and learning of science and mathematics, available evidence from school records, public examination records, and

literature show that students are degenerating in their achievements in science and mathematics.

Science and mathematics educators therefore have invested their time and energy through scientific research in seeking solutions to this problem. The major areas of research in this regard are the development of new teaching or instructional strategies for teaching science and mathematics. E.g. the effect of individualized and conventional approaches to teaching of science and mathematics, effect of practical activities on achievement in science and mathematics; use of concept mapping to enhance learning and the interest and retention level of students consideration in curriculum planning.

MYTH AND DOGMAS ABOUT SCIENCE

The interpretation of any phenomenon in African society will depend solely on the culture. The African culture has been interpreted to mean ways and ideas of the past and it is supposed to be evidenced in language, dress, entertainment (singing and dancing) and belief.

The introduction of science into western education has, no doubt, brought about conflict of African culture and science. In a handbook published in Ghana by Science Education Programme for Africa (SEPA), reference was made to the conflict of science and culture. It stated that: "A tragedy of science education in Africa, which adults and children have shared, is that it has not always paid attention to the culture of the African. In the recent past there was a lack of adequate knowledge of the local cultural environment which was in any case dismissed as wholly inimical to the development of science concepts." A predominant view in

science education in Africa is an academic discipline, which is facing an uphill task because most African students and teachers still hold firmly to superstitions, which eventually contradict and buffer any modern approach to science. Professor S.O. Awokoya wrote about the conflict of science and superstition in Nigeria. "There is a big difference between the position of science in Africa and in the western world. In Africa we have product of science presented to us. We need the searchlight of science to illuminate the dark corridors in our knowledge and it will seem that the first job of science teachers is to eliminate a great deal of superstition to explain natural phenomena in terms of the natural as distinct from the supernatural." For example, according to him, most African children beliefs are that the rainbow is the excreta of the Boa Constrictor. The superstition states that if you are able to find out where the rainbow torches the ground, you will get the excreta of the Boa and if you can manipulate it properly, you can become the richest person in the world. These superstitious beliefs cut across all aspect of science.

The dogmatic of an African child about what science is will create in him a type of cultural ambivalence. Fafunwa once said that "it is due to the fact that the African is a man of two worlds, that of African culture and that of the other world where science has already become a dominant cultural factor. As African you are operating in both of these worlds as best as you can. The problem is that the African child comes to the school with a load of mysteries that plague his mind. If care is not taken, these mysteries usually tagged "superstitions" are capable of causing blockage to any scientific knowledge the child might acquire as a result of schooling.

In order to bail the child from these problems, explanation to scientific problems is better demonstrated by laboratory experiments. The materials to be used for such experiments must be relevant to the material world of the child. In this case, the concept of improvisation in teaching science is of necessity.

THE AIMS AND HISTORICAL CONTEXT OF SCIENCE

The aims of science education therefore will be the development of scientific literacy and inculcation of scientific values in the minds of the citizens. These aims could be simply put as the acquisition of scientific literacy, development of scientific attitude and the acquisition of scientific skills. This is in line with the Bloom's Taxonomy of educational objectives that is, cognitive, affective and psychomotor domains. The aims are also in line with the national objectives of education. Some authorities strongly believe that the aims of science education in schools include, scientific literacy-to inculcate the power of careful observation, classification and interpretation of observed phenomena in young ones. Scientific literacy consists of the relation of science to culture, understanding of the concepts of science and knowledge of how scientific ideas are developed. A scientifically literate person therefore, is one with an understanding of the basic concepts in science, the nature, the ethic that control the scientists in his work, the relationship of science and humanities and the difference between science and technology. Fafunwa once advocated for an education that trains the child to adopt a scientific attitude to problem solving, develops aptitude for vocational pursuits that enables the child and the adult to manipulate simple gadgets through with the hands and eyes, which should supplement the mind and the heart.

Scientific skills should involve solving problem situations where apparatus has to be selected, taking readings and making scientific observations. The five general aims of science teaching are:

- To interest pupils in science
- To develop inquiring mind
- To help pupils to see science in relation to the rest of the culture.
- To prepare some pupils for careers in science
- To help pupils to solve problems.

These general aims pose a big challenge to the science teacher. A teacher of science should develop in his students, the critical mind and the ability to solve problems in addition to arousing their interest in the subject. If the knowledge imparted into students could not be used to solve their problems and that of their immediate environment, such knowledge is useless.

Exercise

Explain the importance of knowledge and its application in science teaching.

Historical Context of Science

Science was introduced into the curriculum of secondary schools In Nigeria in 1859. This was when the first secondary school was established. Before 1859, all educational institutions in the country taught primary school subjects, language, writing, geography, drawing, hygiene, singing and history to the exclusion of science. With the establishment of CMS Grammar school, Lagos

in 1859, some rudiments of science education were injected into school curriculum. Some attention was given to arithmetic, Algebra, Geometry and physiology. In 1878, the Methodist Mission offered to teach Trigonometry, Astronomy, Chemistry, physiology, Geology and Botany to the students of Methodist Boy's High school Lagos, founded in 1879. The same set of subjects was offered to students of Baptist Boys' high school, founded in Lagos in 1885.

The hope Waddell Institution founded in Calabar in 1895, the CMS sponsor Teachers St. Andrew's College Oyo, founded in 1876, the Baptist Training College, Ogbomosho, founded in 1897, the Methodist Teachers' College, Wesleyan Training Institute founded in 1905 and the CMS owned Oron Training Institute founded in the same year had science subjects in curriculum.

Science subjects also featured in the school founded in 1908, King's College Lagos, founded in 1909, Eko Boys' High School, also founded in 1913, Ibadan Grammar School, also founded in 1913, and Ijebu - Ode Grammar School also founded in 1913. Denis Memorial School founded in 1928 at Onitsha, two Colonial Colleges were established in Ibadan and Umuahia in 1925 also made provision for the teaching of science.

In spite of the efforts made by the Christian missionaries and colonial officials to promote science education in schools, very little success was recorded. Science education was by no means popular in schools, very few students offered science subjects at the external examinations. And most of those who attempted examinations in science failed. However, the African education commission sponsored by the Phelps-stokes Fund of America recommended that science subject should be included in the

curriculum of all secondary schools in 1920. The colonial government was most reluctant to encourage the teaching of science in the school in the Northern provinces of Nigeria. The belief was that the teaching of Biology could offend "Muslim susceptibilities." Of course, the first reaction of the people to the teaching of science was that of hostility.

The slow pace of the development of science in Nigeria is understandable. This was because the motive for colonization was essentially trade, another reason was that Africans generally were thought to be inferior human beings and as such not capable of understanding science. Only Biology related subjects such as Nature study, Botany and physiology were taught between 1875 and 1920. The teaching of other subjects began at about 1920 as a result of the recommendation of an African education commission, which toured the British West African Colonies under the sponsorship of the Phelps-stokes Fund of America.

It was in the fact the monetary reward added to the grants made by the British government to schools which taught science that influenced the introduction of science teaching into all schools. The science and mathematics curricula in Nigeria schools were modified by the West African Examination Council after independence in 1960. The realization of the importance of science teaching in the 60s culminated into the teaching of many science subjects in all secondary schools and Teacher Training Colleges in Nigeria. Integrated science was introduced into the junior classes as a result of the Aiyetoro Basic Science scheme and the Nigeria integrated Basic science project of the science teachers Association of Nigeria (STAN). The first set the STAN books were introduced into the Nigeria schools in 1972. With the adoptions of the New National Policy on Education (Revised

1983), the 6-3-3-4 system of education was adopted in September 1982. Integrated science is now being taught in the first three years of junior secondary schools while physics, chemistry, biology and agricultural science are now taught in the senior secondary school.

The Nature of Teaching:

Teaching is the relationship between the three (3) components or major issues in education. Viz.:

1. The teacher
2. The child and
3. The subject matter. For teaching to be successful the teacher must be hardworking, have a thorough knowledge and grasp of the subject matter and a good ability to communicate such knowledge and understanding to his students in an interesting manner by:

i. Asking thought provoking questions

ii. Telling a short story

iii. Giving a brief history relating to the discovery of the subject in question with enthusiasm, being patience and resourceful etc.

iv. Performing a short demonstration

v. Be aware of individual differences in the students

vi. Be knowledgeable about himself in relation to his feelings, attitude and behaviour towards the students

vii. The teachers' ability to present educational knowledge, skills and materials for learners by guiding the mental activities of the students towards the significant educative elements or basic concepts and learning of the subject matter is a must for the success of teaching.

General Principles of Teaching:

There are some basic principles which underpin any successful teaching practice. These are:

a) The principle of activity: i.e. students must be active in any learning activity in the classroom.

b) The principle of interest: Students hardly perform well in any subject matter in which they lack interest. The arousal of their interest in the subject matter therefore is a basic principle for successful teaching and learning.

c) Principle of relevance: the subject matter must be relevant to their life situations and challenges.

d) Principle of definite aim: Each lesson must have a definite aim of presenting one concept. Trying to present too many concepts must be divided into many stages to avoid confusion.

e) Principle of selection: this is the ability of the teacher to select materials that suit students in a particular lesson. Taking materials one after the other.

f) Principle of correlation: Ability of the teacher to establish a link between the subject matter and other life situations and other subject matter and issues.

g) The principle of practice: Students must be given a lot of problems to practice and projects to carryout and write their results. Practice makes for better perception.

h) The principle of revision/evaluation: Students must have a review of the lesson. Black Board summary must be given, their work marked i.e. evaluate students work always, to strengthen weak areas and praise strong areas.

PRINCIPLES OF LEARNING

Learning Is Not Necessarily an Outcome of Teaching

Cognitive research is revealing that even with what is taken to be good instruction, many students, including academically talented ones, understand less than we think they do. With determination, students taking an examination are commonly able to identify what they have been told or what they have read; careful probing, however, often shows that their understanding is limited or distorted, if not altogether wrong. This finding suggests that parsimony is essential in setting out educational goals: Schools should pick the most important concepts and skills to emphasize so that they can concentrate on the quality of understanding rather than on the quantity of information presented.

What Students Learn Is Influenced by Their Existing Ideas

People have to construct their own meaning regardless of how clearly teachers or books tell them things. Mostly, a person does this by connecting new information and concepts to what he or she already believes. Concepts - the essential units of human thought - that do not have multiple links with how a student thinks about the world are not likely to be remembered or useful.

Or, if they do remain in memory, they will be tucked away in a drawer labelled, say, "biology course, 1995," and will not be available to affect thoughts about any other aspect of the world. Concepts are learned best when they are encountered in a variety of contexts and expressed in a variety of ways, for that ensures that there are more opportunities for them to become imbedded in a student's knowledge system.

But effective learning often requires more than just making multiple connections of new ideas to old ones; it sometimes requires that people restructure their thinking radically. That is, to incorporate some new idea, learners must change the connections among the things they already know, or even discard some long-held beliefs about the world. The alternatives to the necessary restructuring are to distort the new information to fit their old ideas or to reject the new information entirely. Students come to school with their own ideas, some correct and some not, about almost every topic they are likely to encounter. If their intuition and misconceptions are ignored or dismissed out of hand, their original beliefs are likely to win out in the long run, even though they may give the test answers their teachers want. Mere contradiction is not sufficient; students must be encouraged to develop new views by seeing how such views help them make better sense of the world.

Progression in Learning Is Usually From the Concrete to the Abstract

Young people can learn most readily about things that are tangible and directly accessible to their senses - visual, auditory, tactile, and kinaesthetic. With experience, they grow in their ability to understand abstract concepts, manipulate symbols,

reason logically, and generalize. These skills develop slowly, however, and the dependence of most people on concrete examples of new ideas persists throughout life. Concrete experiences are most effective in learning when they occur in the context of some relevant conceptual structure. The difficulties many students have in grasping abstractions are often masked by their ability to remember and recite technical terms that they do not understand. As a result, teachers – from kindergarten through college – sometimes overestimate the ability of their students to handle abstractions, and they take the students' use of the right words as evidence of understanding.

People Learn to Do Well Only What They Practice Doing

If students are expected to apply ideas in novel situations, then they must practice applying them in novel situations. If they practice only calculating answers to predictable exercises or unrealistic "word problems," then that is all they are likely to learn. Similarly, students cannot learn to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire other desirable skills unless they are permitted and encouraged to do those things over and over in many contexts.

Effective Learning by Students Requires Feedback

The mere repetition of tasks by students – I whether manual or intellectual – is unlikely to lead to improved skills or keener insights. Learning often takes place best when students have opportunities to express ideas and get feedback from their peers. But for feedback to be most helpful to learners, it must consist of more than the provision of correct answers. Feedback ought to be analytical, to be suggestive, and to come at a time when students

are interested in it. And then there must be time for students to reflect on the feedback they receive, to make adjustments and to try again – a requirement that is neglected, it is worth noting, by most examinations – especially finals.

Expectations Affect Performance

Students respond to their own expectations of what they can and cannot learn. If they believe they are able to learn something, whether solving equations or riding a bicycle, they usually make headway. But when they lack confidence, learning eludes them. Students grow in self-confidence as they experience success in learning, just as they lose confidence in the face of repeated failure. Thus, teachers need to provide students with challenging but attainable learning tasks and help them succeed.

What is more, students are quick to pick up the expectations of success or failure that others have for them. The positive and negative expectations shown by parents, counsellors, principals, peers, and – more generally – by the news media affect students' expectations and hence their learning behaviour. When, for instance, a teacher signals his or her lack of confidence in the ability of students to understand certain subjects, the students may lose confidence in their ability and may perform more poorly than they otherwise might. If this apparent failure reinforces the teacher's original judgment, a disheartening spiral of decreasing confidence and performance can result.

TYPES OF LEARNERS

Since students are centre of teaching/learning processes, teachers must be able to identify the different types of learners in order to be able to help them.

According to Rasaq (2003), understanding the different types of learners will be of immense value in assisting the teachers in preparing suitable materials to cater for the varying learning needs.

There are mainly three categories of learners and they are:

Slow Learners (Backward Learners)

Gifted and Talented Learners (Fast Learners)

Normal Learners (Average Learners)

The Physically Handicapped Learners

The slow learners and the gifted learners are highly problematic whereas the normal learners need to be stimulated and encouraged to make maximum use of their potential and to develop their individual talents.

The fourth group of learners is those that are physically disabled. These disabilities have nothing to do with their intellectual capacity to learn. They are characterized by different types of physical deformities like deafness, blindness and lameness.

The Maxims of Teaching:

a. Proceed from known to unknown i.e. count one before counting two.

b. Proceed from concrete to abstract.

c. Proceed from particular to general.

d. Proceed from easy to difficult (BODMAS) formula is useful for solving mathematics problem.

e. Simple to complex materials.

f. Logical to psychological: Logical deals with steps of presentation, psychological for bids the teacher instilling fear into students concerning any subject matter. Rather the teacher should make it clear to students that the subject matter is not difficult if they work hard.

g. The use of induction and deduction methods: Induction requires that the teacher talks all the time while students are just active listeners while the deduction method allows students to partake actively in decision making and are active in the lesson.

Major Areas in Science and Mathematics Teaching:

Major areas to be considered in science and mathematics teaching are; Thinking, practical and communication skills which involve the following issues in the area of practical teaching and learning.

Thinking skills:

The ability to think in a scientific manner involves the following:

a. Making hypothesis and devising situation to test it.

b. Drawing conclusions from evidence available.

c. Explaining any phenomenon in terms of an appropriate principles or theories.

d. Ability to solve a problem.

e. To evaluate claims in relation to evidence

Practical Skills: Involve the following:

a. The ability to make a careful and systematic observation and measurement.

b. To experiment and to practical assignments in a confident, competent and safe way.

c. To improvise sensibly when situation demand improvisation.

Communication Skills: Involve the following:

a. The ability to communicate (verbally and non-verbally) in an appropriate manner, observations, investigations, insight, solutions and explanations to the students.

b. Ability to comprehend instructions, descriptions and explanations of other concepts both orally and in written form.

c. To seek out, select and apply knowledge and data from a variety of written and other sources.

The Teaching of Concepts in Science and Mathematics

The teaching of concepts in science and mathematics according to fundamental structures (the big idea), was introduced to the educational community by Ausubel (1969). His contention is that an understanding of the fundamental structure of science and mathematics will help students to:

1. Learn how things are related.
2. Learn that one concept reinforces another concept.
3. Be aware of the fact that patterns in nature are more comprehensive than bits and pieces of information.
4. Learn that conceptual development broadens over time.
5. Know that science has identifiable structures and not a collection of multitudes of information items.
6. Concepts help students to remember things learned better.
7. Teaching concepts carters for individual differences where each student is operating at his/her own learning speed rate.
8. Teaching of concepts gives stability to the curriculum because they represent structures of high credibility in the scientific literature.
9. Teaching fundamental concepts assist students to conceptualize the dynamic nature of science and mathematics in terms of the constant interplay between the product and the process of science hence a number of science and mathematics curricula have been developed to reflect conceptual schemes. Ausubel (1969) pointed out the fact that a concept will only remain in a student's mind only if, such taught concepts contain the "critical concept" also referred to as the "regenerative concept". Scientists and mathematicians do not remember all the details of a topic but only remembers the critical concept which ensures that total loss of memory does not occur. The critical concept which is left in the learners mind is sufficient to reactivate and reconstruct the details of a given subject matter when needed.

CHAPTER TWO

THE TEACHING PROFESSION AND THE TEACHER

Historical perspective of the teaching profession throughout the ages indicates that intelligent and special men and women chose teaching as a career. For teaching to be effective and bear fruits, the teaching is plan to be a burning desire to motivate, to lead and to help humanity and not for monetary reward. Other teacher's professional attributes would include; co-operation, attitudes, professional interest, and of course the teachers own personal characteristics which are three fold and include the following:

- Personal attributes
- Professional attributes
- Instructional skills

Methodology of approach to a particular lesson/subject identifying pupil's growth and achievement capacity for identifying the socially disadvantaged and pupils with learning difficulties. Personal attributes of the teacher would include his personal appearance, i.e. a good teacher should be meticulously groomed at all times, they are admirable, patient, courteous, and with a sense of humour and friendly. This appearance is necessary for good teaching. The voice of the good teacher should not be harsh rather it should be gentle and pleasant at all times. Manner makes a man "a teacher must have control, be sympathetic, and empathetic in his manner of doing things. "Health is wealth". The teacher's good health is of paramount importance because health excuses disrupts continuity in teaching. The teacher's scope of interest apart from knowing his subject matter, he needs to know

about events around him too. He should be active and interested in community worthwhile activities in which the school is situated because what goes on in the community have some influence in the school policies and for judicious discussions and decisions cooperation. Implies that teachers co-operate with one another communicate with parents, carryout assignments and support school activities attitudes. The teacher should express positive attitude, accept change, no discussion of confidential information, prepare records of work, perform assigned duties, and seek attention with heads/principals in matters affecting school and students. Interest and scholarship; implies that good teachers should demonstrate professional interest, attend staff development courses, demonstrate adequate scholarship, and express oral and written English clearly, effectively and appropriately. Have in depth of the subject matter, teaching techniques, pupil's needs interest, growth patterns, local and world affairs including professional information and literature. The teacher having good instructional skills implies good

1. Planning and preparation
2. Good teaching techniques
3. Good class management
4. Good classroom climate etc.

Functions of the Teacher

The teachers functions therefore is to identify the functions of the school in which he teaches, and to transmit behavioural change, cultural change, valued elements in the cultural past and present. He should therefore carryout the central task of teaching which is to develop the skills, competence and intellectual capacities which will enable them to live effective in a complex society. The teacher

should organize learning for authentic results which should enter into the personality of the learner, or shape his mental development, affect his thinking, influence his action. Good teacher should be democratic that is he should provide for individual differences in the classroom.

Who then is the teacher? The teacher falls into a group of the working force recognized for the teaching of numeracy and literacy. For any teacher to find out how useful he is, he should be able to answer adequately the following questions.

1. Do I understand the objectives of education and school?
2. Do I know about all the developmental tasks of my students?
3. Do I know about conditions of learning?
4. Do I have a good grasp of the subject I teach?
5. Do I use the correct teaching methods?
6. Have I made provision for individual differences in my students?
7. Do I have a classroom management that makes for self-discipline of my students?
8. Do I offer guidance and counselling to the needy students?

The teacher therefore is the one who understands the objectives of school and schooling, conditions of learning, and uses correct teaching strategy/method to mould the weak features of a student until this molding is seen in his personality change, attitude change, opinion change etc. The teacher light these little candles with ABC and 123, making and marking, works busy night, paid poorly, in some parts of the world but his task is noble. Tribute to the unknown teacher says that it is this little candle that you light, that will shine back to you in later years.

CHAPTER THREE

PHILOSOPHERS VIEW AND AIM OF SCIENCE EDUCATION

Philosophizing about science is primarily concerned with the critical examination of the processes and products of science. Philosophy of science therefore is preoccupied with posing questions, and seeking natural answer relating to the nature of science, the validity of scientific knowledge, knowing how knowledge is acquired and how it progresses. It thus seeks answers to questions like, what is science and how does it differ from and relate to other disciplines? What are facts, concepts, laws, principles and theories in science and how are these related? What are paradigms and how do these influence the development of scientific knowledge? What is the scientific method and what kind of values underlie the scientific enterprise? Answers to these questions and the like help to clarify the nature of science, what the scientist does, and help him to take better decisions to improve what he does. They also suggest what kinds of scientific knowledge should be included in the curriculum and also how these should be implemented in the classroom. The philosophical analysis and explanation of the nature of science have led people to believe that science is not only a body of systemized knowledge, a method, a way of investigating, but is also a way of thinking. These analysis and explanations seem to present the scientific enterprise as being inductive. The inductive thinking tends to proceed from the specific to the general, making generalizations from raw and specific data. It attempt to logically mould raw and incoherent data into a comprehensible whole.

Science reaches out for new ideas and facts, which it contributes to the ever growing stock of knowledge. This is unlike religion, which is more concerned with the preservation of "external truth." Science is used to denote a set of characteristic methods by means of which knowledge is certified. It is also a stock of accumulated knowledge stemming from the application of these methods. Science is therefore a process and a product of investigation. Another perspective proposed for science is that it is an institution. A community of scientists identified and accepts certain procedures, certain explanations of natural phenomena. Science therefore includes a set of cultural values and norms of scientific community that govern the activities termed scientific. Scientist believes and accepts that an agreed body of fact and theory is the bedrock upon which scientific programmed is developed. Non-science has no such agreed body. Rather, it is characterized by schools of thought.

The scientific reasoning is characterized in terms of inductive and deductive logic. Induction is a scheme of reasoning that permits us to generalize, proceeding from singular statement to universal ones, for example, craziness is hereditary. Thus, from particular facts or examples, a general law is obtained or discovered. Deduction on the other hand, involves the formulation of hypothesis or speculation based on one's previous experiences; the hypotheses are tested before a theory is advanced; the theory is then held tentatively since further tests could falsify it. The exact manner of formulating a hypothesis leading to the putting up of a theory is not clear, but it is believed to involve intuition, creativity and ingenuity. Therefore, theories are propositions which vary in credibility.

Philosophers' View of Science

Karl Popper, a philosopher of science, rejects the inductive method as the process by which science advances. M, induction is illogical, irrational and unable to provide a satisfactory criterion of demarcation between empirical science and non-science such as astrology. He said that it is not logical to infer universal statements from singular ones. Induction believes that there are statements in science which we have to accept as true because it is not possible to test them. Karl Popper substituted induction with hypothetical-inductive model as a description of the process by which science advances. Hypotheses are formulated and tested; hypotheses are compared with one another and with any other relevant statements so as to find what logical relations exist between them. Hypothetical-deductive model also examines the consequences of varying the hypothesis. It then accepts the view that scientific change does not always proceed in the direction it started. According to Popper, hypothesis cannot be established conclusively even by extensive testing with favourable results since further tests could falsify it. A single negative instance is sufficient to establish the falsification of hypothesis. Thus, Hypothetical - deductive model is able to provide satisfactory criterion of demarcation between empirical science and non-science since it permits the revision as well as the refutation of theories. So a scientist should approach a theory from the viewpoint of whether it exposes itself to criticism of all kinds and whether it is able to stand up to it.

However, Thomas Kuhn, another philosopher of science criticized Hypothetical - deductive interpretation of the growth of science. He was not satisfied with the implication of the term falsifiability. The suggestion of Popper about rejection of an experimentally

falsified theory was said to be drastic. Kuhn said that it will not be in our interest to reject a theory, which has had considerable past success and reputation until a real alternative one is in sight. According to him, it is by challenging observations and adjusting theories that scientific knowledge grows. Tests need not necessarily lead to the replacement of a theory. Kuhn is concerned with the analysis of how scientists behave normally and not how they ought to behave. He used the term "Normal Science". Kuhn attacks the belief that measurement in science is just establishing the "fact". His normative view of science sees that the success of a measure lies in the explicit demonstration of a previously implicit agreement between theory and the world. In some experiments, for example, the experimenter assumes that his experimental results would represent a straight line graph.

In the Normal science proposed by Kuhn, members of the scientific community are governed by tradition, a strong and document theory (paradigm) is accepted and used as a reference point for all tests. These tests are conducted all the time mainly to test individual member scientist's puzzle-solving skills and only occasionally to test the paradigm. Testing of the paradigm is to remove anomalies or discrepancies. In fact, the occasional revolutions that occur at the time of paradigm change (or when a paradigm stages a come-back) are often, irrational and subjective. There is no clear basis for choice at the time of paradigm change. It is here that the scientist must turn to the wider notion of acceptability than those exclusive to science. At the time of paradigm change, science is more of a philosophy than it is like a Normal science.

According to Kuhn, scientific community is a chosen society and this explains the considerable stability and continuity in science.

This negates Popper's view which regarded scientific community as an open society in which no theory, however dormant and successful, is ever sacred. Popper supports the error will be systematically eliminated by the operation of critical debates in science, those social interests, which produce error, will be vanquished by those social interests who produce truth.

The philosophical and cultural context of science is a way of going deep into what constitutes science and what it entails to be a member of science community. The community must have acceptable principles, which must be used to explain the concept of science. The members must however, realize the limitations of scientific laws and theories.

In order to keep Nigeria secured among the nations of the world, it is necessary for the citizens to acquire scientific literacy since this will lead the country towards the technological advancement. It is necessary to realize the fact that science is a creation of man and its future, both theoretical and technical advancement, will depend upon the quality and number of our future scientists. The need for a scientifically trained manpower increases progressively in a developing country like Nigeria. In order for the citizens to realize the great opportunities, which the development of science has made in the world, identification of a useful set of values that underlie science becomes an increasingly crucial first step in building appropriate curriculum structures to achieve this dimension of scientific literacy. The values of science that must be taught are:

- Longing to know and understand: A conviction that knowledge is desirable and that inquiry directed toward its generation is a worthy investment of time and other resources.

- Questioning of all things: A belief that all things including authoritarian statement and "self-evident" truths are open to question. All questions are prized although some are of greater value than others because they lead to further understanding through scientific inquiry.
- Search for data and their meaning: Pricing of the acquisition and ordering of data because they are the basis for theories, which, in turn, are worthwhile because they can be used to explain many things and events. In some cases, these data have immediate practical applications of value to mankind as in cases in which data enables one to assess accurately the severity of a problem in society and/or the effects of policies directed to improve such situations.
- Demand and verification: A high regard for requests that supporting data be made public and that new empirical tests be invented and/or conducted to assess the validity or accuracy of a finding or assertion.
- Respect for logic: An esteem for those chains of inference that lead from raw data to conclusion according to some logical scheme and an insistence that conclusions on action, not based on such chains be subject to doubt.
- Consideration of premises: A prizing of frequent review of the basic external and internal assumptions from which a line of inquiry has arisen, especially when they are used as a basis for determining further action.
- Consideration of consequence: A belief that frequent and thoughtful review of both the direct and indirect effects resulting from pursuing a given line of inquiry or action is

worthwhile and that a decision to continue or abort the inquiry or action will be made in terms of the consequences.

BASIC METHODS OF TEACHING STM

There are numerous methods of teaching but the following basic methods are discussed below:

1. Expository/traditional/lecture method.
2. Inquiry/discovery/problem solving/experimental method
3. Individualized instruction or program the instruction method
4. Discussion/questioning method
5. Excursion/field trip method
6. Play way/games method
7. Project method
8. Demonstration method
9. Simulation and games method.
10. Socratic Method.
11. Constructivist method.

The Lecture Method: According to Novak (1993), the lecture method was established formally centuries ago as a teaching process that began with a literal reading of important passages from the text by the master, followed by the masters' interpretation of the text. Students were expected to sit, listen and take notes.

Most teaching carried out in schools today are through the lecture method. Due to the great demand placed on paper qualification which are obtained through public examinations, most science teachers use lecture method as the most effective method for easy coverage of the syllabus. Ali (1998), described lecture method as a method of teaching which involves the teacher telling his students what he thinks they need to know and the students listening and copying what they think the teacher needs them to know. Thus, the teacher does most of the talking and occasionally asks few or no question, while students remain passive listeners. The longer the teacher talks to the student, the less they retain the information.

Advantages of Lecture Method

i. Lecture method is economic in terms of time, effort and fund. It takes less time on the part of the teacher when preparing and planning for his lesson.

ii. The method allows for easy coverage of vast unit of knowledge and easy handling of large classes.

iii. It provides the teacher with a feeling of security as the dispenser of knowledge.

iv. The teacher can reach out to large number of students at the same time. He may use the public address system and teach a very large number of students.

v. It saves materials, since only the chalk board is required.

Disadvantage of lecture method

i. Lack of interaction in fact is considered one of the major limitations of the lecture method.

ii. It is boring- Students could get bored as the lesson is teacher centred.

iii. Students are passive- This does not develop the students' interaction ability, as they have no opportunity to express themselves, during the lecture period.

iv. It does not take into consideration individual differences of students.

v. It does not aid better understanding of the subject matter.

vi. Students are made to move at teacher's pace, since the method is teacher's centred.

vii. With lecture method, students do not practice communication skills.

viii. Evaluation of students during the lesson is difficult, since they are passive listeners and do not participate in the development of the lesson.

ix. When students have copies of the lecture notes or text, a significant percentage would prefer reading them rather than attending classes hence there is little or no interaction.

x. Very often, what students learn from lecture is usually forgotten after examination.

xi. The lecture method is not very good in teaching certain topics concepts that required attitudes and feelings of students, change

Guidelines for Effective Use of Lecture Method

1. Lecture method should be used in conjunction with other methods. This idea is supported by Ojiaku (2003). After assessing learning styles of student, Ojiaku recommend that using a variety of teaching styles with an emphasis on participatory and experimental learning enhances the lecture method.

2. A good science teacher should avoid the coverage of too many topics which may tend to confuse students. Sweller, Krischner & Clark (2007) recommend that lectures last no longer than 30 minutes.

3. Teacher should ensure active participation of learners as much as possible by asking questions and making comments. This will minimize boredom on the part of the learner or students.

4. At the end of the lesson, the lecturer should summarize the key points, as follows:

The Key Points:

Thus a good science teacher should avoid using ineffective lecture method, but should adopt effective lecture method.

The two sub-divisions can be differentiated as follows;

Characteristics of Effective and Ineffective lecture Method.

S/N	Effective lecture	Ineffective lecture
1.	Educator-student interaction	100% educator talk, with limited or no interaction
2.	Two-way communication	One-way communication
3.	Shared responsibility for active learning	Students depend on educator for all information.
4.	Educator-student question	Few if any question (educator or student)
5.	Small group, problem solving activities	No student activities
6.	Variety of supporting media use	No supporting media use.
7.	Limited note taking required (students have copies of lecture notes)	Extensive note taking required. No lecture notes.

Therefore with planning and effective presentation techniques, the lecture can be a highly effective and ineffective method for transferring knowledge to students. If a lecture is carefully planned, the educator will have a clear purpose of the lecture and will have considered the logistics associated with the number of students, amount of time allocated for the lecture, room size and available media.

Inquiry Method: Is learner centred. The learner originates his own problem, design experiments, collects data and writes a report. The teacher's role here is purely supervision. He assists in problem identification, definition, and content selection, entertains and

asks thought provoking and probing question, provides materials and renders necessary assistance to see that the set goals are achieved and new discoveries made.

Advantage of inquiry method

i. It equips the students through active participation to develop a mind to solve problems, by finding out information himself.

ii. It is students-centred.

iii. It encourages analytical thinking; manipulative skill is developed because of personal contact with the materials.

iv. Team work is encouraged because of the confidence, they have on one another.

v. It encourages critical thinking and sound reasoning.

Disadvantage of inquiry method

i. It is slow and time consuming.

ii. This method is student-centred.

iii. Much fund is needed to purchase equipment and materials.

Individualized/Programmed Instructional Method

In this method, instruction to the student is given in carefully structured steps depending on the individual student and the nature of the materials to be learnt. The student assumes responsibilities for his own learning, proceeding with activities at his own level, and studying at his own pace.

The students have the same program me and follow the same track, with the difference being their individualized pace of study.

Programmed instruction concept contributes too many individualized learning approaches. These elements are included:

a) Learning objectives and required levels of student's knowledge or performance are clearly stated.

b) Pre-testing permits the student to skip study of one or more objectives if competency is demonstrated.

c) Alternative procedures are specified.

d) Participation on activities and required responses for the learners is included.

e) Confirmation or correction of performance or response is immediately available to the learners.

f) Opportunities are provided for the learner to self-check his understanding, progress and performance against the lesson objectives.

g) The learners decide when he is ready to have his knowledge to performance evaluated by the teacher.

Advantages of Individualized/Programmed Instruction Method

i. Students move at their own pace- Unlike in the traditional lecture method, where students are not rushed, they study according to their own pace and abilities.

ii. It takes care of individual differences of students

iii. Concrete learning is encouraged.

iv. The method reduces student's anxiety as he is able to visualize almost immediately the result of his efforts.

v. It encourages individual study and the learner proceeds at his own learning pace.

vi. It is very useful for remedial studies.

Disadvantages of Individualized/Programmed Instruction Method

i. It is time consuming: This is because students study at their own learning pace and hence lazy students could take advantage of it.

ii. It focuses only on the cognitive and psychomotor domains i.e. information on the knowledge, aspect and good practice of what is learnt.

iii. Peer group interaction is not encouraged: In a group setting, the hidden curriculum is also achieved alongside the conventional learning but in individualized learning, this is absent.

iv. It is an expensive venture since a lot of equipment and materials are needed.

v. It does not encourage co-operative attitude and interpersonal relationship of learners.

Discussion/Questioning Method:

Here the teacher initiates a discussion that leads to the attainment of the learning objective. It involves the sharing of ideas, experiences, and the search for the truth. Discussion motivates the learning process. Brainstorming is a form of discussion in which groups generate many solutions to a specific problem. Criticize and evaluate ideas to arrive at the best solution to the problem. The teachers' responsibility in this regard is to motivate the discussion and presentation of ideas while he leaves the discussion to the students. The teacher is just a moderator of the learning process.

Advantages of Discussion/Questioning Method

i. It promotes critical thinking.

ii. It develops positive and healthy inter personal relationships between the teacher and the students.

iii. Among the students themselves, it encourages healthy competition.

iv. Knowledge is gained through active participation by the students in the discussion.

v. It is students centred.

vi. It makes use of students' initiative and hence develops them (students) intellectually.

vii. It develops deductive reasoning among the students.

Disadvantages of Discussion/Questioning Method

i. It is time consuming.

ii. Not all topics can be treated by this method.

iii. It could be boring to students who know little about the topic.

iv. It cannot be used effectively in young children classes because children have short attention span.

v. It could lead to arguments and irrelevancies if not well handled.

vi. Slow learners may not benefit from this method.

Field Trip Method:

This involves an excursion to an interesting location/site outside the classroom situation for the purpose of making relevant observation and obtaining some specific information. This can be an educational visit or tour to a bank, to study bank operations, a visit to the factory or local art gallery, a factory, a museum, a game reserve. The importance of field trip is that the visited place. The site must be relevant to the course of study. The students are given first-hand information on issues already discussed on the classroom. It makes real the concept study in the class, after the visit.

Advantages of Field Trip Method

i. It provides students with first-hand information about the topic/concept.

ii. It sharpens the students' skills of observation in making them appreciate the orderliness of natural occurring phenomena or events.

iii. All senses are utilized by students to get a clearer picture of the concept under study.

iv. There is a good rapport between the teacher and the students during field trip.

v. The students are able to see live direct and concretely all the abstract subject matter taught in the classroom.

Disadvantages of Field Trip Method

i. It requires a lot of planning to be effective as the teacher has to write for parent's approval take permission from school authority and make preliminary visits to the place of excursion before taking students there. He needs the clearance of the hosts.

ii. It is expensive and risky. This may involve levies on the children while the school may have to subsidize the field trip cost.

iii. It could be dangerous. Taking students on a trip especially by road. Accidents could occur or even robbery in an outdoor activity especially if it involves involving long distances.

iv. It could be time consuming: Field trips covering long distances take days and hence may prevent students from attending other lessons during the period of excursion.

v. It is a difficult task to accomplish, if not carefully planned.

Play Way/Games Method

This method is used to develop skills and good behaviours needed to handle real life situations. The learners are divided into actors and observers. A situation of crisis is imagined and created. Students are made to practice such skills as negotiation, dialogue, persuasion, etc to resolve the crisis without problem, socio-drama plays or games could be used to solve the problem. Such plays can help learners to handle more peacefully, calmly and objectively real life conflict situations.

Advantages of Play Way/Games Method

i. It makes the lesson time to come alive.

ii. It promotes active thinking.

iii. Promotes healthy competition and good interpersonal relationship among students.

Disadvantages of Play Way/Games Method

i. The class is noisy and appears unorganized.

ii. Students can ridicule the whole effort.

iii. Students might not relate the topic to real life situation problems in science and mathematics.

Project Method

This involves the teachers' supervision of classroom based scientific investigation. A project is selected by the class i.e. group or by the individual student. Various aspects of the project are

analyzed and considered. Learners are encouraged to take up the responsibility until the project is executed and accomplished.

Advantages of Project Method

i. It gives the learner and the teacher the opportunity to explore the environment on their own.

ii. It enables them to acquire first-hand information and experience of things and issues.

iii. The students use their initiative under teacher' supervision.

iv. A complete project gratifies all, and develops in the learner the necessary scientific and mathematical skills.

v. The students involved may have a lasting memory of the concept learnt.

Disadvantages of Project Method

i. It requires a lot of planning otherwise some students may drop out of the project.

ii. It could be time consuming.

iii. It is very expensive.

iv. It could be frustrating for students who find it hard to make up their mind on the choice of a topic.

Demonstration Method

The demonstration method is an instructional method in which an instructor/teacher shows and explains the topic. The teacher

demonstrates a selected skill while the students watch. As the teacher demonstrates he explains the complex processes that make up the skill. Demonstration is invaluable in the teaching of science and mathematics and where skill acquisition is necessary. Demonstration may be used to enrich and increase the learners understanding. It is important for instructors to realize that there is more to the demonstration method, than showing only the effective demonstration involve in teaching. The teaching should show questioning and application also. When skill development is the desired outcome, practice must be included as a major component of the method.

Demonstration method includes laboratory experiment. Demonstration means displaying something. When a science teacher shows the action of carbon dioxide on a blue moist litmus paper, he is the topic using the method of demonstration. The teacher can present the dissection of a toad or a rabbit to the pupils/learners. The teacher can also plan the manipulation of equipment and material in order for the pupils/learners to observe a scientist phenomenon. Most exercises in science classes which teachers carry out when they say "we are going to do an experiment" can be identified strictly as the use of the demonstration method.

Appropriateness of the Demonstration Method

- Principles and theories.
- Relationship of ports with use of instructional and devices.
- The people utilization of tool and equipment.
- Manipulative operations or motor skills-steps of procedure.

Requirement of Good Demonstration

The success of any demonstration demands that the following points should be kept in mind:

1. It should be planned and rehearsed by the teacher beforehand.
2. The apparatus used for demonstration should be big enough to be seen by the whole class.
3. Adequate lighting/water arrangements be made on demonstration table and a proper background table should be provided.
4. All the pieces of apparatus are placed in order before starting the demonstration.
5. Before actually doing the demonstration, a clear statement about the purpose of demonstration is made to the students, to draw their attention/focus.
6. The teacher makes sure that the demonstration leads to active participation of the students in the process of teaching.
7. The demonstration should be quick and slick and should not appear to linger unnecessarily.
8. The demonstration should be interesting, so that it captures the attention of the students.
9. It will be better if the teachers demonstrate with materials or thing students handle in their everyday life.

10. For active participation of students the teacher may call individual student in turn to help him in the demonstration.

11. The teacher should write the summary of the principles arrived at from the topic because of the demonstration on the chalkboard.

Advantages of Demonstration Method

i. It teaches the learners manipulative and operative skills.

ii. It develops understanding; it develops an appeal to the sense of vision.

iii. It develops in them a desire to emulate the work of the teacher.

iv. It helps students to acquire new and improved ways of doing things.

v. It is a suitable method for teaching large classes.

vi. It can be successfully used for all types of students.

vii. It is an economical method when compared to a purely student-centred method.

viii. Students take active interest in the demonstration lesson.

Disadvantages of Demonstration Method

i. It is teacher-centred; only few students are allowed to develop manipulative skills especially where equipment's are few and only the teacher and a few students have access to them.

ii. Some students are not keen observers, so they don't see nor understand what the teacher is doing.

iii. Since the method is not child-centred, it makes no provision for individual differences of students.

iv. It provides no scope for learning by doing. Since student observe the teacher performing.

Games and Simulation Method

This is otherwise called games/drama method. They are designed to help students to learn, to achieve specific goals or objectives in an active rather than a passive climate. Many games are advertised as educational, i.e. for use in the classroom namely:

i. Instructional games

ii. Simulation.

All games, simulation and dramatization work on the principle that students are highly motivated and students can achieve the objectives set for each activity, through games students practice science and mathematics. Through simulation they gain insight and knowledge about problems, social processes, and personal responsibilities in the contemporary society. Through dramatization, role plays, puppet or scroll theatre activities students may be released from their hang-ups and be creative and free to actualize themselves or other personalities whose identities they assume in the drama or puppet theatre.

The responsibility of the teacher in games and simulation is to set up conditions under which students can proceed with minimum guidance, towards an enjoyable and spontaneous learning

experience. Here are some examples of simulation and games, which the teacher can use:

CRISIS: This is a fictitious situation of Nations involved in crisis. To minimize their dispute participants are all students who will use all mechanisms of international relations (conferences, bargaining, and alliances, even threats) to achieve their goals. Situations in simulation should be fluid to allow manoeuvring; participants are challenged to think hard, to plan strategies and to anticipate consequences of their actions. The goal of the "Crisis" is to obtain a strategic treasure at the least possible cost and yet avoid war with other Nations. In negotiating, students will deal with a variety of problems arising out of balance of power. Simulation and games are useful in guidance and career choices.

Other areas in real life where simulation can be used is in link trainer, driver trainer, aircraft navigation, telephone services etc. In the link driver example a full scale, full size working model of an aircraft with a cockpit and all essential instruments are provided. The model moves in response of the pilots operation of the aircraft. The instruments respond to the pilots' actions, gives a navigation problem as the pilot flies. This experience gives a realistic sensation of flying. On the remote table a "crab" i.e. a mobile link trailing device accurately records the performance of the pilot for subsequent evaluation with his instructor or the lecturer.

Advantages of Simulation and Games

i. Learners gain insight and knowledge about problems.

ii. It helps to mobilize the society-through play in the mobilization of the society to bring about a solution.

iii. It helps the society to release tension and students learn a lot of things.

iv. Students learn how to manoeuvres situations and plan strategies, to solve problems.

v. They are challenged to think very high to avoid crisis.

Disadvantages of Simulation and Games

i. Sometimes in simulation, there is crisis of balance of power- This is seen in conflict over the roles to be played by actors.

ii. There could be crisis because of a very large satire.

iii. It gives room for telling lies against an opponent.

iv. The class is very noisy and not organized.

v. Students may not relate the games/topic to the real life situation or the subject matter.

vi. There could be serious/fatal injury if the situation is not properly controlled or handled.

Socratic Method

This method is also known as question and answer method. Socrates, a great philosopher, who lived two thousand years ago, popularized this method. The teacher uses questions to bring out answers, around the concept he wants the children to learn. Even if a student asks a question, the teacher, instead of giving an answer, asks him/her a question, the answer of which is what the student is looking for or will help the student to understand better

his own question. This method can be used alongside any other method a teacher is adopting.

Advantages of Socratic Method

i. It develops deductive thinking in the learner. This is because, he/she generalizes in relating one answer to another.

ii. It makes the students to participate actively in the class.

Disadvantages of Socratic Method

Weak and introvert students may be scared. This set of students may not be favourably disposed to answering questions and hence will be passive in class.

Constructivist Method

Constructivist teaching techniques are based on constructivist learning theory. This theoretical framework holds the view that learning always, builds upon the knowledge that a student already has/knows, this prior knowledge is called a schema (a psychology). Because all learning is filtered through pre-existing schemata. Constructivist suggests that learning is more effective whom a student is actively engaged in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claim to be based on constructivist learning theory. Most of those methods rely on the same form of guided discovery, where the teacher avoids most direct instruction attempts to lead the students through questions and activities to discover, discuss, appreciate and verbalize the new knowledge.

Characteristics of Constructivist Teaching

According to Audrey Gray, the characteristics of a classroom are as follows:

- The learners are actively involved, in the learning process.
- The classroom environment is democratic.
- The class activities are interactive and student-centred.
- The teacher facilitates the process of learning in which students are encouraged to be responsible and autonomous.

Constructivist Activities

In the constructivist classroom, students work primarily, in groups and learning and knowledge are attractive and dynamic. There is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. This is contrary to the traditional classroom in which students work primarily alone. Learning is achieved through repetition, and the subjects are strictly adhered to and are guided by a textbook. Some activities encouraged in constructivist classrooms are:

- **Experimentation:** Students individually perform an experiment and then come together as a class to discuss the results.
- **Research projects:** Students to research on a topic and can present their findings to the class.
- **Field Trips:** This allows students to put the concepts and ideas discussed in the class in a real world context.

- Field trips would often be followed by class discussions.
- **Films:** These provide the visual context and thus bring another real visual sense into learning experience.
- **Class discussions:** This technique is used in all of the methods described above. It is one of the most important distinctions of constructivist teaching methods.

CHAPTER FOUR

THE ROLE OF THE TEACHERS

Roles of Teachers

In the constructivist classroom, the teacher's role is to prompt and facilitate discussion. Thus, the teacher's main focus should be to guide students by asking questions that will lead them to develop their own conclusions on the subject matter.

Guidelines for Constructivist Method

David Jonassen identified three major roles for facilitators to support students in constructivist learning environments: These roles are:-

- Modelling
- Coaching
- Scaffolding.

Constructivist Teaching and Learning Models

Constructivism is an approach to teaching and learning based on the premise that cognition (learning) is the result of "mental construction." In other words, students learn by fitting new information together with what they already know. Constructivists believe that learning is affected by the context in which an idea is taught as well as by students' beliefs and attitudes about the concept.

Constructivist teaching is based on recent research about the human brain and what is known about how learning occurs.

Mintzes Novak (Eds) (2000) suggest that brain-compatible teaching is based on twelve (12) basic principles:

1. "The brain is a parallel processor". It simultaneously processes many different types of information, including thoughts, emotions, and cultural knowledge. Effective teaching employs a variety of learning strategies.
2. "Learning engages the entire physiology". Teachers can't address just the intellect only.
3. "The search for knowledge/information is innate". Effective teaching recognizes that meaning is personal and unique, and that students' understanding is based on their own unique experiences.
4. "The search for meaning occurs through "patterning". Effective teaching connects isolated ideas and information with global concepts and themes.
5. "Emotions are critical to patterning". Learning is influenced by emotions, feelings, and attitudes, of the learner.
6. "The brain processes parts and wholes simultaneously". People have difficulty learning when either parts or wholes are overlooked.
7. "Learning involves both focus attention and peripheral perception". Learning is influenced by the environment, culture, and climate of the learner.
8. "Learning always involves conscious and unconscious processes". Students need time to process 'how' as well as 'what' they" have learnt.

9. "We have at least two different types of memory: A spatial memory system and a set of systems for rote learning". Teaching that heavily emphasizes rote learning only does not promote spatial, experiential learning and can inhibit understanding.
10. "We understand and remember best when facts and skills are embedded in the natural, spatial memory". Experimental learning is the most effective.
11. "Learning is enhanced by challenge and inhibited by threat". The classroom climate should be challenging but not threatening to students/learners.
12. "Each brain is unique". Teaching must be multifaceted to allow students to express their unique preferences

Constructivist Learning Environments (CLE)

Jonasen has proposed a model for developing constructivist learning environments (CLEs) around a specific learning goal. This goal may take one of several forms, from the least to the most complex:

- Question or issue.
- Case study.
- Long-term project.
- Problem (multiple cases and projects integrated at the curriculum level).

Jonasen recommends making the learning goals engaging and relevant but not overly structured. Learning is driven in CLEs by the problem to be solved. Students learn contents and theory in order to solve the problem. This is different from the traditional objectivist teaching where the theory would be presented first and problem would be used afterwards to practice the theory.

Depending on students' prior experiences, related cases and scaffolding may be necessary for support. Instructors also need to provide an authentic context for tasks, plus information resources, cognitive tools, and collaborative tools.

Constructivist Assessment

Traditionally, assessment in the classrooms is based on testing. In this style, it is important for the student to produce the correct answers. However, in constructivist teaching, the process of gaining knowledge is viewed as being just as important as the product. Thus, assessment is based not only on tests, but also on observation of the student, the students' work, and the students' points of view.

Assessment Strategies

- Oral discussions. The teacher presents students with a "focus" question and allows an open discussion on the topic.
- KWL (H) Chart: is about (What we know and what we want to know and also. What we have learned. How we learnt it). This technique can be used throughout the course of study for a particular topic, but it is also a good assessment technique as it shows the teacher the progress of the student throughout the course of study.

- Mind Mapping: In this activity, students list and categorize the concepts and ideas relating to a topic.
- Hands-on-activities: These activities encourage students to manipulate their environments or a particular learning tool. Teacher can use a checklist and observation to assess student's success with the particular material.
- Pre-testing: This allows a teacher to determine what knowledge students bring to a new topic and d thus will be helpful in directing the course. Of study.

Advantages of Constructivist Method

1. Constructivist approaches tend to validate individual and cultural differences and diversity.
2. Constructivist approaches can also be used in online learning for example, tools such as discussion forums, wikis and Blogs can enable learners to actively construct knowledge.
3. Constructivist students perform better than their peers when tested on higher-order reasoning.
4. Constructivist teaching techniques attempt to understand how the wheel turns, and how it functions.
5. It brings a better understanding since students are given the chance to explore their environment through the guidance of the teacher.
6. It encourages learning to be behaviourally activated.

Disadvantages of Constructivist Method

1. Cognitive scientists say constructivism is either misleading or contradicts known findings.
2. Due to emphasis on group work, the ideas of the none-active students may dominate the group's discussion and conclusions.
3. Constructivist teaching techniques forces students to "reinvent the wheel".
4. It discourages learning not to be cognitively active.
5. It does not consider the large numbers of varied personal characteristics as well as the prevalence of learning problems in students.
6. It is based on students that are capable of learning more independently.

CHAPTER FIVE

EVALUATION IN SCIENCE AND MATHEMATICS TEACHING WITH EMPHASIS IN CONTINUOUS ASSESSMENT

What is Evaluation?

Evaluation is the judging of the merit or worth of one or more experiences, ideas or processes to determine the students who have satisfactorily completed the course requirements OR to determine students who have done well and those who have performed poorly, based on test scores, of various sorts e.g. field trip reports, term papers, research projects, observations, interviews, anecdotal records etc.

Evaluation will help the teacher to determine the eligibility of a student participation in interschool competitions, or recommendation for a job even after the student has left school. Evaluation can be formal or informal, consciously or unconsciously done.

Types or Forms of Evaluation

In this section the four major types of classroom evaluation and their uses are discussed. These forms or types of evaluation discussed here are:

i. **Placement Evaluation.**
ii. **Formative Evaluation.**
iii. **Diagnostic Evaluation.**
iv. **Summative Evaluation.**

A. Placement Evaluation

This is the evaluation of the pupils' entry behaviour in a sequence of instruction. Placement tests designed by teachers are pre-tests that measure whether children/learners possess the necessary knowledge and skills that will enable them succeed in the planned instruction they are to be exposed to. Secondly, they are useful for measuring how much or the degree to which the students have already achieved the specified objectives of planned instruction. They are usually of low difficulty level.

B. Formative Evaluation

Formative evaluation refers to the evaluation of learning progress of students during instruction. It provides continued feedback to both the teacher and students. The purpose of this type of evaluation is to improve students' learning through the provision of constructive feedback and remediation. Formative evaluation also provides reinforcement when successful learning takes place and also identifies weaknesses that need remediation. The results obtained from formative evaluation are not usually used for assessing course grades or scores. Questions teachers ask students while teaching is still in progress are for formative evaluation purposes.

C. Diagnostic Evaluation

Diagnostic evaluation is the type of evaluation conducted to determine what special difficulties are encountered by the students. In diagnostic evaluation students' persistence in learning, learning difficulties that could not be remedied by the corrective prescriptions of formative evaluation are of major concern. Diagnostic evaluation tests begin with very simple items

and then progress in difficulty. Usually many of the items deal with the same concept, skills or specific area, but with some element of variation from item to item.

D. Summative Evaluation

Summative evaluation is usually conducted at the end of a unit of instruction. The results that are obtained from such evaluation are essentially for assigning grades or scores, or certifying the students mastery of specific learning outcomes or instructional objective. Summative tests used for such evaluation are usually broad in content and with items of varying degree of difficulty. Examples of such tests are end of term examination, end of year examination, first school leaving certificate, junior secondary school certificate, and senior secondary school certificate.

Nature of Evaluation

The nature of evaluation is that each student's progress is monitored to help the student attain his full potential i.e. taking care of the individual differences among the students. Evaluation in the above sense will reveal where the breakdown in learning has occurred and remedial teaching is organized to correct it.

The teacher normally decides the various nature the evaluation will take at a particular points e.g. should it include scores on good behaviour, diligence, regularity in class attendance, good attitudes like co-operation or will, it test only the cognitive domain without affective and psychomotor domains. A good natured evaluation must include the three domains. That is a student must be worthy in learning and in character.

Functions of Evaluation

There are three primary functions of evaluation. These basic functions are:

a. Evaluation improves teaching and learning by highlighting areas where remedial teaching is needed and focuses on areas of improvement on teaching methods, goals not met, and sometimes curriculum review.

b. Evaluation help to determine to which extent the content has been covered and mastered: In a class test where 95% of the students failed the teaching or the testing is faulty, it will be very necessary that re-teaching and retesting be done to find out the difficult concepts that were not mastered. If the teaching and testing are good, then other aspects like maladjustment of students, illness, or even extra task for bright students could be looked into.

c. Evaluation helps to establish a standard or criteria for the course: A well planned final examination for a semester of class work sets the tone for the course. Old students pass on the standard expected by the course, to new students and they are well prepared in advance for the standard expected of them from the course objectives, through independent study and self-evaluation before examination at the end of the course.

There are also some secondary functions of evaluation

i. **Evaluation forms the base for recording students' progress:** an i.e. cumulative evaluation record to date of students accompanies him to the next level i.e. from 100 level to 300

level and above. This record helps the academic adviser to know his aptitude and intelligence plus rating scale such interest inventories for a proper selection of courses of study suitable to the students' aptitudes and demonstrated capabilities. It helps the academic adviser to cope with students who have unrealistic aspirations, with probably unattainable goals which leads most of the time to frustration and discouragement e.g. a student who wants to become an engineer who scores low in mathematics and puts off doing his mathematics assignment as long as possible. By what miracle could such a student hope to succeed as an engineer? OR a student who wants to be a doctor who does not understand chemistry, scores low marks in mathematics, and loathes biology lessons to the extent he would not touch specimens in the laboratory, because it is messy work. On what basis could such a student consider a career in medicine?

ii. **Evaluation forms the basis for placement of students transfer:** particularly in courses that are sequential i.e. courses like: - Science, Mathematics, Music theory, Languages, where new work cannot be successfully undertaken without prior mastery of the proceeding work.

iii. **Evaluation forms base for acceleration of student:** particularly for highly motivated students who have the capacity for sustained hand work with careful validated evaluation, exceptional students can accelerate faster than the average students. Such students are normally identified 4-5 weeks as they make high/perfect scores in all tests, quizzes, finishes his work well ahead of others, shows genuine interest in the subject, works ahead of the teacher by his own

initiative. He could be given the privilege to study the next terms work on his own, if he so desires.

iv. **Evaluation helps to determine whether students are working up to full capacity:** As students enrol for a course in aptitude test the brings to light evaluation a wide range of ability to read, ability to use language, ability to do quantitative reasoning, vocabulary facility. New students who score high in these aptitude tests are expected to earn high marks, if they work diligently in their studies. As students go midway in the course comparison is made with the initial aptitude and orientation test scores for each student. This gives the indication to students, working up to full capacity and students who are underachieving. The underachievers are confronted by the academic adviser with evidence highlighted and are counselled to upgrade their performance by being more diligent in their outside preparation. Many of the students do indeed improve after such counsel and confrontation by their academic adviser.

v. **Evaluation engenders regard for periodic assessment of progress:** A teacher who is genuinely concerned about students long-range welfare must prepare regular, rigorous testing programme which will inspire students to work diligently throughout the term and which will culminate in a thorough final examination for which the students are well prepared, so that both the teachers and the students will experience the joy that comes from a sense of achievement. If the test programme is weak procrastinating students may be happy at that moment but will lack respect for such a weak, system. The responsible students will rest because there is no

opportunity to demonstrate the stuff they have diligently studied.

Evaluation in Science, Technology and Mathematics

Evaluation helps the scientist to determine how well the objectives of science teaching have been attained, or the extent to which the content has been mastered as well as the degree to which the students can apply their learning to new situations.

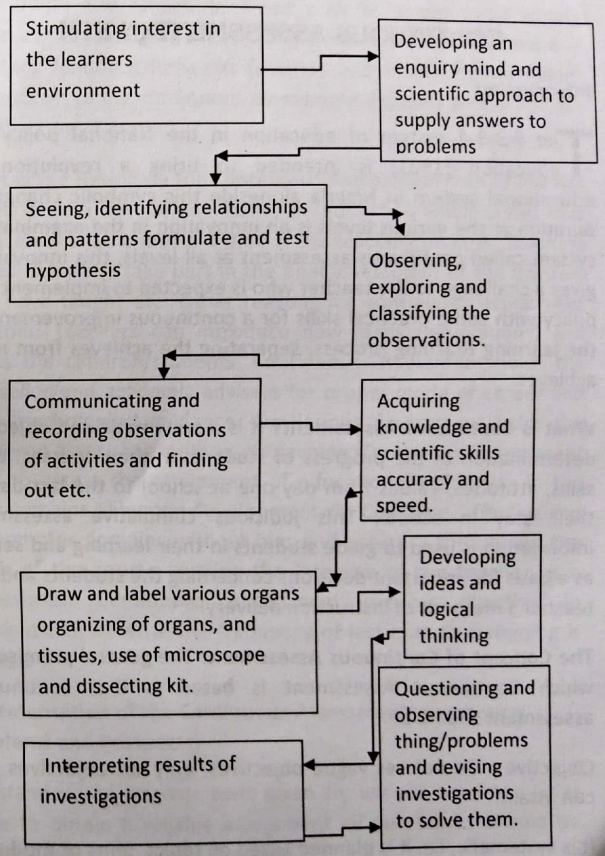
What is Science? It is a conscious and systematic research for organized knowledge about nature of doing, finding out through organized activity, careful observation, recording observations accurately and drawing conclusions which are independent of the observer. In science teaching, evaluation helps the teacher to know to what extent these scientific skills have been mastered viz.

1. **Observation skills** e.g. evaluated in seeing, directly or indirectly, e.g. in case of magnetism.
2. **Classification skills:** e.g. Evaluated in sorting of numbers, grouping up, ordering according to classes, quality and quantity of materials etc.
3. **Communication skills:** Evaluated in writing, speaking, by graph, models, diagrams, bar charts, etc.
4. **Counting numbers and relationship skills:** Evaluated In unit of measurements, counting operations, counting discrete numbers 1,2,3, continuous counting 1.1, 1.2, 1.3, etc.
5. **Measurements skills:** Evaluated in terms of time, length, area, volume, weight, span, arm length, strides, match stick, match

box lengths and standard unit measurements. e.g. centimetres, meter, kilometre. etc

6. **Question asking skills:** Evaluated in the ask questions from a topic. Ability to draw.
7. **Manipulative skills:** Evaluated on formulation of mental models, to solve an issue
8. Perform experiments, make operational definitions, prove theorems etc.
9. Inference, make predictions, formulate hypothesis etc.
10. Interpreting data, analysis of data which provides impetus for fresh investigation. The chart below gives a summary "flowchart" at a glance of the scientific skills to be evaluated by the teacher of science or mathematics.

Scientific Skill for the Evaluation of STM



CHAPTER SIX

CONTINUOUS ASSESSMENT IN STM

Introduction

The 6-3-3-4 system of education in the National policy on education (1981) is intended to bring a revolution in educational system in Nigeria alongside this symbolic change in duration at the various levels is an innovation in the examination system called continuous assessment at all levels, this innovation gives a challenge to the teacher who is expected to implement the policy with some practical skills for a continuous improvement of the learning teaching process, separating the achieves from non-achieves.

What is Continuous Assessment? It is a systematic and objective determination of the progress of students in their courses, their skills, attitudes, values from day one at school to the last day of their stay in school. This judicious cumulative assessment information is used to guide students in their learning and serves as a basis for important decisions concerning the students and the teacher's methods of instruction delivery.

The Concept of Continuous Assessment: The general premise on which Continuous Assessment is based is that continuous assessment should be:

Objective - Do not set vague objectives, only set objectives you can attain.

It is systematic, i.e. it is planned based on topics, units or modules. It is a technique to assess the teaching-learning process and

improve on them. It is objective this means that it must be measurable and attainable. Need a lot of co-operation among students' teachers and the school administration. Demand a constant feedback between teachers and students. The failure and success of the continuous assessment depends on the teacher and the administration.

What is the Rationale for Continuous Assessment? The rationale drawn is from the national policy on education which states that assessment is an important part of the teaching process. Teachers should therefore take part in the final assessment of the learners they have taught etc. Other reasons for continuous assessment are that: Teachers can introduce new ideas (innovations) and assess the children/students. Continuous Assessment helps the counsellor/and academic advisers for proper guide of career and socio psychological guidance. Continuous Assessment helps the teacher to assess her method of teaching. Continuous Assessment helps to assess the attainment of educational objectives in the three domains of human development viz. Cognitive, affective and psychomotor domains without bias and accuracy throughout the length of the course trusting the integrity of the teacher as a professional. Continuous Assessment reduces cheating in examinations, because the frequency of last minute cramming is reduced.

Implementation of the Continuous Assessment programme (Problems and Prospects)

The standard of internal tests given by various teachers differ hence to obtain a reliable assessment all raw scores should be standardized.

The workload on the teacher's time is high, for this heavy responsibility, the teacher must be physically, mentally, attitudinally and professionally prepared to cope with Continuous Assessment implementation challenges.

Quality of staff and expertise differ from school to school. There should be more training in test construction, test administration, simple statistics, concepts like (mean, median, mode, standard deviation) and training in types of tests e.g. t-score, z-score, x2 etc to be able to handle quickly and easily the computation involved in record keeping of the scores and counselling of the underachieving students.

Assessment of Non-cognitive Areas- The instruments prominent among the various instruments for measuring non-cognitive areas of achievement are:

Self-reporting instrument e.g. interviews and questionnaires.

Rating scales e.g. study habit inventory API (SHI) (VII) (MOPS) SPI

Observations- Observation of students in group works, parties, or playground.

Projective techniques- You report on others not yourself.

Socio-metric technique- Mutual choices of the group shows what they think and feel about one another.

Skills for Effective Conduct of Continuous Assessment

Good planning in the construction, scoring and use of test scores and the instruments.

Good interpretation of scores from Continuous Assessment

Good keeping and retrieval of records and goods preparation of reports.

The translation of the Continuous Assessment. National Policy on Education (1981) into practice is a task that requires professional skill and judgment of a very high order. Science teachers must look at the various syllabuses and workout a smooth way of implementing the Continuous Assessment policy.

Prospects for Proper Continuous Assessment Implementation

Teachers in the same school should have a uniform procedure for planning and constructing and administration of the Continuous Assessment tests.

A uniform system of record keeping should be maintained throughout the states and the country in general at each level of education.

Continuous Assessment committee for proper co-ordination of Continuous Assessment records in schools, zones, should be formed. This will help to ensure that an approved standard is maintained in the conduct of Continuous Assessment in schools.

The administration of each school should provide storage spaces like filing cabinets, storage rooms, personnel/clerks for keeping and retrieving continuous assessment information. In conclusion of this section therefore, Continuous Assessment records should be through evaluation of student's continuous performance in academics and his affective and psychomotor domains for the period of stay of the students in the school. In our present system

of education it should constitutes a certain percentage of the student's final performance in the course of study, supporting the idea that one single three (3) hour examination alone cannot exactly show the true ability of a student.

Characteristic of Continuous Assessment: - A continuous assessment scheme has four major characteristics:

It is **systematic** i.e. Follows an agreed plan.

It is **comprehensive** i.e. Covers all aspects of a pupils' development i.e. affective, psychomotor and cognitive domains, using a variety of test instruments not just pen and paper tests but also projects, practical, and inventories.

It is **cumulative** i.e. A system of accumulation of assessment has to be done, so that the final outcome is based on a series of assessments gathered over a period of time, for the student.

It is **guidance oriented** i.e. the results should be used to provide a reliable picture of a students' strengths and weaknesses so that the students, the teachers, the parents may take appropriate remedial action and a realistic career choice, will be made.

Implementation of Continuous Assessment: Some Critical Points for the Success of the Scheme.

Simplicity: The outset should be as simple as possible i.e. Heavy statistical treatment of test scores should be avoided.

Readability: One of the aims of Continuous Assessment is to communicate. This can be done by converting scores to letter grades to keep away from percentile ranks for representing achievements.

Security: Has major two areas to be considered are (a) The physical security of records from loss by fired, flood, theft, etc. (b) Security against fraud, forgery or the introduction of personal bias particularly in assessment of the affective domain. Keeping Continuous Assessment records both in the academic office, department office and the academic adviser's office helps when there is fire hazard. A joint decision making committee protects Continuous Assessment from the later hazard.

Validity: How can students, parents, teachers know if the Continuous Assessment is valid in relation to other schools around them. The way out is a system of Continuous Assessment moderation, may be done annually or biannually especially if the Continuous Assessment is used for certification.

Integrity: Continuous Assessment can actively promote integrity by (a) Sharing the workload of Continuous Assessment equitably (b) Making only reasonable demands on teachers in terms of frequency of assessments, unreasonable demands can only lead to unreasonable responses (c) Making data transfer and affective area assessments group activities (d) Producing and providing well designed and data collection forms (e) Having clearly delineated and delegated responsibilities to staff which ensures proper supervision, of record.

Advantages of Continuous Assessment over End-of–Course Examination

The basic advantage of Continuous Assessment over the end-of-course examination is time. With Continuous Assessment a three-year course can be assessed over a period of three years hence allowing time for:

- Detailed formative assessment of the entire course as it is taught.
- Students who are doing lengthy investigations have would time for project reports.
- Guidance and remedial measures with individual student is possible.
- Time is allowed for learning and assessment of psychomotor skills.
- An investigation of the affective area of the subject and their impact on students so as to facilitate better guidance and tuition.

Psychological Considerations in the Teaching of Science and Mathematics

The teacher should help students to adopt certain attitudes and interests in learning of science and mathematics: Using Bandura & Walter (1963) as a guide, the format helps the students to identify with a certain class of person (a scientist, doctor, engineer, mathematician etc.). The format requires students to act out the desired attitude through positive reinforcement of the learning activities by the teacher. Motivation of students' interest in the lesson: If a teacher deals with matters, concepts (experiences) of interest to the students, they will actively participate in the lesson. The use of interesting materials will sustain student's attention, and will also help in a good management and control of the class. Any good performance should be rewarded and any bad behaviour/performance punished.

Emotional disturbance: The teacher should help the students to see the importance of developing proper study habits, to study effectively to succeed in science and mathematics by developing "I will succeed attitude" through effective studying of my books and "working to full capacity." Effective study skills help students fight stress, tension and reduce worry which are enemies of success. Few examples of study skills are as follows:

To reduce stress and worry, students can talk things over with someone e.g. the teacher, the friend, the parents etc. The students should list, and rank things to be done and do them one at a time allowing a reasonable time for rest.

The student should plan his time 1-2 hours per subject at a time, and study where there is minimal distraction and noise.

Improve his memory through practice, reviews, recitation, and rehearsal of class work after lessons. Practice makes for better perception. Practice makes perfect.

Individual differences and individual attention: The teacher should note that students can never be the same in their learning rates consequently individual attention should be given to the student's performance. The slow learners should be helped, while the fast learners should be encouraged meaningfully work faster and ahead.

Use of a variety and interesting teaching methods and aids: The use of variety and interesting teaching method and teaching materials by the teacher will help comprehension of the topics and better perception and performance by the students.

The Unit and Lesson Plan

In this section the role of the teacher and student in the learning teaching process and interaction is discussed. The unit and lesson plan and their values were explained. Behavioural objectives are also explained. Communication as a major factor in science and mathematics pedagogy is discussed. Improvisation in the teaching and learning of mathematics is also treated. The use of visual aids and the use of locally made instructional materials is treated.

Planning is a major prerequisite for successful learning teaching, a plan of action is essential for efficient and effective learning. A lesson may seem to develop extemporaneously without any visible evidence of lesson plans or units plan that an observer may think, no special planning was involved. As the lesson progresses, the observer gradually becomes aware that learning is taking place in a logical, well planned and defined way. This is because (a) problems raised in the lesson are solved systematically (b) Materials necessary for demonstration exercise are readily at hand at the right time and right place (c) Reference books for further information are ready etc. The observer will now realize that intensive planning and preparation has been done, before the lesson delivery.

The Role of the Teacher and the Student in these learning plans would be that, the teacher must plan thoroughly all activities related to the learning environment, irrespective of the fact that he is a beginning teacher or teacher with considerable experience. Focusing on what the students must learn or what behavioural changes students should exhibit at the end of the instructional period. The teacher being the learning-manager must manage the learning environment in a manner to create freedom of

interaction between students and the teacher and not only the traditional teacher-students interaction.

The traditional student's role has changed, today's students bring to the classroom more information and a broader experimental background, and hence students are more active participants in the teaching-learning dynamic interaction. Programmes for students today must be planned to meet these new challenges.

The Unit Plan: The unit plan of instruction is a means of organizing instruction by objectives which are similar and related in order to achieve significant educational goals. The unit plan is focused on the development of some significant understanding, skill, and ability or in students, attitude that will confirm or modify behaviour. It focuses on one major topic over a period of time. The unit plan deals with the entire system rather than the parts. An analogy to unit plan is like a student who desires to make a trip to FUT, Minna by road from Abuja. First, the destination would be determined, a road map would be secured, a route planned, stops would be anticipated etc. Without a unit plan before the lesson plan it would be like taking a trip without a map.

The Value of the Unit Plan: The unit plan helps the teacher to avoid disconnected lessons, tasks in his teaching. It makes for the incorporation of a great variety of learning activities, like reading, writing, speaking, listening, experimenting, researching and reporting. It makes use of many kinds of learning aids such as audio visual materials, electronic devices, laboratory equipment and community resources. It makes adequate provisions for individual differences because students know the scope of the instructional plan and do not rely entirely on the teacher for all information. It is based upon the sound psychological principles of

learning which emphasize learning by wholes, before parts hence the continuity of learning and the integration of student learning experiences. Elements of the UNIT are made up of the unit title, broad goals, learning outcomes, or specific objectives, learning activities/experiences, learning materials and evaluation. These are explained clearly below.

The Unit Title/Heading: This includes the title of the programme, course title, grade level and the title of the unit itself, and the estimated amount of time necessary to satisfactory complete the unit e.g. Programme title: Electricity/Electronics. Grade level: 100 levels. Unit title: Safety and housekeeping in the electricity/electronic industry. Teaching Time: 6 units i.e. 6 hours

Programme goals: A positive attitude towards safety to be developed in each student and Safety of the student and his friends is paramount. The programme goals are broadly stated objectives which cause the students to focus upon the general direction of the unit of study.

Course content: This element of the unit plan provides a scope and a sequence to the related instructional topics included in the unit to be considered.

Learning activities: This element is used to determine what the student already knows, to motivate the students, and to develop the necessary competences stated in the unit. Learning activities should be extensive and varied in order to meet the student's interests, backgrounds, abilities and learning styles.

Evaluation: The unit plan should indicate the performance evaluation method to be used in each case e.g. an objective-type test, through observation of the individual as he performs the

specified task, oral or written reports to be submitted to the teacher, for evaluation.

THE LESSON PLAN

Definition: The lesson plan is an expanded thoroughly prepared outline of a chosen portion of a unit plan. This represents the events and sequence of events of a similar segment of the learning unit or a well taught out orderly and sequentially arranged lesson on paper. The main features of the lesson plan are the subject, the topic, the class, the age-range, the time/duration, the objectives, students previous knowledge, lesson introduction, lesson presentation, lesson evaluation of self and students, blackboard summary and home work. It serves as a guide to the teacher and is written in such a manner as to cause the teacher to feel confident in the classroom. The components of the lesson plan are similar to those of the unit plan (Objectives, time, materials, activities of the (teacher and the students) and the method of evaluating results). Below are some formats of the lesson plan:

Lesson plan title:

Course title:

Objectives: A list of performance desired of the student is to be made here.

Materials: Any materials and equipment necessary for the completion of the lesson should be listed here.

Activities: Activities of the teacher, students and the time. Here a description of what the teacher is going to do and appropriate student activities are to be listed and explained.

Evaluation: The method/means of evaluating the student's performance, product development or questions to be asked to check student learning should be listed here.

It is important to note here that, while lesson plan format might differ, that the same basic elements are present i.e. performance objectives, materials and equipment supplies, and activities (students and teacher), and evaluation. In addition to the above stated frame of a lesson plan. The teacher should provide a variety of activities in order to keep the student's interest alive and to allow students to respond in more than one manner of evaluation (report writing, oral response, etc.).

Consider many ways of arousing and motivating student's interest.

Provide some link with previous lesson or with future lessons.

Provide sufficient and appropriate practice immediately after, a skill demonstration.

Call the name of any particular student you wish to respond. Do not overlook some students.

A lesson plan can have one or more objectives and one objective might be useful for several daily lessons.

Evaluation can take many forms. Determine the most suitable method and use it. Evaluation methods are paper-pencil test, performance test, observation, supervised laboratory activities etc.

REFERENCES

Abdullahi, A. (1982) Science Teaching in Nigeria. Ilorin Atoto Press Ltd.

Ali, A. (1996). Fundamentals of research in education. Onitsha: *Meks Publishers Nigeria Ltd*.

Ausubel, D. P. (1969). Educational Psychology. A cognitive view. *New York: Holt. Rineham and Winston*

Bandura, A. & Walter, R.H. (1963). Social learning and personality development. New York: Rinehart and Winston.

Conant, J.B. (1951). Science and Common sense. New Haven connection Yale University Press.

Fafunwa, B. (1979). The purposes of Teacher Education in Adaralegbe A.A. Philosophy for Nigerian Education. Ibadan Heinemann Educational Books Ltd.

Jonassen, D. H., & Grabowski, B. L. (1993). "Handbook of individual differences: Learning instruction." *Hillsdale, New Jessey Lawrence Earlbaum Associates.*

Mintzes, J., Wandersee, J. & Novak, J. D (Eds) (2000). Assessing Science Understanding: A Human Constructivists View. San Diego, CA: Academic Press

Novak, J. D. (1993). How do we learn our lesson. Taking Students through the Process. Science Teacher, 60(3), 50-55.

Ogunniyi, M.B. (1986). Teaching science in Africa. Ibadan Salem Media (Nig.) Ltd.

Ojiaku, F. C. (2003). The effects of Combining advance organizers, video package and lecture method on student's achievement in integrated science in Oshodi local government area of Lagos state. Unpublished M. Tec. thesis FUT Minna.

Sweller, J., Krischner, P. A. & Clark, R. E. (2007). Why minimally guided teaching techniques do not work. A reply to commentaries. Educational Psychologist 42(2), 115-121

Urevba, A. (1990). Methodology of science teaching Benin City, Juland Publishers

White, I. & Gunstone, R. (1992). Probing Understanding. New York: Falmer Press

Index