SCIENCE METHODS AND STRATEGIES

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Dedication

On the 50th year of Nigerian's Independence

Dedicated to the martyrs who sacrificed their lives to free the Nigerian sub-continent.

To Timothy, Ebele, Kene, Obi, Onyi and Nnamdi.

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Regarding errors for improvement (This is because despite best efforts, the possibility of some errors in the book cannot be left out. It is hoped that this book will stimulate more discussions that will cause further development of science teaching methods) please send your comments etc. to renemogbo@yahoo.com or gana_celina@yahoo.com

Irene and Celina

Preface

This book is based on the author's years of experience in science teaching, counseling and education, imparting instructions on the subject to practicing professionals, science and Technology students and science education students for the B. Tech, M. Tech and PGDE programmes.

The objective of the book is to guide science methods students and teachers and science education counselors in planning and directing science learning in a manner that will yield the best possible results.

The topics dealt with in this volume is comprehensive enough to serve as a basic text for students taking instructional strategies in the course EDU 312 for teaching STM who can cover the contents in one semester and for any self-study.

Teachers and students are also encouraged to supplement the study of the text by visits to schools and/or by the use of audiovisual materials to reflect new developments in the education industry. It will not be possible to produce a book of this type without assistance from man y good people and organizations; these are highly and gratefully acknowledged. We would also like to express our appreciation to our colleagues and our former students for their helpful suggestions, comments and review of the text. Particularly our thanks are due to Mohammed Iliyasu Gupa, who typed the documents. We humbly solicit for more suggestions.

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Last but not the least for my family for understanding and support which saw me through the extended working hours and reading.

Contents

CHAPTER ONE

BASIC CONCEPTS IN INSTRUCTIONAL STRATEGIES IN SCIENCE AND MATHEMTICS

Introduction

The method of instruction refers to the method deployed by a teacher to convey stimuli to the learners. It refers to the method by which the teacher achieves the goals of learning. It is the process of impartation of learning.

There is various method 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 favorably 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 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 and the teacher, and Basic teaching methods.

1.1 The Nature of Science and Mathematics:

Science and mathematics teaching involves a systematic attempt to define and investigate the problems involved in learning and instruction in science and mathematics (Jacobson, 1970). 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 a lack of closure. The truth is tentative, 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 level of students consideration in curriculum planning.

1.2 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 grasp of the subject matter and a good ability to communicate such understanding to his students in an interesting manner by:
    I. Asking thorough 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 behavior towards the students
    VII. The teachers' ability to present educational 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.

1.3 General Principles of Teaching:

There are some principles which underpin any successful teaching practice. There 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.
c) Principle of relevance: the subject matter must be relevant to their life situations.
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.
e) Principle of selection: this is the ability of the teacher to select materials that suit students in a particular lesson.
f) Principle of correlation: Ability of the teacher to establish a link between the subject matter with other life situations and other subject matter.
g) The principle of practice: Students must be given a lot of problems to practice and projects to carryout and write their results.

h) The principle of revision/evaluation: students must have a review of the lesson. Black Board summary given, their work marked i.e. evaluate their work always.

1.4 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)
e) Simple to complex
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 and students are just active listeners while deduction method allows students to partake actively in decision making and are active in the lesson.

1.5 Major Areas in Science and Mathematics Teaching:

Major areas in science and mathematics teaching are; thinking, practical and communication skills which involve the following issues in the area of practice.

1.5.1 Thinking skills:

The ability to think in a scientific manner which involves;

a) Making hypothesis and devising situation to test it.
b) Drawing conclusion 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 evidenc

1.5.2 Practical skills: involve;

a) The ability to make a careful and systematic observation and measurement.
b) To experimental and practical assignments in a confident, competent and Safeway.
c) To improvise sensibly when situation demand.

1.5.3 Communication skills: involves;

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 both orally and in written form.

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

1.5.4The teaching of concept In Science and Mathematics

The teaching of concept in science and mathematics according to fundamental structures (the big idea), was introduced to the educational community by Bruner (1960). His contention is that an understanding of the fundamental structure of science and mathematics will help students to:

a) Learn how things are related.
b) Learn that one concept reinforces another concept.
c) Be aware of the fact that patterns in nature are more comprehensive than bits and pieces of information.
d) Learn that conceptual development broadens over time.
e) Know that science has identifiable structures and not a collection of multitudes of information items.
f) Concepts help students to remember things learned better.
g) Teaching concepts carters for individual differences each operating at his/her own learning.
h) Teaching of concepts gives stability to the curriculum because they represent structures of high credibility in the scientific literature.
i) 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. Bruner (1960) 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

2.1THE 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 beer fruits, the 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 include the following:

1. Personal attributes.
2. Professional attributes.
3. Instructional skills

Methodology of approach to a particular lesson/subject identifying pupils growth and achievement capacity for identifying the socially disadvantaged and pupils with learning difficulties. Personal attributes of the teacher would include his appearance, i.e. a good teacher should be meticulously groomed at all times, they are admirable, patient, courteous, and with a sense of humor and friendly. This appearance is necessary to 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 our school policies and for judicious discussions and decisions. Cooperation implies that teacher co-operate with one another, communicate with parents, carryout assignments and support school activities. Attitudes that the teacher should express positive attitude, accept change, no discussion of confidential information, prepare records of work, perform assigned duties, and seek attention with principal 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

a) Planning and preparation
b) Good teaching techniques

c) Good class management
d) Good classroom climate etc.

2,2Function of a Teacher

The teachers functions therefore is to identify the functions of the school in which he teaches, and to transmit behavioral 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 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 condition of learning?
4. Do I have a 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 to the needy?

The teacher therefore is the one who understands the objectives of school and schooling, conditions of learning, and uses correct teaching strategy to mould the first 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.

CHAPTER THREE

3.1BASIC METHOD OF TEACHING SCIENCE AND MATHEMATICS

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 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.

(1)**The Lecture Method:** according to Swanson and Torraco (1995), 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 exposed to sit, listen and take notes.

Most teaching carried out in our 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, A. (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 often 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. Economy in terms of time, effort and fund. It takes less time on the part of the teacher 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 dispenser of knowledge.
IV. The teacher can reach out to large number of students at the same time. He may use 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. In fact, lack of interaction is considered one of the major limitations of the lecture method (Munson. 1992).
II. It is boring- Students could get bored as the lesson is teacher centered.
III. Students are passive- This does not develop the students' interaction ability, as they have no opportunity to express themselves.
IV. It does not take into consideration individual differences.
V. It does not aid better understanding of subject matter.
VI. Students are made to move at teacher's pace since it is teacher's centered.
VII. With lecture method, students do not practice communication skills.
VIII. Evaluation of students during 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 that little or no interaction. (Edlich, 1993).
X. Very often, what students learned from lectures are usually forgotten after examination.
XI. The lecture method is not very good in teaching certain types of concepts that required attitudes and feelings of students.

Guidelines for Effective Use of Lecture Method

1. Lecture method should be used in conjunction with other methods. This idea is supported by Cavanagh, Hogan and Ramgopal (1995). After assessing learning styles of student nurses, recommend using a variety of teaching styles with an emphasis on participatory and experimental learning.
2. A good science teacher should avoid coverage of too many topics which may tend to confuse students. Renner (1993) recommends that lectures last no longer than 30 minutes.
3. Ensure active participation of learners as much as possible by asking questionnaire and making comments. This will minimize boredom on the part of the pupils or students.

4. At the end of the lesson, summarize the key points.
   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

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	No supporting media
7. Limited note taking required (students have copies of lecture notes)	Extensive note taking required.

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.

1) **Inquiry Method:** Is learner centered. The learner originates his own problem, design experiments, collects data and writes a report. The teacher's role here is purely supervision. He assist in problem identification, definition, content selection, entertains and asks thought provocative 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-centered.
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-centered.
III. Much fund is needed to purchase equipment and materials.

2) 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 students 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 and follow the same track, with the difference being their individualized pace of study.

Programmed instructions concept contributes to 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 activities and required responses for the learners are 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 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 the traditional lecture method, students are not rushed, they study according to their own pace and abilities.
II. It takes care of individual differences
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 and knowledge.
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 relationships of learners.

3) 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.

Advantages of Discussion/Questioning Method

I. It promotes critical thinking.
II. 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 centered.
VI. It makes use of students' initiative and hence develops them intellectually.
VII. It develops deductive reasoning.

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.

4) Field Trip Method:

This involves an excursion to an interesting outside 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 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.

Advantages of Field Trip Method

I. It provides students with first hand information about the topic.
II. It sharpens the students' skills of observation in making them appreciate the orderliness of natural occurring phenomena or events.
III. All senses are utilised 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 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 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 subsidies.
III. It could be dangerous. Taking students on a trip especially by road. Accidents could occur or even robbery in an outdoor activity especially 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 for the period of excursion.
V. It is difficult task to accomplish.

5) Play way/Games Method

This method is use to develop skills and behaviors needed to handle real life situations. The learners are divided into actors and observers. A situation of crisis is 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 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.

6) 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 analysed 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 scientific and mathematical skills.
V. The students involved may have a lasting memory of concept learnt.

Disadvantages of Project Method

I. It requires a lot of planning else 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 topic.

7) Demonstrative Method

The demonstration method is an instructional method in which an instructor/teacher shows and explains. 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 instructor to realize that there is more to the demonstration method than showing the effective demonstration involve teaching, shows questioning and application. 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 presenting a demonstration. The teacher can present a dissection of toad or a rabbit to the pupils/learners. The teacher can also plan a manipulation of equipment and material in order for the pupils/learners to observe a scientist phenomenon. Most exercise in science classes which teachers carry out when they say "we are going to do an experiment" can be identified strictly as demonstrations.

Appropriateness of 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 the following point should be kept in mind:

i. It should be planned and rehearsed by the teacher beforehand.
ii. The apparatus used for demonstration should be big enough to be seen by the whole class.
iii. Adequate lighting arrangements be made on demonstration table and a proper background table need to be provided.
iv. All the pieces of apparatus are placed in order before starting the demonstration.
v. Before actually the demonstration, a clear statement about the purpose of demonstration is made to the students.
vi. The teacher makes sure that the demonstration leads to active participation of the students in the process of teaching.
vii. The demonstration should be quick and slick and should appear to linger unnecessarily.
viii. The demonstration should be interesting so that it captures the attention of the students.
ix. It will be better if the teachers demonstrate with materials or a thing child handles in everyday life.
x. For active participation of students the teacher may call individual student in turn to help him in demonstration.
xi. The teacher should write the summary of the principles arrived at because of 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 large classes.
VI. It can be successfully used for all type of students.
VII. It is an economical method as compared to a purely student-centered method.

VIII. Students take active interest in the demonstration lesson.

Disadvantages of Demonstration Method

I. It is teacher-centered; only few students are allowed to develop manipulative skills especially where equipments 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.
IV. It provides no scope for learning by doing. Since student observe the teacher performing.

8) <u>Games and Simulation Method</u>

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 have a principle that students are highly motivated and students 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 they can proceed with minimum guidance, towards an enjoyable and spontaneous learning experience. Here are some examples of simulation and games:

CRISIS: This is a fictitious situation of Nations involved in crisis. To minimizing the dispute participants are all students who will use all mechanisms of international relations (conferences, bargaining, and alliances, even threats) to achieve goals. Situations in simulation should be fluid to allow manoeuvring; participants are challenged to think hard, to plan strategy 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 response to the pilots' actions gives a navigation problem 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 plays the mobilization of the society is brought about.
III. It helps the society to release tension and students learn a lot of things.
IV. Students learn how to manovvers situation and plan strategies.
V. They are challenged to think very high avoid crisis.

Disadvantages of Simulation and Games

I. Sometimes in simulation, there is crisis of balance of power-This is seen in conflict over 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 organized.
V. Students may not relate the games topic to real life situation or the subject matter.
VI. There could be serious fatal injury if the situation is not properly handled.

9) Socratic Method

This is otherwise 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, which are the concept he wants the children to learn. Even if a student ask a question, the teacher, instead of giving an answer, ask him/her a question, the answer of which is what the student is looking for or will help the student to understand 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 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 answering a question and hence will be passive.

10) Constructivist Method

Constructivist teaching techniques are based on constructivist learning theory. This theoretical framework holds that learning always builds upon knowledge that a student already knows, this prior knowledge is called a schema (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 same form of guide discovery where the teacher avoids most direct instruction attempts to lead the students through questions and activities to discovers, discuss, appreciate and verbalize the new knowledge.

Characteristics of Constructivist Teaching

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

- The learners are actively involved.
- The environment is democratic.
- The activities are interactive and student-centred.
- The teacher facilitates a 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 research a topic and can present their findings to the class.
- Field Trips: his 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 visual context and thus bring another 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

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 on guiding students by asking questions that will lead them to develop their own conclusions on the subject.

Guidelines for Constructivist Method

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

- Modeling
- 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.

Constructivist teaching is based on recent research about the human brain and what is known about how learning occurs. Caine and Caine (1991) suggest that brain-compatible teaching is based on twelve (12) 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.
3. "The search for is innate". Effective teaching recognizes that meaning is personal and unique, and that students' understanding are 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.

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.
8. “Learning always involves conscious and unconscious processes”. Students need time to process ‘how’ as well as ‘what’ they’ve learned.
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 does not promote spatial, experienced learning and can inhibit understanding.
10. “We understand and remember best when facts and skills are embedded in natural, spatial memory”. Experimental learning is most effective.
11. “Learning is enhanced by challenge and inhibited b y threat”. The classroom climate should be challenging but not threatening to students.
12. “Each brain is unique”. Teaching must be multifaceted to allow students to express preferences.

CHAPTER FIVE

Constructivist Learning Environments (CLES)

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 least to 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 traditional objectivist teaching where the theory would be presented first and problem would be used afterwards to practice 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 presets students with a "focus" question and allows an open discussion on the topic.
- KWL(H) Chart (What we know. What we want to know. What we have learned. How we know it). This technique can be used throughout the course of study for a particular topic, but 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 encourage students to manipulate their environments or a particular learning tool. Teacher can use a checklist and observation to assess student success with the particular material.
- Pre-testing. This allows a teacher to determine what knowledge students bring to a new topic an d thus will be helpful in directing the course.

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 turn, how it functions.
5. It brings a stronger understanding since students are given the chance to explore their environment through the guidance of the teacher.
6. It encourages learning to be behaviorally active.

Disadvantages of Constructivist Method

1. Cognitive scientists say constructivism either misleading or contradict known findings.
2. Due to emphasis on group work, the ideas of the none active students may dominate the group's 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 prevalence of learning problems in children.
6. It is based to students that are capable of learning more independently.

CHAPTER SIX

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 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 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 revaluation is to improve students' learning through 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 assisting 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' persistent in learning difficulties, that could not be remedied by the corrective prescriptions of formative evaluation are of major concern. Diagnostic tests began 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 s of variation from item to item.

C. Summative Evaluation

Summative e valuation 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 objectives. Summative tests used for such evaluation are usually broad inn 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 case will reveal where the breakdown in learning has occurred and remedial teaching is organized to correct it.

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

<u>Functions of Evaluation</u>

There are four primary functions of evaluation. They are:

a) Evaluation improves teaching and learning by highlighting areas where remedial teaching is needed and focuses 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 mastered: In a class test where 95% of the students fail 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 of 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 secondary functions of evaluation

i. **Evaluation forms the base for recording students' progress:** i.e. cumulative records to date of students evaluation accompanies him to the next level i.e. from level 100 to level 300 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 demonstrated capabilities. It helps the academic adviser to cope with students who have unrealistic aspirations with goals probably unattainable which reads 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 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 transfer students:** 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 performance forms a base for acceleration:** 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 enroll for a course aptitude test brings to light 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 a comparism is made with the initial aptitude and orientation test scores for each student, this

gives the indication to students working up to capacity and students who are underachieving. The underachievers are confronted by the academic adviser with evidence highlighted and are counseled to upgrade their performance by being more diligent in their outside preparation. Many of the students do indeed improve after such confrontation by their academic adviser.

v. **Evaluation engenders regard for periodic assessment of progress:** A teacher who 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.

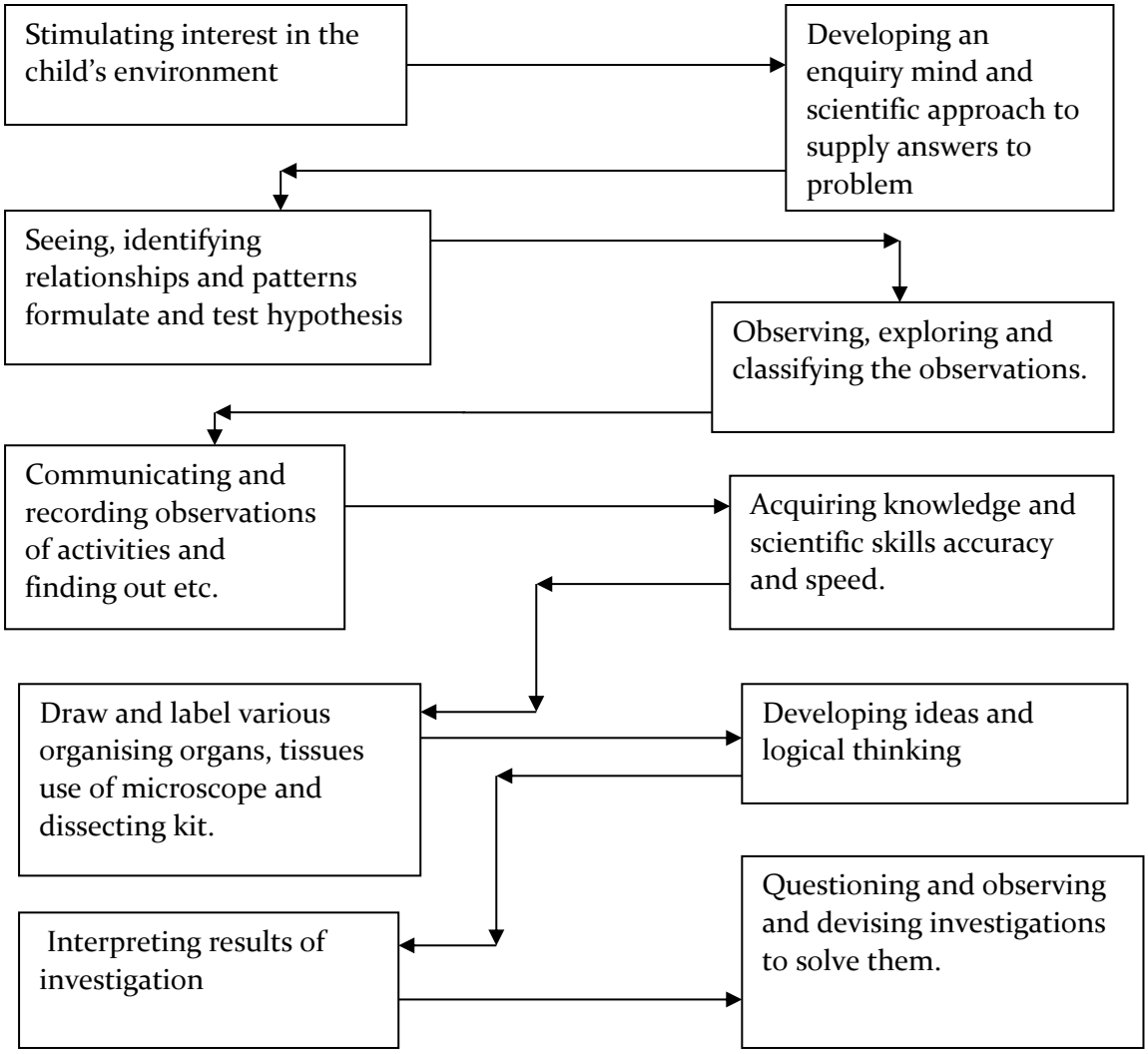
Evaluation in Science and Mathematics

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. seeing, directly or indirectly. E.g. in case of magnetism.
2. **Classification skills:** e.g. sorting of numbers, grouping up, ordering according to classes, quality and quantity.
3. **Communication skills:** In writing, speaking, by graph, models, diagrams, bar charts, etc.
4. **Counting numbers and relationship skills:** In unit of measurements, counting operations, counting discrete numbers 1,2,3, continuous counting 1.1, 1.2, 1.3, etc.
5. **Measurements skills:** of time, length, area, volume, weight, span, arm length, strides, match stick, match box lengths and standard unit measurements. E.g. centimeters, meter, kilometer.
6. **Question asking skills:** and ability to draw.
7. **Manipulative skills:** and formulation of mental models.
8. Perform experiments, make operational definitions, prove theorems etc.
9. Inference, make predictions, formulate hypothesis.

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.



CHAPTER SEVEN

Emphasis In Continuous Assessment

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 teachers' methods.

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

a) Objective- Do not set vague objectives only set objectives you can attain.
b) It is systematic, i.e. it is planned based on topics, units or modules.
c) It is a technique to assess the teaching-learning process and improve on them.
d) Its objectives must be measurable and attainable.
e) Needs a lot of co-operation among teachers and the school administration.
f) Demands 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 reason 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 pupils they have taught etc. Other reasons for continuous assessment are that:

1. Teachers can introduce new ideas (innovations) and assess the children.
2. Continuous Assessment helps the counsellor/academic adviser for proper guide as to career and psychological guidance.
3. Continuous Assessment helps the teacher assess her method of teaching.
4. Continuous Assessment helps to assess attainment of educational objectives in the three domains of human development viz. Cognitive, affective and psychomotor without bias and accuracy throughout the length of the course trusting the integrity of the teacher as a professional.
5. Continuous Assessment reduces cheating in examinations, because the frequency of last minute cramming is reduced.

Implementation of the Continuous Assessment programme (problem and prospects)

1. The standard of internal tests gives by various teachers differ hence to obtain a reliable assessment all raw scores should be standardised.
2. 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.
3. 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-types of tests e.g. T-score, etc to be able to handle quickly and easily the computation involved in record keeping of the scores and counselling of underachieving students.

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

I. Self-reporting instrument e.g. interviews and questionnaires.
II. Rating scales e.g. study habit inventory API (SHI) (VII) MOPS) SPI
III. Observations in group work, parties, or play ground.
IV. Projective techniques- You report on others not yourself.

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

Skills for Effective Conduct of Continuous Assessment

1. Good planning in the construction, scoring and use of test scores and the instruments.
2. Good interpretation of scores from Continuous Assessment
3. Good keeping and retrieval of records and goods preparation of reports.

The translation of this Continuous Assessment. National policy on Education (1981) into practice is a task that requires professional skill and judgement 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

1. Teachers in the same school should have a uniform procedure for planning and constructing the Continuous Assessment tests.
2. A uniform system of record keeping should be maintained throughout the states and the country in general at each level of education.
3. 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.
4. The administration of each school should provide storage spaces like filing cabinets, storage rooms, personnel/clerks for keeping and retrieving information, in conclusion of this section therefore Continuous Assessment records through evaluation of students 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 constitutes a certain percentage of the students 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:

1. It is systematic i.e. follows an agreed plan.

2. 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, inventories.
3. It is cumulative i.e. a system of accumulation of assessment has to be so that the final outcome is based on a series of assessments gathered over a period of time.
4. 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.

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

1. **Simplicity:** the outset should b e as simple as possible i.e. statistical treatment of test scores should be avoided.
2. **Readability:** one of the aims of Continuous Assessment is to communicate. This can be done by converting scores to letter grades to keeping a way from percentile ranks for representing achievements.
3. **Security:** Has two areas to be considered (a) The physical security from loss by fired, flood, theft, etc. (b) security against fraud, forgery or the intrusion 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.
4. **Validity:** how can students, parents, teachers know if they Continuous Assessment is valid in relation to other schools around them. The only way is a system of Continuous Assessment moderation, may be done annually especially if the Continuous Assessment is used for certification.
5. **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) providing well designed and produced data collection forms (e) having clearly delineated and delegated responsibilities to staff which ensures proper supervision.

Advantages of Continuous Assessment over End-of –course Examination

The basic advantage of Continuous Assessment over 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:

1. Detailed formative assessment of the entire course as it is taught.
2. Students who are doing lengthy investigations have time for project reports.
3. Guidance and remedial measures with individual student is possible.
4. Time is allowed for learning and assessment of psychomotor skills.
5. An investigation of the affective area of subject and their impact on students with a view to facilitating guidance and tuition.

CHAPTER EIGHT

Psychological Considerations in the Teaching of Science and Mathematics

1. The teacher should help students adopt certain attitudes and interest in learning of science and mathematics: Using as a guide by Hug (1978). The format helps the students 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.
2. Motivation of students' interest in the lesson. If a teacher deals with matters (experiences) of interest to the students they will actively participate in the lesson. The use of interesting materials will sustain students' attention, and will also help in a good management and control of the class. Any good performance should be rewarded and any bad behaviour punished.
3. 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:

a) To reduce stress and worry, student can talk things over with someone e.g. the teacher, the friend, the parents etc.

b) The students should list, and rank things to be done and do them one at a time allowing a reasonable time for rest.

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

d) Improve his memory through practice, reviews, recitation, and rehearsal of class work after lessons.

4. 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 students' performance. The slow learners should be helped, while the fast learners should be encouraged meaningfully.
5. Variety and interesting teaching methods and aids: The use of variety and interesting teaching method is teaching aids by the teacher will help for easy comprehension of the topic and better performance by the students.

CHAPTER NINE

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 plans and their values were explained. Behavioural objectives are explained. Communication is a 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 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 defined way, 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.

The Role of the Teacher and Student in these learning plans would be that the teacher must plan thoroughly all activities related to the learning environment irrespective of the facts that he is a beginning teacher or one is considerable experience, focusing on what the students must learn or what behavioural changes students 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-teacher and not only the traditional teacher-students interaction.

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

The Unit Plan: The unit of instruction is a means of organising 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, ability or 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 would be like taking a trip without a map.

The Value of Unit Plan: is that it 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 man y kinds of learning aids such as audio visual materials, electronic devices, laboratory equipment and community resources. 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 of psychological principles of learning which emphasize learning by wholes, 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.

The Unit Title/Heading: 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 level

Unit title: Safety and housekeeping in the electricity/electronic industry

Teaching Time: 6 units i.e. 6 hours

Programmes goals: Safety of the student and his friends and a positive attitude towards safety to be developed in each student. 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 sequence to the related instructional topics included in the unit.

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 need to be extensive and varied in order t meet the students' interests' backgrounds, abilities and learning styles.

Evaluation: the unit plan should indicate the performance evaluation method to b e used in each case e.g. an objectives type test, through observation of the individual as he performs the specified task, oral or written reports to be submitted to the teacher.

THE LESSON PLAN

Definition: The lesson plan is an expanded thoroughly prepared outline portion of a unit plan, which 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 are the subject, topic, class, age range, time/duration, objectives, previous knowledge, introduction, presentation, 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 (teacher and students) and method of evaluating results). Below are some formats of the lesson plan:

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

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

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

2. Consider many ways of arousing interest and motivating students.
3. Provide some link with previous lesson or with future lessons.
4. Provide sufficient and appropriate practice immediately following a skill demonstration.
5. Call the names of any particular student you wish to respond. Do not overlook some students.
6. A lesson plan can have one or more objectives and one objective might be useful for several daily lessons.
7. 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.