SCIENCE METHODOLOGY 1

The Module on Science Methodology is a 2 credit Unit Course consisting of ten Units. As an intending science teacher, there is the need to expose yourself to the nature of science, some historical development in science, the psychological theories and their applications as well as how to teach science.

The module is broken into 10 units as follows:

Unit 1: The Origin of Science and Historical Development of science Education in Nigeria 1

Unit 2: The Origin of Science and Historical Development of Science Education in Nigeria 11

Unit 3: Curriculum Reform in Science Education, Various Curriculum Packages and Implications

Unit 4: The Nature and Meaning of Science 1

Unit 5: The Nature and Meaning of Science 11

Unit 6: Psychological Theories of Learning and their Application to Science Teaching and Curriculum Development 1

Unit 7: Psychological Theories of Learning and their Application to Science Teaching and Curriculum Development 11

Unit 8: Preparation for Science Teaching 1

The Science Teaching & the Curriculum

Unit 9: Preparation for Science Teaching 11

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UNIT 1 THE ORIGIN OF SCIENCE AND HISTORICAL DEVELOPMENT OF SCIENCE EDUCATION IN NIGERIA I

INTRODUCTION

In this unit, you are going to learn the origin and history of science. This will also contain the significant periods used in describing history of science. The developments and scientific inventions that were made during these periods will be discussed. The unit will also discuss the development of science teaching and missionary activities in Nigeria toward the teaching of science.

OBJECTIVE:

After studying this unit you should be able to:

1. write briefly the origin of science.
2. discuss vividly the five significant periods used in explaining the history of science.
3. outline the development of science teaching in Nigeria.
4. identify the activities of missionaries in development of science teaching in Nigeria.
5. give reasons for the study of the history of science.

HOW TO STUDY THIS UNIT

1. Go through this unit carefully.
2. Take note of all events and their dates.
3. You should study this unit step by step as key have been arranged for you.

Reasons for Studying the History of Science

1. History promotes the better comprehension of scientific concepts and methods;
2. Historical approaches connect the development of individual thinking with the development of scientific ideas;
3. History of science is intrinsically worthwhile. Important episodes in the history of science and culture – the Scientific Revolution, Darwinism, the discovery of penicillin and so on – should be familiar to all students.
4. History is necessary to understand the nature of science.
5. History counteracts the scientism and dogmatism that are commonly found in science texts and classes.
6. History, by examing the life and times of individual scientists, humanizes the subject matter of science, making it less abstract and more engaging for students.

7. History allows connections to be made within topics and disciplines of science, as well as with other academic disciplines; history displays the integrative and interdependent nature of human achievements.

THE ORIGIN AND BRIEF HISTORY OF SCIENCE

The origin of science is often traced to human attempt to search for the first principle. It was an attempt to search for the truth behind the universe. Right from the pre-historic days, human beings had always been bothered about what is responsible for stability and change.

What makes things stand firm or change?

What are things made of?

What is responsible for flood?

These and many other questions pre-occupied human's mind and answers provided for some of these questions formed the basis of our science. Science could therefore be said to be as old as human existence.

The history of science can be anchored on five most significant periods. Which are:

4. Rivers period
5. Greek period
6. Renaissance period
7. Period of the scientific revolution.
8. The 18^{th} and 19^{th} century.
9. The modern world period.

The Rivers Period

This was the time when the Egyptians and the Babylonians were responding to the challenges posed by their environment. Notable among the rivers are Tigris, Euphrates, Nile and some rivers in Mesopotamia which is now part of Iraq, Iran and Turkey. These rivers overflow their banks at some periods of the year. This experience forced the people around these rivers into applied sciences. For instance, the overflowing of the Nile led to the development of season's calendar and agriculture. Some also developed the art of building, writing and medicine. During this period, science was rather mythological as well as theological. This is because people were yet to know the cause(s) of events occurring in their environment e.g. flood.

The Greek Period

This refers to about 600BC. It was the period when people moved from mythology to speculations. Some of these speculations later formed what we now call scientific theories and laws. According to Abdullahi (1982), such speculations about the material nature of water began with Thales (640-546BC), Thales felt that water is a fundamental substance, since it can exist in three states of matter namely solid, liquid and gas. It follows that

everything in the world is made up of water. For example a table is water in the solid state. Anaximander (611-547BC), a student of Thales, speculated that something that can constitute the material world should not be made up of any specific substance but must be character less.

Anaximander felt that the basic stuff is neutral. For example, energy is neither magnetic nor electric, neither kinetic nor potential, neither matter nor radiation, but must be capable of manifesting itself, alternating either as electric, magnetic or kinetic etc. anaximander (585-525BC) postulated two ideas. Which are:

(i) That matter is composed of air or (Pneuma)

(ii) That when pneuma is diluted, it is fiery, when pneuma contracts, it turns into wind, when wind contracts it turns to water, and when water contract it turns to rock.

Renaissance Period

This period is the second half of the medieval period which is also known as the middle Ages of Europe (476-1400AD) and it started from the 9^{th} to 15^{th} century. During this period, men began to be dissatisfied with the way of life, which made progress very slow. People felt that changes in ideas, in beliefs and in ways of thought were necessary.

The ancient Greeks and the people of other ancient civilizations had written many books on mathematics, astronomy, geography etc, and were learned. Men of this period began to study these ancient writings. This increasing of desire for knowledge was satisfied by translation of the Greek books into Latin. This period that was characterized by the spirit of questioning old beliefs and forming new opinions came to be described as the 'Renaissance', means rebirth or revival of learning.

The revival started in Italy by three famous scholars: Dante (1265-1321AD), Petranch (1304-1374AD) and Boccaccios (1313-1321AD). These artists tried to show how superior the learning, art and culture of the ancient Greeks were, and this led to a revival of interest in the Greek language. the field of science were dominated by two very influential theologians and philosophers. Albert 'The Great' (1193-1280AD), a Burarian Dominican priest and Thomas Aquinas (1225-1274AD), an Italian Monk. Both of them taught at the University of Paris. They were the first to accept the idea of a distinction between knowledge of nature and revealed knowledge.

The Scientific Revolution

The development of science between 600BC and 600AD was by mere speculations about things and nature in general. This '*Greek Science'*, as it was then known, was found inadequate to support the *observations* in vogue in the 15^{th}, and the 17^{th} centuries. Hence, speculations had to be played down for empiricism. People started to gather data for whatever claim made. Mathematics, Physics and treatment of phenomena were treasured. There was challenge of authority. Even the authority of Bible, which people dare not to before, was challenged.

The period produced scientists who achieved a lot in devising new methods for discovering knowledge.

Various instruments were also devised to test the exactness of their observations. Examples of which are:

1. Galileo Galilei (1564-1643) discovered moons around the Jupiter.
2. Leeuwenhoek (1637-1723) discovered spermatozoa, protozoa and bacteria.
3. Copernicus (1473-1543) formed hypothesis on rotation of earth around the sun.
4. Harvey (1578-1657) discovered the circulation of blood.
5. Gilbert (1540-1605) gave report on the magnet.
6. Robert Boyle (1627-1691) formulated his famous law concerning the relation of temperature, pressure and volume of gases.
7. Isaac Newton (1642-1727) made invention on Mathematics.

The 18th and 19th century

This is a period of world utilization of science. It was a period of industrialization. There was progress in Galileo and Newtonian physics. Chemistry and chemical industries wee making great strides. There was mechanization of biology i.e. people explain life as if it is a machine. During this period, science was limited to Europe and America. The period is generally known as the age of matured science.

The Modern World Period (The 20th Century)

This was a period when science moved across the Atlantic to other parts of the world. It was a period of world utilization of science in industries, such that human labour was no longer used except for productions; harvesting and processing were handled by planters, harvesters and sprayers. At home, machines do most of our household chores. For instance, dish washers, washing machine, automated laundry were introduced.

Automation in communication also came into being. That is telephone, telex, fax, e-mail services; internet etc. space communication was not left out as well.

Unfortunately, some other inventions which are widely regarded as destructive to human lives were also produced. Such products are atomic bomb, dangerous radio-active substances and other weapons for biological warfare. The rapid expansion of science in all nook and crannies of the universe assisted in improving the quality of our environment and life expectancies.

ACTIVITY 1

1. Describe the five significant periods used in describing the history of science.
2. What does the term ‘renaissance’ stand for?
3. Mention three great Greek philosophers and their contributions to science development.

4. Describe two important activities that took place during the period of scientific revolution.
5. Discuss the events that took place in 20^{th} century that warranted its being referred to as 'Modern Period'.
6. Which of the periods in history of science is referred to as the age of matured science?

DEVELOPMENT OF SCIENCE TEACHING IN NIGERIA

The teaching of science in Nigerian schools dated back to the era of Christian missionaries, who brought Western Education into the country. **Although, there was delay in including science into the school curricula at that time.** This delay was due to the fact that the missionaries were not prepared to give functional education to the native people. They were only interested in training clerks and evangelists to support their efforts towards converting Nigerians to Christianity and making some of them catechists.

Before 1859, all educational institutions in the country taught school subjects like languages, writing, Geography, Drawing, Singing and History to the exclusion of science. Although, Geometry and Algebra were introduced into the primary school curriculum at a later stage but science continued to be absent in schools teaching programmes.

With the establishment of Church Missionary Society (CMS) Grammar school in Lagos in 1859, some rudiments of science education were injected into the school's curriculum.

Some attentions were given to Arithmetic, Algebra, Geometry and Physiology. When St. Gregory's College was opened by Roman Catholic Mission in 1876, similar subjects were put on the school's timetable. In 1878, the Methodist Mission offered to teach Trigonometry, Astronomy, Chemistry, Physiology, Geology and Botany to the students of their Methodist Boys' High School, Lagos, founded in 1878. Both Methodist Girls' High School, Lagos founded in 1879 and Baptist Boys' High School, Lagos founded in 1885 were made to offer similar subjects.

The Hope Waddell Institute founded in Calabar in 1861, St. Andrew's College, Oyo, founded in 1876, Wesleyan Training Institute founded in 1905, Baptist Training Center, Ogbomoso, opened in 1899 and the CMS owned Oron Training Institute founded in 1905 had science subjects in their curricula. Also the Abeokuta Grammar school, founded in 1908, King's College, Lagos, founded in 1909, Eko Boys' High school, Lagos, Ibadan Grammar School, Ibadan, and Ijebu-Ode Grammar School, Ijebu-Ode, all were founded in 1913. The Dennis Memorial School, Onitsha established in 1928 by CMS and the colonial government founded colleges at Umuahia and Ibadan in 1929 also made provision for the teaching of science.

Up to 1932, there was no post secondary institution for the learning of science after the only specialized institution, the 'medical school' attached to the CMS Theological Institute founded at Abeokuta in 1961 folded up.

However, the educational ordinance of 1908 marked another phase in the development of science teaching in schools. Nature study was then made mandatory in both primary and secondary schools.

The teaching of science gained a better footing about 1920. This was as a result of the recommendation of an African Education Commission which toured the British West African Colonies under the sponsorship of the Phelps strokes Fund of America. By 1926, Nature Study became popular subject in both the Teacher Training Colleges and the Primary Schools. Later, the enthusiasm for Nature Study was beginning to die off. This was because of a belief that the subject was obsolete. Thus, they swing from the nature study to science.

ACTIVITY 2

1. State the three types of schools that emerged in the early development of science in Nigeria.
2. Mention the major issue that made the teaching of science to gain a better footing in 1920.

MISSIONARIES ACTIVITIES

As earlier mentioned in previous sub-unit, the Christian missionaries played pioneering and significant role in the introduction of rudiments of science in the curriculum of schools. Abdullahi (1982), however, claimed that the foundations of science teaching were laid in Nigeria between 1861 and 1897 when science was introduced in the time-table of some missionary secondary schools and teacher training colleges. Some of these notable institutions have also been mentioned in the sub-unit above. The same Abdullahi (1982) noted that three major patterns emerged in the establishment of post-primary institutions established by missions during this period. These were the grammar or classical educational schools; teacher training and pastoral institutions; and the vocational and agricultural schools.

It can be reasonably assumed that science teaching progresses with the further establishment of more missionary schools in Nigeria. But unfortunately, the number of schools doing science at that time and the extent to which science was taught in these schools remain unclear. Bajah (1982) claimed that the rudiments of science at that time was Nature study that involved the teacher and pupils "learning about the environment in form of out-door observation of plants, animals and non-living things".

ACTIVITY 3

1. Enumerate some of the missionaries' activities in the development of science in Nigeria between 1861-1897).

SUMMARY

- The origin of science was traced to human attempt to search for the truth behind the universe.
- Five significant periods used in discussing the history of science are:
  - The Rivers Period-the time when Egyptians and Babylonians were responding to the challenges posed by their environment.

- The Greek Period – About 600BC, the period when people moved from mythology to speculations.
- The Renaissance Period – This is the period of rebirth or revival of leaning. It is the second half of the medieval period known as the Middle Ages of Europe. It started from the 9th to 15th century AD.
- The Scientific Revolution Period – The period of science development. It started in the late 15th century and reached its peak point in 17th century. This period also produced many notable scientists who devised new methods for discovery of knowledge. Some of the scientists are Galileo, Leuwenhoek, Copernicus, Harvey, Gilbert, Bole and Isaac Newton.
- The 18th and 19th Century – This is the period of European utilization of science and industrialization.
- The Modern World Period – This is the period when science is being used for the benefit of humankind. This is the 20th century. The knowledge of science was being transformed to reality.
- The teaching of science in Nigeria started in CMS Grammar School, Lagos in 1859. This later spread to various schools established by the missionaries.
- Some missionaries activities include: establishment of various schools namely grammar, teacher training, pastoral, vocational and agricultural; introduction of rudiments of science in school curricular and the teaching of it.

ASSIGNMENT

1. Discuss briefly the contributions of ancient Egyptians and Babylonians to science.
2. What are the major contributions of Galileo and Newton toward the change in scientific outlook of the 16th and 17th centuries?
3. Why is the 19th century regarded as the beginning of the scientific age?
4. What will you consider as the gains of science to human beings in the 20th century?
5. Describe the efforts of missionaries in the development of science.

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UNIT 2: THE ORIGIN OF SCIENCE AND HISTORICAL DEVELOPMENT OF SCIENCE EDUCATION IN NIGERIA II

INTRODUCTION

This unit is the continuation of the previous unit, unit 1. it will go further to discuss the colonial government activities and private participation in science teaching in Nigeria. Government efforts in science and technology development will also be discussed.

OBJECTIVE:

After studying this unit you should be able to:

1. Discuss the colonial government activities in development of science education in Nigeria (1883-1930).
2. Outline the contribution of private participation in science education development in Nigeria.
3. Enumerate the government efforts between 1931-1959 in science education development in Nigeria.

HOW TO STUDY THIS UNIT

1. Go through this unit carefully.
2. Try to master all the important changes that took place in science education since the time of colonial regime to the time when Nigerians took over the government.

COLONIAL GOVERNMENT ACTIVITIES

As already discussed in the proceeding unit, the various Christian missions played a pioneering role in the introduction of rudiments of science in the curricula of schools. However, this position changed during the period of 1883-1930 as this marked the beginning of colonial government participation in the development of secondary education (Adelabu 1971).

The education ordinance was passed in 1908and it stipulated among other things that the conditions to be satisfied by missionary schools for government grants. These grants enabled some of the missionary schools to acquire some basic materials for science teaching. During this period, King School, Lagos (Now King's College), was the first government secondary school established in 1909 to have a chemistry laboratory (Abdullahi 1982). King school, Lagos for many years remained the only school that consistently offered science to the standard of Cambridge University Senior Local Examination (Taiwo, 1975). Science education was by no means popular in schools during this period as only very few students offered sciences at external examination (Omolewa 1977)

However, many more missionary schools were established during this period in Lagos, Southern and Northern parts of the country. They include Abeokuta Grammar School,

opened in 1908, Ijebu-Ode and Ibadan Grammar Schools, both opened in 1913, Eko Boy's High School, Lagos, opened in 1913, Dennis Memorial School in Onitsha, opened in 1928, and Igbobi College, Yaba, opened in 1932, Katsina College, established in 1922 and Kaduna College established in 1938.

ACTIVITY 1

1. Name the first government secondary school that started the teaching of science subject and when it was established.
2. List the government secondary schools that were established after the education ordinance of 1908 and their years of establishment.

The establishment of many more schools led to the spread of science teaching mostly in the Southern parts of the country. The attempts to open such mission schools in the Northern parts of the country met stiff opposition because of the intolerance of the Muslims. Although a few schools existed during this period in the North, but the colonial government was most reluctant to start the teaching of science due to the fact that the teaching of biology might offend the Muslim north. In spite of this, the first colonial government school in the north was Kaduna College (1938) established out of Katsina College (1922) that has been in existence.

PRIVATE PARTICIPATION

The period 1931-1959 witnessed a lot of local community participation at spreading science education in Nigeria as individuals, groups and communities set out to establish more secondary schools in the country.

Prominent Nigerians who studied abroad like Professor Oyerinde, Professor Eyo Ita, N.D, Chief Daniel Henshew, Rev. O. Offiong and Alvan Ikoku saw the need for technical/vocational education. They formed a National Education Movement and later opened secondary schools that were somehow technically oriented. The schools emphasized the training in such trades as printing, carpentry, tailoring and bakery (Eke, 1998). Many of such schools were opened in Lagos, Calabar, Ibadan, Aba, Port-Harcourt, Ikot-Ekpeme and Arochukwu.

Some of the schools founded by different categories of Nigerians according to Eke (1998) include the following:

Schools Established by the Elite Group

1. Entonna High School, established in 1932 by Rev. Patts-Johnson, I.R.
2. Aggrey Memorial College, established in 1933 by Alvan Ikoku.
3. Ibadan Boys High School, Ibadan, established in 1938 by Oyesina, O.L.

School Established by Non-Elite Nigerians

1. Christ High School, Lagos, established in 1934.

2. New African College, Onitsha, established in 1938
3. Okpe Grammar School, Sapele, established in 1941
4. New Bethel Collehge, Onitsha, established in 1942.
5. Lisabi Grammar School, Abeokuta, established in 1943.
6. African College, Onitsha, established in 1943
7. Adeola Odutola College, Ijebu-Ode, established in 1945.
8. Western Boys High School, Benin-City, established in 1947.

Schools Established by Communities

1. Ibibio State College, Ikot-Ekpeme established in 1949 by the Ibibios.
2. Urhobo College, Effurum, established in 1949 by the Urohobos.
3. Egbado College, Ilaro, established in 1950 by the Egbados.

ACTIVITY 2:

1. What will you consider as the major contributions of some prominent Nigerians to education during the period (1931-1951)?
2. Identify the roles of the Non-elite Nigerians in the establishment of secondary schools in Nigeria during the period (1931-1959).
3. When was the first secondary school established by a private individual opened in Nigeria?

GOVERNMENT EFFORTS IN SCIENCE AND TECHNOLOGY DEVELOPMENT

Before 1931 science education in Nigeria was not so popular in schools as very few students offered science at external examinations and these few that attempted it failed. The general attitude of Nigerian parents to science education was equally disturbing. This is because many of these parents were merchants, traders, clergymen, carpenters, farmers etc. the few educated parents preferred to send their children abroad to study humanity, law and medicine. Thus, little progress was made in the development of science education until 1932 when as a result of pressures by the few Nigerians who studied abroad, that the colonial government decided to establish the Yaba College (Upgraded in 1963 to Yaba College of Technology)

The college was to provide well-qualified assistants in engineering, medicines and other vocation as well as provide teachers for science subjects in the secondary schools. Initially, the college offered sub-degree courses in science, engineering, agriculture, survey, medical studies and teacher training to fill vacancies in relevant government departments. The college operated a four year programme leading to award of Diploma in science and Mathematics and other subject areas through a competitive entrance examination in English, Mathematics, Biology, Chemistry, Physics, Geography and History. According to Abdullahi (1982) the first set of graduates from this college were recruited into the secondary schools to teach

science and they played a major role in laying the foundation for the development of appropriate curriculum for science in the secondary schools.

Other notable events that occurred during the period up to 1959 towards further popularizing science teaching was the enactment of the 1948 Education Ordinance which served as the first document to provide education policy and practice in Nigeria. The policy decentralized educational administration by classifying education as a regional service. According to Adesina (1988), the features highlighted in the ordinance were:

1. Appointment of a Director of Education for Nigeria.
2. Appointment of Deputy Director of Education for the Regions.
3. Establishment of a central Board of Education for Nigeria
4. Establishment of Regional Boards of Education and a separate one for a colony.
5. Establishment of Native Authority and government schools.
6. Registration of teachers.
7. Regulations for school inspection.
8. Grants-in-aid regulations.
9. Tuition fees

The second event was the establishment in 1948 of the University College, Ibadan, as college of University of London. The report of Elliot Commission on Higher Education set up in 1943, which recommended the establishment of a University College in Nigeria was a major factor in establishing the college. It is interesting to note that out of the initial 210 students offered admission, over 120 students were admitted to study sciences. The institution remained with this status of college of University of London up to 1960 and 1962 when it started awarding its own degree and became University of Ibadan.

The third event was the introduction of Higher School Certificate (HSC) in 1951. This school afforded many students another opportunity to further study biology, chemistry and physics at a higher level, with the emphasis on laboratory work to meet the practical requirements of the science subjects. The syllabus reflected British requirements hence the high rate of failure in science subjects.

The fourth event was the setting up in 1952 of an examining board with the headquarters in Accra, Ghana. This followed Jeffrey Report of 1950. The board later became West African Examination Council (W.A.E.C.), with Nigeria, Ghana, Sierra-Leone and Gambia as member nations. The council reviewed curriculum of school subjects. The setting up of the council marked the end of foreign examination bodies moderating our examination at this level. W.A.E.C. conducted its first examination in 1955 (Mattri, 1973).

The fifth event which occurred during this period was the collective effort made by science teachers towards popularizing science which resulted in the inauguration of the Science Teachers' Association of Nigeria (S.T.A.N.) on the 30th November, 1957.

The sixth event that occurred during the period to further promote the teaching of science was the introduction in 1955 of the Western Region of Nigeria Free Universal Primary Education which led to massive expansion in primary school enrolment. Two years after the introduction of Free Universal Primary Education in the Western Region, the Eastern Region initiated its own in 1957.

The last event that occurred during this period to promote the teaching of science and government efforts in science and technology development was the establishment of Federal Colleges of Arts, Science and Technology at Ibadan in 1950, Zaria in 1952 and Enugu in 1954. These colleges administered a fairly comprehensive curriculum in science education and science related fields such as architecture, engineering, pharmacy etc. These colleges continued to produce students in science for the University college in Ibadan until two of them later became full-fledged universities. University of Nigeria, Nsukka (1960) and Ahmadu Bello University, Zaria (1962). The other college in Ibadan remained the temporary site of the University of Ife (now Obafemi Awolowo University) for some years before being converted into the Polytechnic, Ibadan.

ACTIVITY 3

1. State two government efforts toward the establishment of the first University College in 1948?
2. Briefly explain the events that led to the termination of foreign examination bodies moderating the performance of Nigerian students at school certificate level.
3. Provide argument against some aspect of the Education Ordinance of 1948 with regards to what operates in our tertiary institutions presently.

SUMMARY

- This unit show-cased the colonial government's participation in the development of secondary education and science teaching in Nigeria through the passage of Education Ordinance of 1908 which stipulated the conditions for collection of government grants by missionary schools. The education ordinance promulgated led to the establishment of more secondary schools by the missions and science subjects formed part of the curriculum.
- The private participation in the establishment of schools and teaching of science which was spearheaded by some notable individuals, groups and communities led to opening of schools in Lagos, Calabar, Ibadan, Port Harcourt, Sapele, Abeokuta, Ijebu-Ode, Ikot-Ekpeme etc.
- Government efforts in the development of science and technology led to the establishment of Yaba College in 1932, which later became Yaba College of Technology in 1963. Also the enactment of the Education Ordinance in 1948 that provided education policy and practice in Nigeria, establishment of University College (now known as University of Ibadan), introduction of Higher School Certificate (H.S.C) in 1951, setting up of examination board in 1952, formation of

association by science teachers, provision of Free Universal Primary Education by Western Region Government and the establishment of three Federal Colleges of Arts, Science and technology were parts of government efforts towards science teaching in Nigeria.

ASSIGNMENT

1. Explain the failure of the colonial government to start the teaching of science subjects in the Northern part the same period it was started in the southern part of Nigeria?
2. Using the present position of education in Nigeria as a yardstick, will you support the continuing participation of private individuals, community and missions in the establishment of schools?
3. Discuss the implications of government running education at all levels in Nigeria?

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UNIT 3: CURRICULUM REFORMS IN SCIENCE EDUCATION, VARIOUS SCIENCE CURRICULUM PACKAGES AND THE IMPLICATION OF CURRICULUM REFORM TO SCIENCE TEACHING.

INTRODUCTION:

If science is not static as said earlier, then there should be constant revisiting or reform in the curriculum to cope with the changing world of science and technology.

In this unit, you will be introduced to curriculum reform in Science Education and some science curriculum packages.

OBJECTIVES:

By the end of this unit you be able to:

1. advance reasons for a reform in the curriculum of science.
2. list some curriculum projects
3. mention some previous efforts made by some bodies in Nigeria to develop materials.
4. argue for or against the conceptual basis for the reform.
5. list some themes that reflect the new curriculum reform.

HOW TO STUDY THE UNIT.

1. this unit looks historical in nature, so be sure you fully grasp the concept of reformation.
2. read through each step carefully.
3. attempt all the activities and assignments.
4. make reference to the references provided when in doubt

Step 1: Development of Some Science Curriculum

ACTIVITY 1

1. Could you advance one reform why there should be curriculum reform?
2. Which science curriculum material are you familiar with?

Before early 1960s, the science curriculum was geared towards the fulfilment of overseas examination requirements namely, the Cambridge School Certificate Examinations or the London General Certificate in Education. In recent times, a clear pattern for science project development at the primary and junior secondary schools levels has been the integration of

subjects from the field of science and technology. At the senior secondary, the emphasis has been on inquiry and problem solving activities.

The sudden launching into space of the satellite "sputnik" by the Soviet Union sparked off science curriculum development efforts in the western world. This lead to the awareness as regards the need to re-examine the school science circular, objectives, content and evaluation. Subsequently, several new science curricula were developed in many countries such as those of the Physical Science Study Committee (PSSC), Chemical Education Materials Study (CHEM Study), Biological Science Curriculum study (BSSC) all in the U.S and the Nuffield Science Projects in the U.K.

For Nigeria, the historic National Curriculum Conference held in 1969 spurred various bodies including government agencies to develop science curricula for both primary and secondary levels of education. Notable among these previous efforts according to Ayodele (2001) are:

- The Nigeria secondary Schools Science Project (N.S.S.S.P.) by the defunct Comparative Education Study and Adaptation Centre (C.E.S.A.C., now part of NERDC).
- The Nigeria Integrated science Project (N.I.S.P.) by the Science Teachers Association of Nigeria (S.T.A.N).
- Basic science for Nigerian Secondary Schools (B.S.N.S.S) by CESAC and STAN.
- Primary Education Improvement Project: Northern States Primary Science Project (N.S.P.S.P.) by the Institute of Education, Ahmadu Bello University, Zaira.
- Science is Discovering: Mid-western State primary Science project (M.S.P.S.P) by Abraka College of Education.
- The Yoruba Medium Project:Western State Primary Science Project (W.S.P.S.P) by the Faculty of Education, University of Ife (now Obafemi Awolowo University).
- African Primary Science Project (A.P.S.P) by the African Development Council.
- Lagos State Primary Science Project (L.S.P.S.P) by the Lagos State Ministry of Education.

ACTIVITY 2

1. What are some of the consequences of these inadequacies as regards the curriculum or general approach to science teaching?

Did you mention?

- low enrolment in science.
- poor science grades at the SSCE levels.
- declining popularity of science subjects.
- science students not skilled enough for the job market

- shift of science graduates to the Business Management courses e.t.c

Step 11

With some of these consequences you have mentioned, there is no doubt for the need on the New Reform in Science Education. Science education in many nations of the world has again been through another process of change. (Ogunleye 2001).

These new reform initiatives in science education, which started in the 1980's and 1990's, squarely positioned science as a social process and cultural practice with particular ways of knowing and doing science. Also, a series of influential publications in the United States (AAAS, 1993; NRC 1996) have advocated a nationwide reform in science education. For example, the American Association for the Advancement of Science (AAAS; 1985, 1993) established a curriculum reform project code-named "Project 2061" The conceptual basis for the reform has some basic features with the following aims:

a. to achieve scientific literacy as the central goal of science education (i.e. "Science for all Americans"). It was considered particularly important to focus on students' understanding of the nature of science, for instance by studying the history and the philosophy.

b. to relate an understanding of major concepts, principles and habits of thinking in science, mathematics, technology to events/activities in the society.

c. to achieve science standard for all students including girls, language, ethnic minorities and all ability groups in an attempt to encourage all students to succeed and to enhance excellence and equity.

d. to design science education to reflect that science is an active process. So that both "hands-on" as well as "minds-on" activities should constitute the core of the education process. Thus, emphasis on content should be "less is more" i.e. teach less content with greater depth of understanding.

e. to focus in inquiry as a central element of the curriculum; to promote students to actively develop their understanding of scientific concepts, along with reasoning and thinking skills through group-based approaches and greater cooperation among science teachers and students while de-emphasizing competition in the classrooms.

f. to explore the use of alternative assessment techniques to paper and pencil test.

In their report on a new vision for Science Education "Beyond 2000", Millar and Osborne (1998) advocated the wide use of narratives in teaching. After criticizing an over concentration on the detailed content of science in U.K schools, they propose that:

> "Science Education should make much greater use of the worlds most powerful and pervasive ways of communicating ideas in the narrative form – by recognising that its central aim is to present a series of explanatory stories"

Thus, in accordance with the "Beyond 2000" report, a new GCE syllabus was recently introduced in Britain, called "Science for Public Understanding" (NEAB, 1998). This new syllabus aims to increase students:

(1) understanding of everyday science.

(2) confidence in reading and discussing media reports of issues concerning science and technology.

(3) appreciation of the impact of science on how we think and act.

Similar goals are seen in science education reforms in other countries of the world. This include the implementation of a new science curriculum in Australia (Curriculum Corporation, 1994) Science, Technology and Society in Canada (Aikenhead and Ryan, 1992), the introduction of "Public Understanding of Science in the Netherlands (Devos and Reiding, 1999).

Generally, therefore, the new reforms in science education all emphasize the importance of scientific literacy and understanding for all students especially for those students, women and ethic minorities, who traditionally have been neglected by and deprived of science.

ACTIVITY 3

1. As a Post-graduate Diploma in Science Education student, if you are to choose a seminar theme in line with the New Science Education Reform, what will be your theme and why?

   Some common themes include.

   - Gender issues in Science Education.
   - Assessment and Evaluation.
   - Science, Technology & Society (STS).
   - Hands on Activities
   - ICT and Classroom Teaching
   - Cooperative learning
   - Science for All
   - The nature of Science

     Thematic approach etc

ACTIVITY 4

1. What are some of the implications this Science Education Reform will have on your teaching?

According to Jan H. Van Driel et al (2000), the implications for science teaching are as follows:

- instead of transmitting content knowledge in a rigid manner, the emphasis in teaching will be on designing situations and a variety of activities which enables students to learn actively. In this respect, the teacher needs to investigate what students already know. Identify possible misconceptions and then design an appropriate educational setting. In any case, teachers need to be able to respond to situations in their classroom they might not have anticipated (Kennedy, 1998)
- consequently, the number of topics in the curriculum will probably have to decrease. For teachers, this implies the acceptance of the idea that "less is more" and resisting "the temptation to include too much" (Millar & Osborne, 1998. p.17)
- if generally, a shift toward reflection on science rather than focusing solely on the content of scientific ideas is implied. Teachers will thus be asked to pay more attention to aspects of science they usually ignore, or do not feel very comfortable with like the history and philosophy of science, or the relation between science and societal issues
- teachers will be confronted with the challenges of teaching science in a way it appeals to all students both from cognitive and effective perspective and not just students with high abilities or high motivation for science.
    - a shift towards the teaching of inquiring skills, which is definitely more complex than the traditional training of practical skills.

SUMMARY

- In this unit, you were introduced to some curriculum packages, the deficiencies in these science curriculum and teaching methods, which necessitated the curriculum reform. The implication of this reform to science teaching was also highlighted.

ASSIGNMENT

Go to the library and get one Science Education Journal in the 80's and another one in the late 90's to 2000's. Compare the topics and justify if there had been any curriculum reform

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UNIT 4: THE NATURE AND MEANING OF SCIENCE 1

INTRODUCTION:

The unit will make you aware of the various definitions of science, how scientific knowledge is generated through deductive and inductive reasoning philosophy of science and patterns of scientific investigation.

OBJECTIVES:

After studying this unit you should be able to:

1. define science
2. explain what nature of science means.
3. differentiate between deductive and inductive structure of science.
4. outline the three components which science is made up of namely products, processes and ethics.
5. describe each components of products, processes and ethics of science.
6. explain the patterns of scientific investigation.

HOW TO STUDY THIS UNIT

1. Go through this unit carefully.
2. Take note of all the scientific terminologies and make sure you understand them.
3. As you read through this unit, try to take note of the main issues.
4. You should study this unit step by step as they have been arranged for you.

DEFINITION OF SCIENCE

There are lots of misconceptions on the body of knowledge called science. From its linguistic origin, 'Science' is derived from Latin word, 'Scientia' which means 'knowledge' (Eneh, 2000). In the simplest term, science has been defined as the knowledge of the world of nature. (The New Encyclopaedia Britannica, 1995). This definition however does not exhaust the full meaning of science. So it is difficult to define it. Abdullahi (1982) reported that some people defined science as an organized body of knowledge in form of concepts, laws and theories.

Mapaderun (1998) on the other hand defined science from its sociological point of view as an intellectual activity through which man seeks to understand nature. Ogunniyi (1986) defined science as an attempt by human beings to organize their experiences about nature into meaningful systems of explanations. What could be said about the definitions so far cited is tat they are not comprehensive enough to adequately define science.

Emovon (1985), attempted a fairly comprehensive definition of science when he stated that "It is a body of knowledge which is acquired through observation and systematic experimentation. It is not dogmatic and has special characteristics, that its tenets are universal and capable of reproduction under the same condition anywhere" (P.3).

Abdullahi (1982), defined it as activities culminating into a testable, falsifiable and verifiable body of knowledge. However, selecting anyone of these definitions of science would be inadequate and misleading, therefore we can look at science as an enterprise participated in by human beings, concerned with the study and parsimonious explanation of the materials and forces of nature. Science employs a variety of techniques, is motivated by a desire to know, assumes an orderliness in nature, is governed by understandable and acceptable ethical principles and terminates in credible concepts in the form of descriptive, comparative and quantitative concepts. Science is a human enterprise, the consequences of which have human implications.

ACTIVITY 1

1. List two ways in which people viewed science.

WHAT IS THE NATURE OF SCIENCE?

The nature of science refers to those characteristics of scientific knowledge that derive directly from how the knowledge is developed. The major characteristics are:

- There is no single set or sequence of steps in a scientific investigation (i.e. there is no such thing as the scientific method)
- Scientific knowledge (both theories and laws) is subject to change (i.e. all scientific knowledge is tentative.)
- Scientific knowledge must be at least partially supported by empirical evidence.
- Scientific knowledge is partially the product of the creative imagination of the scientist (i.e. all scientific knowledge combines both empirical evidence and the creative interpretation of data by scientists.
- Given the importance of scientists' individual creativity, scientific knowledge is necessarily subjective to some degree (i.e. scientific knowledge is not totally objective as is commonly believed).
- Scientific knowledge is a product of both observation and inference.

By carefully addressing these characteristics of scientific knowledge and keeping in mind the developmental level of your students, you can help your students develop understanding that will help them in making decisions for the rest of their lives. In particular, your students will begin to develop a more balanced view of the "truth" of scientific knowledge. (Gega and Peters, 1994)

Deductive and Inductive Science

Deductive science involves generating knowledge from generalization to observation. It is a way of thinking in science which thrives best in an atmosphere of freedom of thought, creative imagination and intuition. The proponents of this view are of the opinion that when a scientist confronts a genuinely significant problem, he has insufficient facts, imprecise techniques and incomplete context. Popper (1959) holds that knowledge never starts from firm foundations but exists only so far as one progresses from necessarily uncertain starting points.

Deductive logic therefore is a handy tool used by many scientists in their attempt to describe, explain or predict natural phenomena. This they do by setting up a hypothesis and testing its validity on the basis of experimented findings

Inductive Science

Inductive science involves generating knowledge from observation to generalization. It is a way of thinking in science that starts from particular facts. It does not view scientific investigation as a humanistic enterprise that starts from the level of hypothesis, whose premises imply the conclusion with certainty. The nature of science does not; however 'rest on a limb', for according to **Madeawar** (1969) the two views of science are complementary episodes of thought involved in scientific investigation.

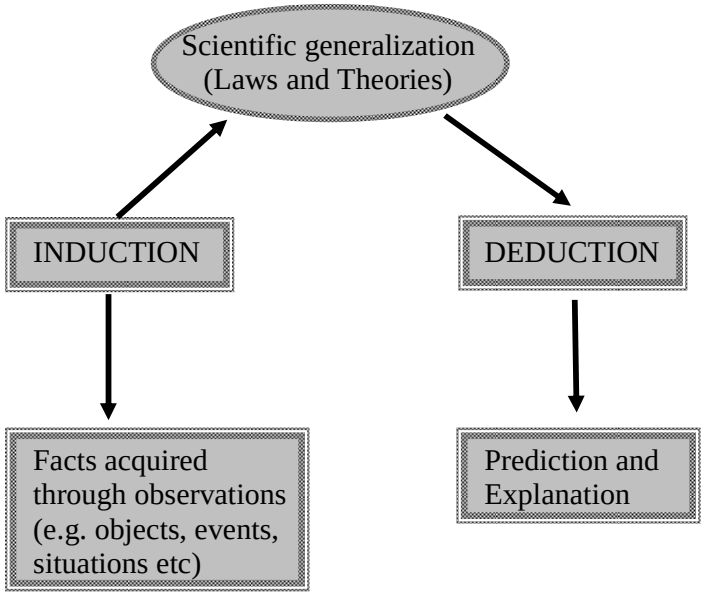

Fig. 1: *Schematic diagram of Induction and Deduction*

ACTIVITY 2:

1. Differentiate between the views of the proponents of deductive and inductive science.

PHILOSOPHY OF SCIENCE (PRODUCTS, PROCESS AND ETHICS)

The nature of science refers to the structural components of science, and the processes of generating the attitude and its regulatory principles. Science is made up of three components namely

1. Products of science
2. Processes of science
3. Ethics of science

The Products of Science

These are the outcomes of scientific investigations. They constitute the library of scientific knowledge. They are in forms of: facts, concepts, theories and laws of science.

1. **Facts**

   These are singular observations about nature. For example, it is raining', 'the car is moving', 'a leaf is green', 'there is a colour change from white to pink', etc. All these are facts. Scientific assumptions are based on facts. According to Connant (1951), a scientific fact is not considered valid unless it is observable and demonstrable. Facts are building blocks of scientific concepts.

2. **Concepts**

   Concepts are meanings attached to scientific terms e.g. ecology, heredity, esterification, pressure, gravity etc. each concept represents series of related facts. The function of scientific concepts is that they are used to formulate scientific laws and theories.

   A concept can be either empirical, theoretical or rational. An empirical concept is an observable phenomena e.g. plant, diffusion, volume etc. Theoretical concepts are unobservable phenomena e.g. atoms, electrons etc. A rational concept relate two or more concepts together e.g. greater than, equal to etc.

3. **Laws**

   These are observable regularities in nature. They are generalization used to describe, predict and explain events in nature. Examples are Newton's Law of motion, law of gravity, Boyle's Law, Mendel's law of inheritance etc. There are empirical laws and theoretical laws following the nature of concepts used in formulating them.

   Empirical laws predict only while theoretical laws predict and explain.

4. **Theories**

   A theory is defined as a generalization requiring further experimental testing. It is usual to regard scientific laws as generalization of observable phenomena, while scientific theories are generalization of unobservable phenomena in nature. E.g. Dalton's atomic theory.

ACTIVITY 3

1. When is a scientific fact considered valid?
2. Mention two classes of concepts and give an example of each.
3. Name two scientific laws.
4. Differentiate between scientific laws and scientific theories.

PROCESSES OF SCIENCE

These are methods of enquiry in science. They are the methods which a scientist will follow when confronted with a genuine problem. Such methods include observation, formulation of hypotheses, testing hypotheses, analysis of data, interpretation of data, drawing valid conclusions etc. Abdullahi (1982), attempted a serial order of scientific method. They are:

1. The recognition of a problem.
2. The collection of relevant information.
3. The formulation of a working hypothesis.
4. Making deductions from the hypothesis.
5. Testing by actual experimentation of deductions
6. Depending on the outcome or result of the experiment, the working hypothesis is accepted, modified or rejected. (P.3)

   However, it is generally argued that there is no single approach to solving a problem. It depends on the nature of the problem and the experience of the investigator.

ACTIVITY 4

1. List the steps you will take when confronted with a scientific problem in hierarchical order

ETHICS OF SCIENCE

These are the moral constraints of science. They include objectivity, curiosity, scepticism, willingness to change opinion, humility, precision, open-mindedness etc. for example, one would not expect a scientist to 'cook-up or panel beat' result in order to conform to a preconceived idea or model. The in-congruent result may be the beginning of a new invention. The psychologists and educators agree that there is no particular way of acquiring these attitudes. It evolves as one caries out scientific activities using the process skills. The scientific attitudes emerge the way other professing attitudes emerge i.e. by practice and rational decision.

Regulatory principles refer to the conventions of science. Like careful recording, careful reporting, interaction with colleagues, attending learned conferences, reading journals etc. all these will keep scientists current and alert.

ACTIVITY 5

1. Explain two (2) ethics and regulatory principles of science using relevant classroom examples.
2. List 5 scientific attitudes.

PATTERNS OF SCIENTIFIC INVESTIGATION

Scientific investigation is a dynamic human enterprise, aimed at seeking the understanding and control of nature. Science philosophers differ in their analysis of the nature of scientific investigation. To some, scientific knowledge is generated through deductive reasoning while some see its generation through inductive reasoning. According to Ogunniyi (1986), there is no single approach to a scientific investigation. There are many approaches as there are scientists. What is carried out in a scientific investigation is quite flexible and personal without any overall model. Incentive, intuition, creativity, alertness of the mind, trial and error etc. all play important role in the scientific investigation.

Investigation lies in the heart of science. Disciplines such as physics, agriculture, technology, environmental studies etc. would not have existed if women and men lacked investigation and inquiring minds. Debates on whether science precedes technology or technology precedes science, assumes less importance when one recognizes the paramount of inquiry.

Scientific inquiry is not easily described apart from the context of particular investigations. There is simply no fixed set of steps that scientists always follow (i.e. there is no specific scientific method). There are, however, certain features of science that give it a distributive character as a mode of inquiry. Although, those features are especially characteristics of the work of professional scientists, everyone can exercise them in dealing scientifically with many matters of interest in everyday life.

Scientifists often disagree about value of piece of evidence or about the appropriateness of particular assumptions that are made and therefore disagree about what conclusions are justified. But they tend to agree about the principles of logical reasoning that connect evidence and assumptions with conclusion. It is necessary to mention that formulating and testing hypothesis is one of the core activities of scientists. To be useful a hypothesis should suggest what evidence would support it and what evidence would refute it. A hypothesis that cannot, in principle, be put to test of evidence through scientific investigation may be interesting but it is not scientifically useful. The essence of science is validation of observation but the credibility of scientific theories often comes from their ability to show relationships among phenomena that previously seemed unrelated.

ACTIVITY 6

1. What is scientific investigation?
2. Explain briefly what makes scientific investigation flexible.
3. Mention two important activities of scientists.

SUMMARY

- Science was defined in terms of
  - (a) a body of knowledge.
  - (b) an intellectual activities through which man seeks to understand nature.
  - (c) an activity culminating into a testable, falsiable and verifiable body of knowledge.
  - (d) An enterprise participated in by human beings concerned with the study and parsimonious explanation of the materials and forces of nature.
- Deductive science involves generating knowledge from generalization to observation while inductive science involves generating knowledge from observation to generalization.
- The products of science deal with scientific facts, concepts, laws and theories.
- The processes of science are methods which a scientist follows when carrying out scientific inquiry. Such activities are
  - Hypothesizing
  - Observation
  - Testing hypothesis
  - Analysis of data
  - Interpretation of data
  - Drawing valid conclusions.
- Ethnics of science are moral constraints of science or code of conduct of scientifists. This includes
  - Objectivity
  - Curiosity
  - Parsimony
  - Scepticism
  - Willingness to change opinion
  - Humility
  - Precision
  - Open-mindedness
  - Seren
- Scientific investigation is a dynamic human enterprise, aimed at seeking the understanding and control of nature.

ASSIGNMENT

1. Justify the definition of science as an enterprise participated in by human beings.
2. Explain when deductive and inductive science will come into play when teaching science in school.
3. Briefly describe each of the following.
   (a) Facts
   (b) Concepts
   (c) Theories
4. Explain processes of science using relevant classroom examples.
5. Explain why ethical issues increasingly arise in the classroom these days.
6. Justify the need for scientific investigation in solving scientific problems.

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UNIT 5: THE NATURE AND MEANING OF SCIENCE 11

INTRODUCTION

This unit will introduce you to the differences between science and technology, science and non-science subjects, and impact of science and technology on the society. The limitations of science and objectives of science education in Nigeria will also form part of the discussion in this unit.

OBJECTIVE

After studying this unit, you should be able to:

1. distinguish clearly between science and technology.
2. list the areas of knowledge which qualify to be science.
3. differentiate between science and non-science disciplines.
4. mention at least four areas where science and technology have had impacts on the society.
5. discuss the limitations of science.
6. mention the objectives of science education in Nigeria.

HOW TO STUDY

1. Go through this unit carefully.
2. As you read through this unit, try to take note of the main and important ideas.
3. You should study this unit step by step as they have been arranged for you.

DISTINCTION BETWEEN SCIENCE AND TECHNOLOGY

In unit 3, various definitions of science were given. There, science is defined as:

1. The knowledge of the world of nature.
2. The organized body of knowledge in forms of concepts, laws and theories.
3. An intellectual activity through which man seeks to understand nature.
4. An enterprise participated in by human beings, concerned with the study and parsimonious explanation of materials and forces of nature.

   Technology is therefore defined as the application of scientific knowledge and research to solve problems of life in the society, thereby making life more comfortable to human beings. Technology is not a body of theoretical related laws and principles. It is characterized by techniques, devices, procedures, processes and materials. It is more of a collection of practical information that can be used to do something. It affords man to interact more effectively with the environment.

In spite of the seeming differences between science and technology, they are ultimately linked or symbiotic. This is because technology will be crippled and blinded, if not for the new knowledge which science provides it. Science, on the other hand, will not progress much, if technology does not supply it with new instruments, new techniques and new powers. The driving force in science is curiosity while that of technology is know-how.

ACTIVITY 1

1. Science is an enterprise participated in by (a)……., concerned with the study and (b) …….. explanation of the (c)…….. and (d)……
2. Technology is characterized by (a) …….. (b)……. (c) ……. and (d)……..
3. Name the motivating factors in science and technology.

SCIENCE AND NON-SCIENCE SUBJECTS

Science disciplines can be grouped into formal and empirical sciences. The formal science subjects include Mathematics (which comprise geometry, algebra, trigonometry, and arithmetic), logic, theoretical physics and statistics. They have a formal and deductive character. Science is said to be formal if its content, arguments and procedures obey certain rules. For example, in Mathematics, there are rules of addition, subtraction, multiplication and division. There are also rules for solving equations and problems, theorems etc.

Empirical science subjects, on the other hand, include botany, biology, chemistry, biochemistry, Zoology, geology, physics, medical sciences, etc. These subjects study objects and phenomena which can be observed through any of the senses and can be tested with instruments such as the telescope, microscope, ruler, tapes and scales.

Another way of grouping scientific disciplines is according to the class of objects or phenomena they deal with (Nwala, 1977). For example,

(a) Natural sciences deal with all natural objects. Under this are sub-branches such as:

- (i) **Physical Sciences** – These include subjects like physics, geology, chemistry, applied mathematics, astronomy, etc. these deal with physical and animate objects such as rocks, rivers and mountains.
- (ii) **Biological Sciences** – Subjects under this include botany, biology, Zoology, microbiology etc. these deal with living bodies such as human beings, animals, insects and plants.
- (iii) **Hybrid Sciences** - Biochemistry, Biophysics, etc.
- (iv) **Medical Science** – These include general medicine, anatomy, physiology, surgery and veterinary medicine. These subjects deal with objects and problems that affect human and animal health.

(v) **Pharmaceutical Sciences** – These also include pharmaceuticals, pharmaceuticals chemistry, pharmacognosy and pharmacology. They are subjects concerned with drugs and drug contents of plants and other objects.

(b) Social Sciences:- The subjects under this discipline deal with society and social institutions. They are:

(i) Economics

(ii) Geography

(iii) Social Philosophy

(iv) Social Psychology

(v) Sociology and anthropology etc.

Non-science subjects are art, religion, metaphysics (a Branch of philosophy), common sense, mysticism, imagination, etc

Non-science discipline are said to be subjective, unverifiable, non-factual, unsystematic and unquantifiable. Religion, for example, is concerned with worship of the supernatural; it is speculative and based on truth or dogma. The basic religious beliefs are not questionable. Religion relies on the principle that the universe is governed by spiritual laws. The study of non-science discipline are often a matter of guesswork, involving trial and error. Knowledge based on non-science discipline does not allow us to explain, predict and control phenomena in the way scientific knowledge can.

Science disciplines are not dogmatic. They are based on reasons and do not accept any idea or belief on faith. It subjects all that are within its study to critical examination. It does not accept anything as sacred and unquestionable. It relies on the principle that the universe is governed by material law which may be chemical, biological, electrical, mechanical, etc. it also seeks knowledge that is objective, systematic, certain, provable and supported by evidence. This is achieved through the processes of science and further overcome the limitation of human senses through the use of instruments, equations, diagrams and formal symbol (Nwala, 1997).

ACTIVITY 2

1. List three characteristics each of science and non-science subjects.
2. How do the natural science subjects differ from the social sciences subjects?
3. Give five subjects that make up the non-science discipline.

IMPACT OF SCIENCE AND TECHNOLOGY ON THE SOCIETY.

In the last three decades or so, tremendous achievements have been recorded in the area of science and technology development in the world. Modern inventions and discoveries have cumulatively helped to improve man's progress in health, happiness and productivity.

Science and technology have gone a long way in turning deserts into arable lands. Wheat and barley, which hitherto were foreign to is, now thrive in the northern part of Nigeria. Crude oil, which used to be refined abroad, us now being refined in the country. In the realms of biological science, there has been increase in food production, antibiotics and other pain relieving drugs to treat various diseases and ailments.

Space science has gone a long way in reducing the distance between the earth and other planets. Man has successfully transported himself against the force of gravity to other planets and he has also landed on the moon. Communication between a state capital and the remotest village in Nigeria can be achieved within seconds. Through satellites, one is given the opportunity to see and hear reports of events, while a single transmission or broadcast can reach a whole hemisphere of the earth. Computers of various brands and sizes can be used to process large amount of information within few seconds.

Electricity helps to illuminate our environment, cook food and drive our ploughing machines; tractors and harvesters have tremendously increased crops yields in recent time. Genetic engineering, development of hybrids has increased agricultural productivity through development of new breeds of crops and animals. All these and many more are examples of product of technology.

It is interesting to note that before each of these products were developed; a significant scientific discovery had been made. Each of those examples demonstrates a symbolic relationship between science and technology.

ACTIVITY 3

1. Explain briefly how science and technology affect human life.
2. Mention four negative impact of science and technology on human being?

LIMITATION OF SCIENCE

Science is one kind of knowledge that human beings based decisions upon. It does not take decisions by itself, hence, science, especially pure science, does not concern itself with moral issues. However, scientists in applied science have to contend with moral issues that relate to the knowledge arising from their work. For instance, a scientist attempting to clone a human being cannot claim ignorance of the full implications of the outcome of his or her work.

Science summarizes observations in the form of laws. These laws are as certain as the instruments that are used and the inferring techniques that are employed assuming normal conditions operate while doing this. Science use summaries to predict unknown past and future events. If there is any change in the conditions that scientists assumed initially, predicted events may not occur.

It is difficult for scientists to deduce with certainty any past or future event because past and future conditions are difficult to be wholly known. The farther away these past and future events are the more difficult they are deduced with certainty. Science does not deal with final causes. Hence, it does not accommodate miracles in the subject matter. Unexpected events do

occur during scientific investigations. These events are usually explained in the end using appropriate theories and laws. Whatever scientists are unable to explain remains a challenge to the scientific community and their members will not rest until they are able to reduce the unknown to the familiar.

Scientific laws are generalizations that summarize observations. They are not decrees or legal enactments that are enforceable. The only authority of science resides in the logic of human beings and the force of the scientific community. The scientific community sanctions what it considers to be a major scientific discovery or invention. It does not lay down any set of rules for arriving at a discovery or invention because it is not a mechanical process.

ACTIVITY 4

1. Discuss the limitations of science.

OBJECTIVES OF SCIENCE EDUCATION IN NIGERIA

Science education is a field of study concerned with producing a scientifically literate society. Also, it lays the foundation for future work in science and science related fields by acquainting the students with certain basic knowledge, skills and attitudes.

Science education is the bedrock upon which scientific and technological development depend. It is believed by most educators that the giant strides made by the developed countries such as Japan, United State (U.S), Germany and Britain are not unconnected to the type of science education available in these countries. Nigeria as a late starter in science education may not have achieved like some of the developed nations of the world. Nigeria's entry into scientific and technological pursuit is not an accident but as a result of a well planned science education programme. The policies that shaped Nigerian science and technology curriculum points to a well thought out science education objectives. These are:

1. Observe and explore the environment;
2. Develop basic science process skills, including observing, manipulating, classifying, communicating, inferring, hypothesizing, interpreting data and formulating models;
3. Develop functional knowledge of science concepts and principles;
4. Explain simple and complex natural phenomena;
5. Develop a scientific attitude including curiosity, critical reflection and objectivity;
6. Apply the skill and knowledge gained through science to solving everyday problems in his environment;
7. Develop self confidence and self-reliance through problem solving activities in science;
8. Develop a functional awareness of and sensitivity to the orderliness and beauty in nature.

ACTIVITY 5

1. What is helping the Nigeria to emerge as a developing nation?
2. Mention some of the objectives of science education in Nigeria.

SUMMARY:

- Science is both the process and product of investigation, while technology consists of what can be done with the products of investigation and how they can be used.
- Science disciplines can be grouped different ways, viz:
  - (a) Formal science such as Mathematics, logic, theoretical, physics ands statistics.
  - (b) Empirical sciences are botany, biology, chemistry, biochemistry, zoology, geology, physics, medical sciences.
- Other ways of grouping scientific disciplines are
  - (a) Natural sciences which deal with natural objects.
- The sub-branches of natural sciences are physical sciences such as physics, geology, chemistry, applied mathematics, astronomy etc; biological sciences such as biology, zoology, microbiology, etc; medical sciences such medicine, anatomy, physiology, surgery and veterinary medicine; pharmaceutical sciences such as pharmaceutics, pharmaceutical chemistry, pharmacognosy and pharmacology.
- Social science disciplines include economics, geography, social philosophy, social psychology, sociology and anthropology.
- Non-science disciplines include art, religion, metaphysics, common sense, mysticism, imagination etc.
- Science and technology have affected our life styles for better when compared to human life styles 100 years ago.

  Various developments today in the area of communication, electricity, medication (i.e. health), agriculture, automation, etc are good testimonies.
- Science does not take decisions by itself; science summarizes observations in the form of laws; science does not deal with final causes; etc.
- Some of the objectives of science education in Nigeria are
  - Observe and explore the environment.
  - Develop basic science process skills including observing, manipulating, classifying etc.
  - Explain simple and complex natural phenomena,
  - Develop a scientific attitude including curiosity, critical reflection and objectively.

- Apply the skill and knowledge gained through science to solving everyday problems in his environment.

ASSIGNMENT:

1. Discuss what you consider as the negative impact of science and technology to human life.
2. Discuss briefly the relationship between the science and social science disciplines.
3. Since the introduction of science education into the school curriculum in 1985, will you agree that the objectives of Science Education in Nigeria have been achieved?

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UNIT 6: PSYCHOLOGICAL THEORIES OF LEARNING AND THEIR APPLICATION TO SCIENCE TEACHING AND CURRICULUM DEVELOPMENT 1

INTRODUCTION:

The study of psychological theories of learning is very important and valuable because the learning theories are the fundamental theoretical foundations for the present innovative instructional strategies which are used in the teaching – learning process of science. This unit will deal with David P. Ausubeli and Robert Jerome Brunner's theories of learning and their application to science teaching/curriculum development.

OBJECTIVES:

After studying this unit; you should be able to:

1. describe what the Ausubel's theory of learning is all about
2. enumerate the application of Ausubel's theory of learning to science teaching and curriculum development
3. describe Brunner's theory of learning
4. enumerate the application of Brunner's theory to science teaching and curriculum development

HOW TO STUDY THIS UNIT:

1. As you read through this unit, try to take note of the main and important ideas.
2. You should study this unit step by step as they have been arranged for you.

DAVID P. AUSUBEL'S THEORY OF LEARNING:

Ausubel stresses the value of prior (i.e. previous) knowledge in students learning. It is generally accepted that what a student already knows could aid or hinder new learning. According to Ausubel as cited in Abdulahi (1982), meaningful learning occurs where there is appropriate link between prior knowledge and new learning task i.e interaction between the students' appropriate element in the knowledge that already exists and the new material to be learnt. When there is no such interaction, no learning occurs. The parts of the learner's cognitive structure (i.e prior knowledge) which can provide the intraction necessary for meaningful learning are called **subsumers** i.e prior knowledge or knowledge already existing in the cognitive structure as subsumers.

Ausubel defined subsumers as a principle or a generalised body of knowledge that the learner already acquired that can provide association or "anchorage" for the various components or the new knowledge. That is a new learning must be linked to the existing knowledge to create

meaning. If the prior knowledge has no subsumers, advance organisers can be introduced. Advance organisers are alternative set of link or "anchors" (Urevbu, 1990).

Application of Ausubel's Theory of Learning to Science Teaching and Curriculum Development

- Teaching of science must begin with new learning or knowledge in a sequential manner.
- Teacher must present no new material on science until the learner is ready.
- He supported the use of expository method in teaching science as this can lead to high level of understanding and generality as against the use of discovery approaches which are extremely time consuming.
- Science teaching must not begin until the teacher is sure of previous knowledge and if not, it should be provided.
- Contents in the curriculum must be arranged in sequential order
- Determination of the stability of what is learned depends on the discriminability of the new material from previous learning.

ACTIVITY 1

1. Explain briefly Ausubel's theory of learning .

2. Mention three implications of Ausubel's theory of learning to science teaching.

JEROME BRUNNER'S THEORY OF LEARNING:

Brunner introduced the concept of learning by discovery. The theory stresses cognitive effectiveness. Because of this, some referred to Brunner's theory of learning as *Brunner's theory of cognitive development.*

Brunner believed that learning by discovery begins when science teacher purposefully (i.e intentionally) create (i.e presenting) problem and present to students by introducing some inconsistencies (i.e contradictions) among source of information which are given in the process of instruction. According to Brunner such inconsistencies lead to intellectual discomfort that will stimulate (i.e. motivate) the students to initiate individual discoveries through *cognitive restructuring* (i.e. internal reorganisation).

The intellectual discomfort created by the inconsistencies make the learner to attempt to bring order out of this confusion by engaging in mental processes i.e. discovery activities which involve observation, hypothesizing, measuring, stating problem, data collection, classifying, inferring etc. Through mental processes, the student can generate facts from his desperate experiences. Experiences gained during the mental processes enable the students to sense the disparity.

According to Brunner as cited in Akanbi & Opasina (2000), there are two forms of discovery processes, which are:

Assimilation: This occurs when a student recognises a new situation that is familiar to one of the elements in his existing structure of knowledge (i.e cognitive structure) and he easily assimilates it.

Accommodation: This occurs when a new situation (i.e. a new knowledge) is incompatible to the existing structure of knowledge (i.e. cognitive structure) the learner first restructures (i.e reorganises) his cognitive framework (i.e cognitive structure) in order to be able to accommodate the new knowledge.

Brunner believes that the student should find out information on their own through use of mental processes. The theory places great emphasizes on the three types of human activity for learning i.e. the three information processing systems which are:

i. Physical activity (i.e motor activities) called Enactive representation.

ii. Imagery called Ionic representation

iii. Symbolic activities

The three activities coexist with each other and for this reason the attainment of one does not mean the total abandonment of the others.

At enactive stage, the child manipulates the learning materials directly by neuro muscular activities.

At ionic stage the child deals with mental images of objects, but does not manipulate them directly.

At symbolic stage the child uses language. The interpretation of the above is that when a child, say at secondary school level shows deficiencies in his learning capacity especially in symbolic representation, it could be that he/she was deficient at the earlier stages (i.e enactive and ionic stages) which he skipped. It is therefore necessary to fill in the missing gap by providing concrete support that will make up for the deficiency.

Discovery learning, when encouraged in the science class also aids problem solving because learning by discovery starts with problem solving (Akanbi & Opasina 2000) Discovery learning also causes creativity in the student which is one of the major objective of science teaching.

Application of Jerome Brunner's Theory of Learning to Science Teaching and Curriculum Development.

- The science teacher should intentionally create or present problems to students either in form of apparent contradiction or inconsistency among sources of information which are given in the process of instruction.
- Encouraging discovery learning in science class by science teachers will result into aiding problem solving.
- One of the major objectives of science teaching is creativity. Therefore discovery learning encourages creativity.

- Students must be taught concepts in such a way that they have applicability beyond the situation in which they were learned.
- Retention of science concepts are aided by knowledge acquired through discovery learning.
- Teachers must encourage students to make intuitive guess more systematically.
- Brunner supported a radical reorganisation of the curriculum across all levels of education.

  He advocated the fundamental structure of curriculum to begin with simple contents and later graduated to complex contents. That is learning should proceeds from simple to complex, from concrete to abstract, and from specific to general.
- Teaching should be inductive.
- He supported the spiral nature of curriculum as we have in our present science curriculum at all levels of education.

ACTIVITY 2

1. Discuss briefly the two forms of discovery processes as propounded by Jerome Brunner.
2. Which of the learning theorists stress learning by discovery?

SUMMARY

- Ausubel's theory of learning stresses
  - the value of prior knowledge
  - that meaningful learning occurs where there is appropriate link between prior knowledge and new learning task.
  - Sequence of instruction
  - That learning by discovery is time wasting, inefficient.
- Brunner's theory of learning centres on
  - learning through discovery

    He sees discovery activities to involve mental processes like observing, measuring, hypothesizing, stating problem, data collection, classifying, inferring etc.,

ASSIGNMENT

1. Discuss what Ausubel suggested a science teacher should use in the absence of subsumers when teaching.

2. How are the Ausubel's and Brunner's theories of learning see a learner in the classroom situation?

3. How would you as a science teacher apply Brunner's theory of learning in your teaching? Use an example to illustrate.

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UNIT 7: PSYCHOLOGICAL THEORIES OF LEARNING AND THEIR APPLICATION TO SCIENCE TEACHING AND CURRICULUM DEVELOPMENT 11

INTRODUCTION

In unit 6, you studied two cognitive psychologists whose works have had tremendous impact on teaching/learning process. The psychological theories of learning are very important and valuable because they are fundamental theoretical foundations for the present instructional strategies in science.

In this unit, you will learn about other cognitive psychologists like Robert Gagne and Jean Piaget together with the application of their theories of learning to science teaching and curriculum development.

OBJECTIVES

After studying this unit, you should be able to:

1. describe Robert Gagne's theory of learning.
2. explain the applications of Robert Gagne's theory of learning to science teaching and curriculum development
3. describe Jean Piaget's theory of learning.
4. explain the applications of Piaget's theory of learning to science teaching and curriculum development.

HOW TO STUDY THIS UNIT

1. Go through this unit carefully.
2. As you read through this unit, try to take note of the main and important ideas.
3. You should study this unit step by step as they have been arranged for you.

ROBERT GAGNE'S THEORY OF LEARNING

Robert Gagne's theory of learning is often referred to as Gagne's Theory of learning hierarchy (Abdullahi, 1982). He states that "*the learning of a new concept or skill depends upon the mastery of prerequisite concepts*". This implies that prior (i.e previous) knowledge determines what further learning may take place, which also implies that materials meant for learning must be sequentially structured by the teacher. Gagne emphasizes the importance of task analysis of instructional objectives. He also believes in task analysis of the concepts, skills and knowledge to be taught.

Gagne's theory believes that materials meant for learning (i.e. learning task) in order for the students (i.e. learners) to acquire the desired knowledge (i.e. terminal task) must be sequentially structured so that the learning of one topic (i.e. acquisition of one knowledge)

aids the learning of the next higher topic (i.e. acquisition of the next higher knowledge). This invariably implies that learning must be sequentially structured by the teacher from simple to complex until the desired objective is achieved. In Gagne's hierarchy of learning, problem solving is the highest level while lower levels involve facts, concepts, and generalisation.

Gagne's theory also advocated administration of pre-tests to find out whether the students possess the relevant prerequisites for the next knowledge (i.e. higher knowledge) (Akanbi & Opasina, 2000). The result of the pre-tests will help the teacher to know the entry point for learning to begin in the hierarchy of learning tasks. Gagne also suggests that in a teaching situation the teacher should begin with a question like "*what is it that I want the learner to be able to do*? This objective must be stated in behavioural form.

Application of Gagne's Theory of Learning to Science Teaching and Curriculum Development.

1. Content in science subjects should be arranged in hierarchical fashion so that those simpler abilities and concepts which are necessary for later learning are mastered first (Urevbu, 1990).
2, Science teachers need to state specifically the objectives for learning any material.
3. He developed a very useful five category system, for examining the different types of learning outcomes which could be applied for science teaching. They are (i) intellectual skills (ii) verbal information (iii) attitudes, (iv) motor skills and (v) cognitive strategies.
4. The contents in science curriculum should be arranged hierarchically so that the simpler contents are treated first at lower class before the complex ones at higher class.
5. After completing the structured hierarchy of learning tasks, the teacher administers diagnostic pre-tests in order to find out the point where the learning hierarchy can start.

ACTIVITY 1

1. Explain Gagne's theory of learning.
2. Which of the following is the highest level of learning hierarchy according to Gagne?
   - task analysis
   - accommodation
   - problem solving
   - prerequisites
3. Use Gagne's theory of learning to explain briefly the importance of pre-test in a science classroom.

JEAN PIAGET'S THEORY OF LEARNING

Jean Piaget was a developmental psychologist. The emphasis of his theory is that learning ability corresponds to the level of intellectual development (i.e cognitive development).

Piaget identified four overlapping stages of human intellectual development which are:

- Sensory-motor stage (0 - 2 years)
- Pre-operational stage (2 – 7 years)
- Concrete operational stage (7 – 11 years)
- Formal Operational stage (11 -15 years)

Sensory-motor Stage (0 – 2 years)

The entire child's learning activities at this stage consist mainly of sensory and motor activities, like touching, seeing, tasting, sucking, pushing, shaking, etc the objects in his/her environment. In the process of these actions on the objects in the environment, the child builds up ideas about the external world, such as how things behave, react etc. The body of knowledge acquired in this process is organised into what is called Schema.

Schema is the frame-work of the child's knowledge and by means of which he approaches the later learning. The process of learning at all stages of Piaget's model of intellectual development has two concepts which are:

- Assimilation
- Accommodation.

Assimilation is a process of acquiring a new knowledge which fits into an existing frame-work of knowledge. You do not need to rearrange anything in the existing framework of knowledge (i.e cognitive structure). The new knowledge just fits in.

Accommodation is a process involving modification of the existing framework of knowledge before the learner can incorporate a new piece of knowledge.

The two processes (i.e assimilation and accommodation) are common and the same for all the intellectual development stages. It is the functioning and the structure at each stage that differs from one another.

In the sensory-motor stage the major intellectual activity is interaction of the senses and the environment.

Pre-operational Stage (2 – 7 years)

At this stage, the child may be able to speak clearly, use symbolic representations by drawing writing and reading and perform complex physical manipulations, he is perceptually oriented and cannot reason logically or see contradictions that to an adult are glaringly obvious.

At this stage also, the child develops the idea of volume, length and number. The child easily confuses the physical change of an object with the change in quantity of the object. For instance, if the same volume of tea is poured into two different cups having different shapes

e.g. narrow and wide. To the child, the tea in the narrow cup is more than the wide one, which illustrate that the child has confused height with volume. This is because at this stage the thinking of the child is irreversible.

In addition at this stage, the child represents object by image. For this reason, he constantly reorganises his picture of the world (i.e. his environment) through imaginative play. The child also uses language (i.e. words) by talking, questioning, listening and experimenting. Talking to self or object is part of the characteristics of this stage. Akanbi & Opasina, (2000) referred to this as age of animism.

Concrete-operational Stage (7 – 11 years)

At this stage, the child's mental process is limited to thinking about thing. He is able to solve problems, but is limited in his ability to do so. He is limited by the nature of the problem. Problems involving concrete objects that can be observed and manipulated can be solved. He cannot cope with problems where hypothetical situations must be considered, beyond simple extensions, extrapolations, or interpolations. In consequence, solutions to problems are achieved mainly by trial-and-error (Urevbu, 1990). The child at this stage also develops the ideas of conservation of matter, length, weight, volume and concepts of time and space.

At this stage, the child can also perform logical operation with concrete objects, which implies that the child can carry out some logical processes like observing, describing, classifying and measuring real objects. The implication of the stage is that the primary school years should be a period of exploration (i.e. the time for children to examine relationship between man and the physical and biological environment).

This implies that the study of science in primary schools should begin with the art of observation which involves the use of the basic senses of seeing, smelling, hearing, touching and tasting. Greater emphasis should be placed on doing them and not telling (i.e. talking). During the concrete operational stage, teaching of the child should involve the use of models i.e. specimen, real objects, apparatus, etc, because the child depends on facts and not theories.

Formal Operational Stage (11- 15 years)

This stage is characterized by freedom from reality. Reality provides merely a starting point for thinking, the first step being the consideration of other possibilities. In this stage, there is thinking about tasks, during which there is manipulation of verbal and other symbols and propositions in place of the concrete objects of the previous stage. It is only when this stage has been reached that the hypothetico-deductive nature of reasoning can be fully understood (Urevbu, 1990).

The child at this stage can also follow logical arguments. He can as well make deductions, comparisons and inferences from ideas. The child can solve ideological problems and can relate symbols with concepts.

Application of Jean Piaget's Theory of Learning to Science Teaching and Curriculum Development

- New ideas and knowledge should be presented at the level consistent with the child's present state of development of thinking and language.
- Learners must occupy themselves with exploration particularly at the primary stages.
- Problem solving rather than rote memorization should be the focus of science.
- Science teaching should promote exploration and interaction with environment using locally available materials.
- Science concepts should be taught by science teachers starting from simple to complex.
- Science teachers should ensure that learners deal with concrete materials before going to the complex and later learn abstract concepts and generalizations.
- Science curriculum should be designed in such a way that students will have opportunities to perform desirable mental operations.

ACTIVITY 2

1. Identify the four stages of human intellectual development as propounded by Jean Piaget.
2. List the two concepts of the process of learning at all the stages of Piaget's model of intellectual development.

SUMMARY

- Robert Gagne's theory of learning also known as Gagne's theory of learning hierarchy states that the learning of a new concept or skill depends upon the mastery of prerequisite concepts.
- In the application of Gagne's theory to science teaching and curriculum development:
  - contents in science should be arranged in hierarchical order
  - emphasises on science teachers stating specifically the objectives for learning any material.
  - Contents in science curriculum should also be hierarchically arranged.
  - Emphasises on pre-testing.
- Jean Piaget's theory of learning states that learning ability corresponds to the level of intellectual development.
- Piaget identified four stages of human intellectual development as:
  - Sensory-motor stage (0 - 2 years)
  - Pre-operational stage (2 – 7 years)

- Concrete operational stage (7 – 11 years)
- Formal Operational stage (11 -15 years)

- In the application of Piaget's Theory to science teaching and curriculum development:
- New ideas and knowledge to be presented by the teacher should at the level consistent with his/her development of thinking and language.
- Teacher should emphasise problem solving rather than rote memorization in their teaching.
- Teaching should start from simple to the complex
- Science curriculum should be designed to give learners the opportunities to perform desirable mental operations.

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UNIT 8: PREPARATION FOR SCIENCE TEACHING (1) THE SCIENCE TEACHER AND THE CURRICULUM

INTRODUCTION:

Ibrahim who is a graduate of Microbiology could not get a job for the past four years in any of the Hospitals/Laboratories he had applied to. He finally settled to picking up a job to teach Biology in a Private Secondary School near his residence. Tomorrow is Ibrahim's first time to start this "new job", what are some worries in Ibrahim's mind at this time?

ACTIVITY 1

Well, one of such problems might be related to what to teach and how to face the students to teach them. So this unit prepares you for Science Teaching in the classroom.

OBJECTIVES:

By the end of this unit you should be able to:

1. describe some preparations necessary for science teaching
2. critically analyse Issues necessary in preparing for science teaching.
3. differentiate between knowledge and pedagogy.
4. differentiate between the content and pedagogy.
5. criticise the researchers idea on teachers' lack of knowledge and confidence in teaching.

HOW TO STUDY THE UNIT:

This unit is already linked to other 2 units to help you plan how to teach. So:

1. Go through the unit step by step.
2. Make sure you attempt all the activities.
3. Your ideas in the assignment given at the end should be well presented and supported by necessary authorities.

Step 1

Reflecting on you Secondary School days, which subject attracted you in the first instance because of the "teacher"?

From some research reports, students' interest in subjects or disciplines could be influenced by the peer, parents, teacher, counsellor or personal view. So it is important that you realise as a teacher that the first encounter a student has with any subject may have a long-term impact on his/her interest, attitude and understanding of that subject.

Although there are considerable variations between countries in terms of curriculum emphasis on content, local and national aims, traditions and priorities, yet in all these countries teachers are the key to realizing curriculum aims and the quality of the science education which the students receive rest ultimately on them. Asoko (2000)

Step 11: Lack of Knowledge: – A barrier to students' progress and the curriculum

ACTIVITY 2

1. But what are some of the barriers facing the teacher of science in implementing the curriculum thereby affecting the student's progress?

According to Asoko (200), Teachers' lack of subject knowledge in science has been documented and frequently identified as a barrier to the implementation of curriculum reform and to pupils' progress (see for example Wragg et al, 1989; Alexander et al, 1992; Summers 1992; Ofsted 1994; Harlen et al, 1995). Teachers who lack knowledge and confidence may naturally attempt to avoid or minimise their difficulties through a variety of strategies, including avoidance of topics, heavy reliance on texts, and over-emphasis on practical activities which, over time, may result in an impoverished science education for children (Lee 1995; Harlen and Holroyd 1997). Osborne and Simon (1996) have discussed some pragmatic solutions to the problem of lack of expertise within the existing teaching force. However, sustained improvements in primary science will depend on improved teacher capability.

Step 3: Some Solutions

ACTIVITY 3

1. But what could be the solution to the teachers' lack of knowledge?

This could be viewed from both the initial and in-service education of teachers. So there is the need for the teacher to be knowledgeable and know how best knowledge could be developed and transformed. The knowledge utilized by teachers has been categorised by Shulman (1987) as:

- Knowledge of the science curriculum.
- The content appropriate to it.
- The pedagogy necessary to teach it.

These three are very essential to the science teacher as a weapon in the classroom. Studies have also shown that subject knowledge and pedagogy can develop hand in hand in a mutually inter-dependent manner, though this development characteristically takes some considerable time (Smith & Neale 1989; Bell & Gilbert 1996; Rosebery & Puttick 1998).

Student teachers have little time. Unlike experienced teachers, they may also be struggling with generic pedagogical issues (such as classroom management) simultaneously with

developing their teaching of, not one, but several subjects. What they need to learn, when they need to learn it, and how and by whom it should be taught are important questions.

SUMMARY

- This is the first unit that exposes or prepares you for the classroom and as a "would be trained teacher" You have seen the importance of knowledge and pedagogy in your training and the importance of the grip of both of them. To teach science effectively requires adequate planning which should not be rushed.

ASSIGNMENT

Ngozi has a first degree in Chemistry and a Masters degree in Analytical Chemistry. She had taken Physics at the SSCE and 100 levels in the University. Having passed the subject at these levels, she felt daunted and excited of her ability to teach physics in a Senior Secondary School.

What are the issues to be considered in this case (Support with relevant authorities?)

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UNIT 9: PREPARATION FOR SCIENCE TEACHING 11

INTRODUCTION:

This unit will introduce you to the preparation for teaching of science in school. It will also enable you to understand that science teaching is an effort made to transfer the nature of science to non-scientists, through formal institution. The unit therefore, focuses on providing necessary information on documents that are available for teachers to teach.

OBJECTIVE:

After studying this unit, you should be able to:

1. describe a science syllabus
2 describe a science scheme of work
3. differentiate between goals and educational objectives.
4. discuss the three types of educational goals as specified by wheeler (1967).
5. mention uses of instructional and behavioural objectives.

HOW TO STUDY THIS UNIT

1. Go through this unit carefully.
2. As you go through this unit, try to take note of the main and important ideas.
3. You should study this unit step by step as they have been arranged for you.

THE SCIENCE SYLLABUS AND SCHEME OF WORK:

A science Syllabus

A science syllabus could be described as a condensed outline or statement of the main points of a course of study in science springing from the broad science curriculum of the school. It is the framework of future operation in the school. In Nigeria, the science syllabus is prescribed and laid down by the government through its Ministry of Education in conjunction with the examining bodies. The team of experts who draw the science syllabus at any level of education takes into consideration matters which are not narrowly educational but contains socio-cultural background, economic policies, government policies, resources, national needs, etc.

There are two types of syllabus;

(i) Science examination syllabus

(ii) Science teaching syllabus

The science examination syllabus will indicate topics to be covered for a particular examination in science without arranging the content in any order.

The science-teaching syllabus is an outline of the work planned to be done in a course of a term or a year with each class in each science subject.

Science syllabus construction is not a matter which is left to individual head-teachers, teachers or schools. Although selected experienced science teachers are consulted when syllabi are devised or revised, it is a complex and sophisticated process, which involves all those who are concerned with science education.

A balanced science syllabus includes relevant topics in science subjects. This means that there are as many syllabi in school as there are school subject offered in a particular school. Each science syllabus therefore contains topics arranged in logical sequence, provision for practical and manual work to be studied, relevant learning methods and special teaching resources including textbooks to be used.

A Science Scheme of Work

A science scheme of work is the weekly arrangement of topics from the science syllabus. This is done by dividing the science syllabus into three parts, corresponding to three terms of the school academic year. In the context of classroom teaching, it is that part of a subject matter that the science teacher will be required to teach a period of time. This subject matter (topics) are placed in the order which they are going to be studied and the time to be spent on each topic is estimated. Basically, science scheme of work consists of an aim and an itemized outline of the science topics to be taught. It may also be appropriate for the teacher to re-examine the amount of ground that had been covered (i.e. previous knowledge) and include some reference of this in his scheme of work.

According to Abdullahi (1982), in drawing up a science scheme of work from a science syllabus, the following factors should be borne in mind;

- The need for logical sequence;
- The age, ability and previous knowledge of the pupils;
- The amount of time required by each topic;
- The number of effective weeks of learning in a term or year;
- The number of periods as per week including practical periods;
- Materials and resources to teach;

A good science scheme of work must include the following information:

- Periods.
- Topics.
- Sub-topics/teachable units.
- Instructional objectives.
- The contents/teacher’s activities.
- The students’ activities.

- Instructional aids.
- Evaluation.
- References.

A good science scheme of work, set out at the beginning of term, is a good guide for the science teacher to know how much he is expected to cover and should then strive to cover. It also helps the science teacher to know when a topic is coming up and when to gather the necessary materials that could make teaching of the topics more effective.

Essentially, science scheme of work enables the head-teacher and science teacher to meet the special needs of the science students. It helps to ensure continuity of the learning process and ensures correlation in the learning that can take place. It is important to note tat science scheme of work are guides and not masters in science teaching.

ACTIVITY 1

1. Differentiate between the science syllabus and scheme of work.
2. Differentiate between science examination syllabus and science teaching syllabus.

Goals and Objectives

Goals are expected outcomes often stated in general terms. Such general terms simply provide orientation for what would be emphasized in the educational programme. Goals have different degree of specifically.

According to Wheeler (1967), educational goals consists of three types viz:

- Ultimate goals.
- Mediate goals.
- Proximate goals.

Ultimate goals - are the end product of education carried out over a time. This is the last, terminal, final or highest intended outcome of the educational process. It is stated in broad terms and often difficult to measure or observe.

It is expected to be achieved at the end of a long period of time. The ultimate goal could be derived from aims. One aim as stated in the National Policy on Education is:

> The acquisition of appropriate skills, abilities and competencies both mental and physical as equipment for the individual to live in and contribute to the development of his society (FRN, 1998p.8)

Before the attainment of this aim, an individual should develop literacy skills and become a patriotic citizen". Appropriate skills are many and they should be more clearly defined in goal setting. An individual may not be able to acquire appropriate skills, abilities and competencies – both mental and physical needed by him to live, and develop his society in

the modern days – unless he can read and write effectively. From the derived goal, it is clear that effective literacy (and of course, numeracy**)** are behaviour patterns achievable over a long period of time. A literate citizen, for example can be identified and his level of literacy ascertained at the end of the primary or adult education.

Ultimate goals because of their general outlook are however, of little relevance in specific learning situations such as the classroom. This is the more reason why ultimate goals should also be broken down to smaller and more defined units called mediate goals.

Mediate goals - states behaviours, which could be attained at a particular stage as we progress towards the attainment of the ultimate goals. Mediate goals give curriculum planners better sense of direction or focus in the planning of learning experiences and evaluation strategies. They are statements of intended behaviours or behavioural patterns expected of learners at given stages in the educational process, in the effort to achieve the ultimate goals (Nnadozie, 1995). The behaviour patterns expected in the final end (i.e. the ultimate goal) can only be made manifest after the realization of the mediate goal. According to Orukotan (1993), it is after the learner has achieved the mediate goals by different stages within the educational system that he can demonstrate those behaviours in the ultimate goals. This is to say that mediate goals are the behaviour patterns expected of learners at given stages during the long period of learning. For example, to produce a literate citizen of a primary school pupil (an ultimate), the individual should be able to read and write, at least, in his/her mother tongue – a mediate goal derived from an ultimate goal.

Proximate goal are generated from mediate goals. They are statement of expected behaviour, which are less general and seemingly specific in outlook. Proximate goals state the behaviour that should be demonstrated at various periods as we proceed towards the attainment of the ultimate goal. The period for attaining it is shorter than that of mediate goal. They are not as discrete and specific as behavioural or instructional objectives.

Proximate goals are somehow used in stating behavioural patterns expected of learners in day-to-day classroom instruction. They are the likely goals achievable within units of classroom work. To a reasonable extent, they can be learner centered. They however, also need to be broken down to specific instructional or behavioural objectives that are used in lesson plans after diagnosing specific individual and group needs.

To illustrate proximate goal with our earlier examples, efforts will have to be geared towards ensuring that a child can speak and read his/her mother tongue before writing is introduced. Therefore, proximate goals from the foregoing can be “to be able to

(a) Speak in his /her mother tongue, and

(b) Read the alphabets in his/her mother tongue.

These are derived from the mediate goal “to read and write at least, in his/her mother tongue.

ACTIVITY 2

1. Explain the term goal.
2. Write short notes on.

(i) Ultimate goal.

(ii) Mediate goal.

(iii) Proximate goal.

EDUCATIONAL OBJECTIVES

Educational objectives are the criteria by which materials are selected, content is outlined, instructional procedures are derived and tests and examinations are prepared (Tyler, 1949). Educational objectives are end desired. They are obtainable from the philosophy of education, studies of the learners, and studies of contemporary life outside the school, school subjects and psychology of learning. Objectives give direction to education (Oduolowu, 2000).

They help to plan instruction, guide students' learning and provide criteria for evaluating students' learning outcome (Orukotan, 1994). All these point to the fact that educational objectives bring about significant changes in the patterns of behaviour of learner. Therefore, any statement of the educational objectives should be a statement of expected changes in students rather than what teachers intend to do in an effort to attain the objectives. In other words, objectives should not be stated in what the teacher is going to do, because they are not ultimate purposes of educational programmes.

Unknowingly, educational objectives are often stated in listing topics, concepts and other elements of content to be dealt with in the course of study. For instance, objectives stated in this manner, do indicate the areas of contents to be dealt with by the students. These are not satisfactory objectives since they do not specify what the students are expected to do with these elements.

The most useful form of stating objectives therefore is to express them in a manner which identifies both the kind of behaviour and the content areas in which this is used to operate. This form of statement tells us what students should be able to do after going through an instruction.

A good objective in education consists of the following:

(i) It should be stated as learning product not as a learning process. It should have action verbs, which indicate what students should be as an evidence of having achieved the objectives. Verbs like titrate, mention, draw, identify, define, demonstrate, describe, compute, list, recite, solve, enumerate, differentiate, construct, sketch, add and tabulate should be used.

(ii) It should not contain covert words, such as understanding, critical thinking, know, appreciate etc. this is because the behaviours described with these words cannot be directly observed. They are terms opened to multiple interpretations.

(iii) It must contain conditions under which the learners will be expected to exhibit what he has achieved. This includes whether he will be given paper and pencil to write, or he should be given some apparatus to manipulate.

(iv) It must indicate level of acceptable performance, that is, whether the students were expected to "label all the features in a mammalian eye" or to label only part of the features. The number to label should be stated.

(v) It should not contain the list of subject matters to be covered. As these are not behavioural objectives but a list of topics to be covered.

(vi) It should not describe teacher's behaviour.

ACTIVITY 3

i. Define educational objectives.

ii. Using a named concept, state a good educational objective.

iii. Give the characteristics of a good educational objective.

USES OF INSTRUCTIONAL AND BEHAVIOURAL OBJECTIVES

- Instructional and Behavioural objectives are used for guiding the teacher in selecting learning experiences and which ones should be emphasized.
- They assist the teacher in determining the choice of learning materials to use when teaching.
- They serve as a guide for evaluating curriculum achievements.
- They give another teacher the opportunity to continue with the lesson in case the teacher that prepared the objectives becomes unavoidably absent.
- When clearly stated, it allows good students to use and work ahead of the teacher.
- They are used in giving clarifications to educational intentions.
- Clearly stated objectives serve as a basis for the principal, parent and educational administrator to assess the curriculum of instruction.
- They are used to a great extent in determining the financial assistance/materials to be provided by parents, government and the community.

ACTIVITY 4

1. Discuss the uses of instructional and behavioural objectives.

SUMMARY:

- A science syllabus could be described as a condensed outline or statement of the main points of a course of study in science springing from the broad science curriculum of the school.
- A science scheme of work in the context of a classroom teaching is that part of a subject matter that the science teacher will be required to teach during a period of time.
- Goals are expected outcomes often stated in general terms. Goals according to Wheeler (1967) can be divided into three, namely
  - Ultimate goals
  - Mediate goals
  - Proximate goals
- Educational objectives are the criteria by which materials are selected, content is outlined, instructional procedures are derived and tests and examinations are prepared (Tyler, 1949). They are the end desired.
- Instructional and behavioural objectives are used for:
  - Guiding the teacher in selecting learning experiences and which ones should be emphasized.
  - Assisting the teacher in determining the choice of learning materials to use when teaching.
  - Guiding in evaluating curriculum achievement.
  - Allowing for continuity in teaching.
  - Allowing good student to do personal reading ahead of the teacher.
  - Clarifying educational intentions.
  - Assessing the curriculum of instruction by stakeholders.

ASSIGNMENT

1. Differentiate between a science curriculum and a science syllabus.
2. Mention the features of a science scheme of work.
3. Discuss the purpose, which educational goals and objectives serve in educational discourse.
4. What are the merits and de-merits of educational objectives.
5. Identify the common errors, which science teachers often commit while stating behavioural objectives.

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UNIT 10: PREPARATION FOR SCIENCE TEACHING II

INTRODUCTION:

This unit is the continuation of what you learnt in Unit 9. There, we saw science teaching as an effort made to transfer the nature of science to non-scientists preferably learners, through formal institutions.

So, because of the complexities surrounding the teaching of science to students, considerable thought must be given to the planning of instruction. Therefore, this unit will look into practicing how to teach using micro-teaching approach, continue with the process of planning which was started in unit 9, planning science lesson, lesson plans and lesson notes in science teaching.

OBJECTIVES:

After studying this unit, you should be able to:

1. explain the term micro-teaching;
2. demonstrate how to teach any science concept to your colleagues in the science group;
3. list and discuss nine teaching skills;
4. prepare a unit plan of instruction in science;
5. differentiate between science lesson plans and science lesson notes

HOW TO STUDY THIS UNIT:

1. Go through this unit carefully.
2. As you go through this unit, try to take note of the main and important ideas.
3. You should study this unit step by step as they have been arranged for you and be able to practicalise as suggested.

PRACTICING HOW TO TEACH

Practicing how to teach can be simply referred to as "micro-teaching". So microteaching is a laboratory training procedure geared towards simplification of the complexities of regular teaching/learning process. Salawu and Afolabi (2002) referred to microteaching as the teaching in miniature-teaching scaled down in terms of class size, time, task or content and skill. Clifttal (1973) described microteaching as "contrived but nevertheless real teaching".

A microteaching session simulates a regular classroom instructional period in every way except that both the time and the number of students are reduced. It should be established that the teacher in training works with a small group of real students, but in a situation where it becomes rather difficult to provide real students, the other trainee teachers are asked to play

the roles of the real students. When this method is adopted, we refer to it as peer-teaching. There have been criticisms against the adoption of peer-teaching for microteaching.

Of all the objectives to the use of microteaching, the major one is in the fact that mature/adult students usually over react and over-dramatize the normal behaviours of the real pupils. Thus, at the end of the microteaching session, what might have been a rewarding exercise for the student teachers may turn out to be a verbal battle between them and the supervisor who is expected to monitor the programme and provide professional advice in a form of feedback on the demonstration of the student teachers.

It is however inevitable to use peer-teaching in microteaching because even where a college runs a practicing primary school, making use of the pupils may disturb the school programme and activities. Therefore, the supervisor needs to be very cautious of the excessive activities of the peer-grouping members and call them to order so as to make the whole experience, in microteaching a rewarding one rather than an "over-dramatized, and anxiety-producing session that helped no one" (Oliver, 1970).

Whether microteaching or direct classroom instruction, it is obvious that in order to maximize teacher effectiveness, there is the need for the teacher to put into practice some teaching skills. These are:

1. set induction
2. stimulus variation;
3. non-verbal communication;
4. questioning;
5. instructional media'
6. reinforcement;
7. closure;
8. planned repetitions (communication redundancy)
9. use of examples and illustration.

Set Induction

This is what you as a teacher do at the beginning of a lesson. In other words, your efforts to get pupils' undivided attention to arouse their interest and to prepare their minds for the task at hand for the lesson are all embraced in the term of set induction.

It has been established that if the teacher succeeds in creating a positive set, the likelihood of pupil involvement in the lesson will be enhanced.

Stimulus Variation in the Class

This has been established to have an effect on the teaching/learning process in the classroom. It will be wrong for the teacher to assume that the pupils do not see or think beyond what goes on in the classroom particularly when the lesson is on. In fact, there are lots of competing external stimuli that can affect negatively, pupils' learning. The extent to which

pupils are able to benefit from the classroom instruction will be determined by the degree to which the teacher is able to shift the attention of the pupils' mind away from the visible and many a time, invisible external stimuli. To learn is to pay attention. Therefore, failure on the part of the pupils to show appreciation in learning during and after a lesson may be due to lack of attention.

Non-Verbal Communication Skills

The degree of occurrence of learning depends on the way and manner the learnable items are encoded by the teacher. Teachers cannot but involve themselves in communication. This can be verbal or non-verbal. Research findings according to Salawu and Afolabi (2002) have however revealed that not less than 80 percent of our total communication was effected through non-verbal communication.

There is more to non-verbal communication than gesticulations. The statement "*action speaks louder than voice*" is a statement of fact. More often than not, receives, especially the mature ones, are interested in the way and manner the sender encodes the message. As you may be aware, "yes" may not sometimes imply "positive". Indeed you must be careful in interpreting what people say. In an attempt not to be misquoted, good communicators often resort to the use of non-verbal communication to express "non-commital" statements.

Questioning Skills

Questioning is one of the important skills involved in the teaching/learning process and when skilfully handled, it often makes for a good teaching. Questioning helps in calling a mind-wondering student to order and keeps every student at alert in the classroom. Since no student knows when the teacher may call on him/her, everybody pays attention and gets prepared for the "bullets" from the teacher.

Questioning also exposes the direction of thinking of the student to the teacher and enables the teacher to know the areas of need of a particular student. It provides information to the teacher about the entry behaviour of the students. This becomes very important so that the teacher does not build the new lesson on a shaky "foundation:. It as well serves as evaluation instrument to the teacher. The student's response to question in the class promptly informs the teacher of the student's understanding or otherwise of the lesson.

Instructional Media Skills

One of the skills a practicing teacher needs to be proficient in is the skill of handling the instructional materials available for his lesson. This skill is thus learnt in a microteaching classroom session so that the inexperienced teacher will gain expertise on it before moving into the real classroom situation.

From a general view point, the teacher should watch out for the following qualities and conditions of the instructional materials.

- Delicacy and fragility of the instructional materials.
- Sensitivity of the instructional materials to certain atmospheric conditions.
- Sensitivity of electric voltage.

- Mastery of manufacturer's instructions.
- Display and replacement of instruction material.

Reinforcement Skills

The concepts of reinforcement and feedback become very important ingredients to be noted in a microteaching class. Reinforcement is a kind of feedback given to the students as a result of the students' performance in a particular task. If a student knows that he is performing a task well, he is likely to desire to continue doing that good thing and even may be doing it better than before.

It can however be argued that a student who knows he is performing poorly may want to struggle to improve if he is encouraged and motivated with some other incentives. It all amounts to feedback. Reinforcement is to strengthen the performance of a student who receives it. A positive reinforcement encourages the performance while a negative reinforcement extincts the emission of that performance.

Closure Skills

Closure is the technical teaching skill that a teacher can use to help students perceive the logical organisation of a classroom lesson. The closure of the microteaching lesson is as important as every other part. Whether it is called "conclusion or summary or evaluation or recapitulation" etc. The most important thing here is for the teacher to note that the handling of this aspect of microteaching will certainly determine the success or failure of a lesson more than any other aspect of the microteaching will do.

Planned Repetition

Repetition occurs when an action that has taken place before takes place at least once again. Sometimes such an action can take place several times over after the first occurrence. Psychologists believe that when an action occurs again and again, it implies that the object (person) that emits the action is certainly receiving a positive feedback or reinforcement to warrant the re-occurrence of the action.

Repetition can be intentional, planned and purposeful when the need arises. Such a repetition could be planned by the teacher, if it is at his own instance and it could otherwise be planned by the students, if it is at their instances. The need to make repetition may equally be dictated by certain peculiar situation and circumstances that come up during the lesson. Repetition can be planned, during a lesson when:

- Rainstorm or any other uncontrollable circumstance brings a lesson to a close prematurely.
- A teacher discovers through summative evaluation, that a good portion of the stated objectives of the lesson has not been achieved.
- A teacher sees the need to emphasize an aspect of the lesson as against the other aspects.

- The teacher intends to revise/review the lesson probably in preparation for an examination or so.

Examples and Illustrations

"*Examples are better than precepts*" goes an adage. Some people are so parochial in their imaginations that they seem to cast doubt in almost anything they hear. They always feel nothing can work in the situation that we find ourselves. But when the speaker now makes illustration and cites examples of similar issues that had taken place here and there and the amount of success recorded, then they start to change their minds. Examples and illustrations play vital roles in assisting learners to assimilate what the teacher says in the class.

Examples and illustrations on the surface view have the same meaning. But at a closer look, there are few differences here and there. Examples, it appears are more real and concrete than illustrations. When examples are cited in a discourse, it takes the form of:

(i) A story/ an incident.

(ii) A demonstration/practical/real life show e.g. working a mathematical sum before giving students similar fresh sums to solve.

Both of these are relevant to the discourse in question. Illustration on the other hand appears to be somehow positive. It takes the form of a graphic representation, a description of an event.

ACTIVITY I

1. What do you understand by the term "microteaching"?
2. Explain the term "set induction skill".
3. Describe in clear terms "non-verbal communication".
4. Discuss briefly why a teacher needs to ask questions frequently from the students during a lesson.
5. What is reinforcement?
6. Give an example of how planned repetition can be used during lesson.

The Science Lesson

In the previous unit (9), you learnt about scheme of work. You will then see that once a science scheme of work has been decided upon and its various contents and sub-contents identified and placed in a suitable sequence, the science teacher could proceed to a consideration of the individual science lessons or units of learning. As preliminary to this stage in the preparation for learning, a general orientation will be provided which will help to give the lesson contexture and direction.

When planning a science lesson, therefore, consistency among three components of instruction should be sought. These components are:

(i) The lesson objective.

(ii) The teaching methods, materials, media, aids, learning experiences and or exercises and their organisation.

(iii) Evaluation procedures. (Urevbu, 1990)

Gagne and Briggs (1974) refer to these components as "anchor points" in the design of instruction constant reference to which helps to keep the lesson 'on target'. Mager (1968) expresses these same elements in terms of fundamental interrogatives thus:

(i) Where am I going (objective)

(ii) How will I get there? (Step by means of which the objectives is achieved).

(iii) How will I know I have arrived? (The use of appropriate evaluative procedures).

Evidence by Briggs shows that when these "anchor points and corresponding questions are borne in mind in lesson planning, instruction tends to be successful.

Urevbu (1990) opined that there is no fixed and rigid pattern that will suit all lessons, and that all the teacher needs to do is to adopt a flexible approach that will arise out of the particular objectives he/she has in mind in relation to the various state of the classroom situation. Such flexibility will depend on the teachers understanding of the psychological processes underlying an act of learning and of how these relate to the behaviour of both the teacher and learner. Given this kind of understanding, the teacher is in a better position to tailor his/her plans to meet the requirements of the individual lesson or unit he/she is preparing, regardless of whether it is a traditional class lesson or laboratory work, a demonstration of field work.

Preparation of science lessons involve dishing out the science subject matter sequentially and logically to students. This underscores mastery of the subject matter by the science teacher and his ability to use instructional materials appropriately. There should be a logical presentation of materials. As no materials should be an isolated entity of itself. Every point should be completely introduced, brought to its climax and concluded. Provide activities for the students. Since research has proved that children learn best from concrete objects (piagetian theory). There should be very clear explanations on the work expected of such student. Rowdiness in the practical room should be avoided. In science classes, some degrees of noise making are allowed as long as such will lead to realisation of the set goal.

When using the chalkboard, there is need to always maintain distinction between major and minor points. The practice, where science teachers copied notes on the chalkboard for students after teaching a lesson should be discouraged. Good teaching requires the teacher to write out the chalkboard summary just as teaching progresses.

In concluding a lesson, the science teacher should summarize the lesson, allow students to ask questions and probably complete the chalkboard summary. Proper evaluation is also necessary at all stages of instruction. This is the period when the teacher tests the effectiveness of his teaching strategies in a lesson. Questions based on the stated objectives are asked by the teacher. The responses from students will show whether the objectives had

been achieved or not. Teacher should ensure that evaluation is not delayed to the end of the teaching. After the instructions, assignments are to be given to the students. This will give the students the opportunity to go over the lesson, collect more facts and prepare for the next lesson.

ACTIVITY 2

1. List what you consider as the three components of instruction.
2. Name the appropriate place where science lesson should take place.

THE LESSON PLANS IN SCIENCE TEACHING

Lesson plan in science teaching is a detailed analysis of how a science subject matter shall be taught during a lesson. It is meant to guide the science teacher in presenting a good and effective science lesson. It also ensures a conducive and purposeful classroom atmosphere. It is important for a science teacher to prepare a lesson plan because:

- It will ensure that the science teacher knows the subject matter.
- It will give the science teacher the opportunity to think about the method to be used in the classroom.
- It will generate confidence in the science teacher.
- It will ensure adequate preparation in terms of looking for appropriate instructional aids in and outside the science laboratory.

ACTIVITY 3

1. What is a lesson plan?
2. Mention two usefulness of a lesson plan to a teacher.

THE LESSON NOTES IN SCIENCE TEACHING

Lesson notes emerge from lesson preparation. The lesson notes in science teaching contain information which indicates clearly what is going to happen during the course of a science lesson. It is difficult to pinpoint or say categorically that this is the best way or form of writing lesson notes. The form lesson notes take depends on the nature of the subject, the category of learners and the available resources, among other things.

In science curriculum, emphasis was on the use of discovery or inquiry method of teaching. So, whenever lesson notes are going to be prepared, it has to reflect the recommended teaching method.

Apart from the necessary activities of both the teacher and students that should be contained in the lesson notes, a good science lesson note should also contain the following features.

- **General information**: date, time of the day, the lesson to be taught, the class, the topics to be treated, the piece of apparatus to be used to make the lesson more understandable and the reference materials which may be textbook.
- **Objective**: - this is the most important part of the lesson because it sets the limit to the lesson and keeps the teacher from wondering away from the topic.
- **Previous knowledge**: this is the stage at which the teacher builds upon the knowledge the children have acquired previously in relation to the present lesson.
- **Introduction**: this is the stage when the teacher refers to and explores the children's experience, and interest and what they already know.
- **Presentation**: - this stage can be further divided into steps which may contain the subject matter/content, emphasizing the key facts, the method and the phases of the presentation, both teacher and students' activities and the use of instructional materials for illustrations.
- **Conclusion/summary**: - this is the part where the objective is finally nailed home.
- **Evaluation**: - here, the objective is tested and confirmed whether achieved or not.
- **Assignment**: - This is a follow-up stage for the lesson.

ACTIVITY 4

1. What are the features of a good science lesson note? Prepare one for discussion in the classroom.

SUMMARY

- Practicing how to teach can be simply referred to as "Microteaching"
- Microteaching is a laboratory training procedure geared towards simplification of the complexities of regular teaching/learning process.
- Some teaching skills that are capable of maximizing teaching effectiveness when utilized in teaching are:
  - set inductions
  - stimulus variation in the class
  - non-verbal communication
  - questioning
  - instructional media
  - reinforcement
  - closure
  - planned repetitions

- examples and illustrations

- Three components of science lessons are:
  - The lesson objective.
  - The teaching methods, materials, media, aids, learning experience and/or exercises and their organisation.
  - Evaluation procedure.
- Lesson notes emerge from lesson preparation.
- Lesson notes depend on the nature of the subject, the category of the learners and the available resources.

ASSIGNMENT

1. Differentiate between microteaching and peer-teaching.
2. What steps would you recommend for a student-teacher who is keenly interested in the acquisition of set induction skills?
3. Why is it necessary to emphasize the use of stimulus variation skills in the classroom?
4. Why does a teacher need to ask questions frequently from the students during a lesson?
5. At what stage in the lesson will you as a teacher bring in the use of instructional materials?
6. Explain how the use of reinforcement can be abused by a teacher in a classroom setting.
7. Differentiate between a lesson plan and lesson note.

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