SED 214: History & Philosophy of Integrated Science Education in Nigeria

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MODULE 1: HISTORY OF INTEGRATED SCIENCE

UNIT 1: CURRICULUM DEVELOPMENT ACTIVITIES

CONTENT

1.0 Introduction

In the search for new and innovative way of teaching an improved science concepts led to the invitation of Science Teachers' Association of Nigeria (STAN) by West African Examination Council (WAEC) to help revise and improve the science syllabuses for West African School Certificate (WASC) and Higher School Certificate (HSC) in 1968.

Also, the launching of Sputnik into space by Russia in 1957 resulted in innovations which began in the United States of America and the United Kingdom to sought for new ways to teach Science. Integrated Science was one of such innovative ideas and Nigeria was not left out in this quest.

In this unit therefore, an attempt will be made to discuss the innovations, reforms that took place over the years until Integrated Science.

2.0 Objectives

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

1. Explain the type of traditional education that was on ground as informal education in Nigeria.
2. Identify the various innovations and projects before Integrated Science came into the scene.
3. List the various projects initiated at different regions of Nigeria.
4. Mention the differences and similarities of General Science and Integrated Science

2.1 How to Study the Unit

1. This unit forms a general introduction to all others in the module.
2. Read carefully through the unit
3. Take special notice of new concepts and definitions.

4. You will need to search for other textbooks to collaborate what you have in this book.
5. There are many activities in this book, make sure you attempt all. The answers are at the back of the book.

3.0 Main Content

3.1 Agents of Change in Curriculum Development Activities

Science informally had been in existence in Nigeria when herbs had been used for food, medicine, dyes and poison for hunting games. Science had been taught through traditional education which had been knowledge transfer within a community or family long before the advent of Western and Islamic education in Nigeria (Aliyu, 1982). This informal way of transfer of knowledge, had its curriculum, methodology, organization and administration based on the beliefs, custom, principles and practices of the communities where it was practiced and differ slightly from community to community (Pemida, 2007). Some of these were listed by Prof. Awokoya in Aliyu (1982) which include:

i. Traditional Science and Speculation
ii. Traditional Technology and Production
iii. Traditional Language and Communication
iv. Traditional Aesthetics Studies and Assessment
v. Traditional Mathematics and Calculation
vi. Traditional Physical Education and Prowess

You can imagine the local method for the production of dyes, gin, black soap, herbal drinks, the blacksmith, etc. These are chemistry and technology in nature. The traditional way of calculating days, records of events by drawing with charcoal on the walls. All these and more were forms of Nigerian indigenous educational structure which were done informally and verbally from one generation to another.

By 1940s this type of education began to give way to modern science n formal settings. The history of science teaching had its roots in the primary schools where nature study, hygiene, agricultural science and domestic science featured prominently.

Generally, science emerged in the late 1930s and was offered at the primary school to the first two years in the secondary school even up to school leaving certificate level (Aliyu, 1982). Science teaching actually took off from here and had undergone several restructuring and modification over the years till 1968, when Integrated Science came into the scene. It s to be taught at the first two years of the then five year secondary school which is now three years tier of junior secondary level (JSS). This took effect when 6-3-3-4 system of education came to effect fully in the early 1980s and the name changed to Integrated Science.

By 2009, the nomenclature of Integrated Science once more changed to Basic Science when the policy of 9-3-4 came to been. It did not change the system on ground but a regrouping which made the first nine years of education compulsory and free for the Nigerian Child (FME, 2009). The Basic Science was broken to lower, middle and upper basic. Lower basic is from primary 1-3, middle basic – primary 4-6 while upper basic refers to Junior Secondary School 1-3.

3.2 Needs for Science Curriculum Development

Early in the year 1968, Science Teachers' Association of Nigeria (STAN) received a request from West African Examination Council (WAEC) to help revise and improve the Science Syllabuses for West African School Certificate (WASC) and Higher School Certificate (HSC) because of massive failure. STAN went into action immediately by setting up three National Executive Committees for Biology, Chemistry and Physics. Later the fourth committee was added to oversee that of Mathematics. The terms of reference for these committees were to:

i. Review and revise the existing Science and Mathematics syllabuses.
ii. Produce teachers and pupils materials relevant to the revised syllabuses.
iii. Perform such other functions connected with Science curriculum development as STAN executive may from time to time direct.
iv. Cooperate with any other Science Curriculum development groups to achieve these ends (Baja, 1982).

3.2.2 The reports and recommendations of the four committees brought about the new syllabuses and guidelines for their operations. Before this period, WASC and HSC syllabuses terminated with the final leaving school Examination organized and moderated by WAEC. In addition, there was great decline in their performances, which brought about the need for the invitation to STAN, for the search for a way to improve.

Therefore, the committees in the various sciences and Mathematics came up with the reports and recommendation for the way out. However, at one of the executive committee meetings, a member wanted to understand the foundation on which these new syllabuses for WASC and would be build. The answers generated to the question, led to the beginning of what became Nigerian Integrated Science Project (NISP).

Also, some members of STAN who had gone outside Nigeria to study discovered that the teaching of science had undergone great changes from head knowledge only to doing of Science. This happened after the launching of Sputnik by Russia into space in 1957. This triggered the overhauling of science curricula in all the great nations of the world like USA, UK, France and they though Nigeria should not be left out.

Assignment 1

1. Mention the seven traditional education system that existed as listed by Prof. Awokoya.
2. Distinguish between nature study and General Science

4.0 Summary

In this unit, you learnt about the invitation of STAN by WAEC to help review and revise the existing syllabuses for Science core subjects and the informal traditional Education in Nigeria. In addition, the terms of reference for the National Executive Committees to revise and improve the syllabuses were discussed.

5.0 References

Aliyu, A. (1982). *Science teaching in Nigeria*. Ilorin: Atoto Press Ltd.

Bajah, S.T. (1978). Meaning and philosophy of Integrated Science. *The Journal of Science Teachers' Association of Nigeria,* 16(2), 26-33.

Pemida, R.O. (2007). *African traditional education in Nigeria. Essentials of foundations of education*. Zaria: CPSE Publications.

UNIT 2: HISTORY OF INTEGRATED SCIENCE IN NIGERIA

1.0 Introduction

In this unit you will study about the various reforms and projects initiated before the emergence of Nigerian Integrated Science Project (NISP)

2.0 Objectives

By the end of this unit, you would be able to:

i. Name projects that were before NISP
ii. Relate the events that followed the launching of Sputnik in 1957
iii. Mention the aims of Nature Study
iv. Identify the needs and aspirations of science educators.

How to Study this Unit

1. Read carefully through the unit
2. Take special notice of new concepts and definitions.
3. Attempt all activities and assignments.

3.0 Content

3.1 Reforms Over the Years in Integrated Science

Reform means changes in the Science Curriculum over time in order to make it better for easy implementation. Nature study was one of the earliest formal science education curriculum which came up as the desire to study natural phenomena. In the nineteenth and twentieth centuries, Nature Study was a movement to study nature as expressed by many science educators in Europe, America and parts of Africa. The main aims and purpose for this move were to:

i. Improve the quality of life
ii. Improve the quality and quantity of farm produce
iii. Attract youths to farm. But it focused on the following objectives which were to:
    a. Teach and learn fact about nature
    b. Engage the learners appreciate God's creations or work based on scientific observations and experience.

c. Teach and learn moral derived from scientific observations

Nature study was a programme designed to provide knowledge in various fields of science but in reality, the content was majorly biological sciences and that of materials. This was largely because the specialists handling nature study in schools were biology teachers, who had little or no knowledge of both the chemical and physical sciences. In Africa and other parts of the world like Europe and America, Nature study was referred to as General Science, Rural Science or Hygiene based on the country and the curriculum adopted.

In Nigeria, Nature Study changed to Hygiene one time, then Rural Science, later Agricultural Science and Domestic Science and then Genera Science until 1968 when NISP was initiated in Ibadan (Bajah, 1983).

3.2 Launching of Sputnik in 1957 by Russia in USSR

The launching of the Russian Sputnik in 1957 marked the beginning of reforms in the science curriculum. The Americans ascribed the success of the Soviet Union in this space race to the nature of their science curriculum which America considered superior to theirs. This called for an overhaul of the science curricula in American school.

The reform embarked upon was not only in term of science content but also in the way and manner science should be taught.

Based on this scenario, the responsibility of developing curricula that could bring out the best from learners was assigned to seasoned American Psychologists, scientists and educators such as Glen Seaborg and Paul Linus. Some of the curricula that resulted included:

i. Biological Science Curriculum Study (BSCS)
ii. Physical Science Study Committee Course (PSSC)
iii. Chemical Bond Approach (CBA) and
iv. Chemical Study

At the same time the above listed curricula were been developed in USA, the Nuffield Curriculum Projects were also developed in United Kingdom (U.K). All these new projects came with strategies that allow for deeper understanding of scientific concepts and principles. The process approach and other teaching strategies that provide for individual difference in the learning process were sought for. These strategies also incorporated learners' practical activities and guided heurism, which were departure from the conventional methods used before. This yielded great results and new orientation to learning science. Nigeria and other parts of Africa were not left behind in seeking for new science curricula, which were result oriented than just memorizing fact, theories and laws of Science.

Assignment 2

1. Identify the curricula that sprouted up after the launching of 'Sputnik' in both USA and UK

4.0 Summary

The unit drew attention to the reforms that followed the launching of a suttle named 'Sputnik' in space by Russia in 1957. It highlighted the resulting curriculum projects all over the world which led to a new era of doing science rather than learning of facts only.

5.0 References

Atadoga, M.M. & Onaolapo, M.A. (2008). *A handbook on science teaching Method. Vol. 1.* Zaria: Shoal Press.

Bajah, S.T. (1993). *Teaching integrated science creatively*. Ibadan: Ibadan University Press.

UNIT 3: NIGERIAN INTEGRATED SCIENCE PROJECT (NISP)

1.0 Introduction

This unit explains how the outcome of the National Executive Committees for the review and revise of Science Syllabuses gave impetus to Nigerian Integrated Science Project (NISP).

2.0 Objectives

By the end of this unit, you will be able to:

1. State the reasons and needs for change to Integrated Science at the primary and secondary school.
2. Understand the objectives for teaching Integrated Science
3. Identify skills learnt in Integrated Science
4. Mention the integrating principles

How to Study this Unit

1. Read carefully through the unit
2. Take special notice of new concepts and definitions.
3. Attempt all activities and assignments.

3.0 Content

3.1 Curriculum Development Newsletter No. 1

The communiqué at the end of several meetings brought about what was contained in Curriculum Development Newsletter No. 1 in 1970. It contained the statement of philosophy, methodology, course content and methods of evaluation of Integrated Science course. The issues of integration in science were also provided which were intended to produce among other things a course which:

i. Is relevant to the learners' needs and experiences
ii. Stresses the fundamental unity of science
iii. Lays adequate foundations for future specialist careers in science and technology and
iv. Adds a cultural dimension to Science Education.

3.2 Objectives for the Teaching of Integrated Science

The Newsletter No. 1 spelt out the specific skills desirable for learners of Integrated Science who follow the NISP. These include the ability to:

i. Observe carefully and thoroughly
ii. Report completely and accurately what is observed
iii. Organize information acquired from observation
iv. Make generalization based on acquired information
v. Predict according to the generalization made
vi. Design experiments to check prediction with control.
vii. Use models to explain natural phenomena where necessary.
viii. Continue the process of inquiry when new data do not conform to prediction.

Also, the document specified that the child-centred approach should be employed in order to stress the importance it was suggested that the following three strategies should be used which are:

a. Use of discovery teaching strategies
b. Inclusion of problem solving activities.
c. The involvement of learners in open-ended laboratory exercises.

3.3 Skills Acquisition in Integrated Science

In the learning of Integrated Science, there are three types of skills that the learners can acquire which are:

a. Process skills such as observing, measuring, collecting, sorting, recording, reporting, analyzing, predicting, etc.
b. Manipulative skills which include: drawing, cutting, coupling, dissecting, fitting equipments, painting, fixing, etc.
c. Social skills such as: socializing, relating, cooperating, sharing etc.

All these skills are easily acquired during the learning of Integrated Science when strategies which are child-centred and full of activities are employed. Learners are grouped together, which draws them together and closer. Skills for manipulation can be developed when they are allowed to carry out simple laboratory exercises and outdoor activities.

Activity 1

1. Go outside and pick things you can see around your home. Sort out these into living and non-living things. Base your classification on whether they can move or not.
2. Identify the type of skills you require for this activity.

4.0 Summary

- You were able to learn the reasons for teaching Integrated Science and to identify the type of skills that can be acquired.

- In the unit, you could trace the origin of NISP to the National Executive Committee Set up by STAN

5.0 Reference

Atadoga, M.M. & Onaolapo, M.A.O. (2008). *A handbook on science teaching Methods.* Zaria: Shola Press.

Bajah, S.T. (1983). *Teaching integrated science creatively*. Ibadan:Ibadan University Press.

Federal Ministry of Education (2013). *National policy on education*. Lagos: Federal Government Press.

UNIT 4: DEFINITIONS AND CHARACTERISTICS OF INTEGRATED SCIENCE

1.0 Introduction

Various Science Educators had defined integrated Science and in this unit; you will discover that several people had attempted to do justice to it. From these definitions, the different features are but together as the characteristic features of it.

2.0 Objectives

By the end of this unit, you would be able to:

i. List the various characteristics of Integrated Science
ii. Define Integrated Science using your own word.
iii. Understand the opinions of various educators about Integrated Science
iv. Compare Integrated Science and General Science

How to Study this Unit

1. Read carefully through the unit
2. Take special notice of new concepts and definitions.
3. Attempt all activities and assignments.
4. Try to identify some scientific attitudes you posses.

3.0 Content

3.1 What is Integrated Science?

Integrated Science as an interdisciplinary curriculum deals with the different methods to the teaching and learning of Science in the following ways which cover the aspects of:

a. Fundamental unity of scientific thoughts;
b. Strategies and processes of scientific enterprise and;
c. Scientific knowledge of the environment of the learners.

Integrated Science therefore, covers all areas of science cutting across subject boundaries and includes all areas leading to meaningful understanding of the chemical, and physical science, the material world and technology.

Various science educators attempted to define Integrated Science thereby given different interpretations. Some of these would be considered and out of them the features of Integrated Science which make it unique would be identified. They include:

D'Arbon (1972) who stated that integration when applied to Science, produces a course which "Eliminates the repetitions of subject matter from the various sciences and does not recognize the traditional subject boundaries when presenting topics or theme"

Howell (1970) wrote that Integrated Science is "the essence of a beginning course to teach learners what science is and how a scientist works". He regarded Integrated Science as some forms of unified science.

Khabele (1975) on his part, drew attention to the UNESCO publication in which Integrated Science was defined as "and approach to the teaching of science in which concepts and principles are presented so as to express the fundamental unity of scientific thoughts and avoid premature or undue stress on the distinctions between the various scientific fields".

3.2 Characteristic Features of Integrated Science

Looking critically at the various definitions, you can identify some special features which are:

From D'Arbon:
Integrated science as a course:

i. Eliminate the repetition of subject matter from the various sciences.
ii. Does not recognize the traditional subject boundaries.
iii. Topics are presented as themes

Howell's definition shows that the course is
iv. a beginning course
v. teaches learners what science is and;
vi. how scientists works.

While Khabele pointed out that the course is:
vii. an approach to the teaching of science
viii. it presents concepts and principles so as to express the fundamental unity of scientific thoughts
ix. it avoids premature stress on the distinction between the various fields

From the different definitions, you can see that the several sciences are characterized by a common methodology and their contents represent a WHOLE becoming more meaningful when interrelated.

Therefore, integration can be seen as "the removal of boundaries between subjects to produce a course that is more solid and has an entirely different identify of its own".

Assignment

1. If Integrated Science is an approach to the teaching of science concepts and principles, how best should it be presented to learners?

4.0 Summary

From the unit, we learnt the various definitions and out of them, the unique character of Integrated Science was identified.

5.0 References

Atadoga, M.M. & Onaolapo, M.A.O. (2008). *A handbook on science teaching Methods.* Zaria: Shola Press.

Bajah, S.T. (1983). *Teaching integrated science creatively*. Ibadan: Ibadan University Press.

UNIT 5: NATURE AND PHILOSOPHY OF INTEGRATED SCIENCE

1.0 Introduction

In previous units, you had learnt about the various forms and projects that existed before Integrated Science surfaced. Reasons been that there had not yet found a satisfying curriculum that will create the science that will bring out the best in the Nigerian child. In the National Policy on Education, the Federal Government expressed their desire on laying solid foundation for technology development. The Federal Government of Nigeria derived the philosophy of Integrated Science from the National Policy on Education (FME, 2013). Therefore, this unit will look at the views of Science Educators and the Federal Government.

2.0 Objectives

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

1. State the philosophy and nature of Integrated Science
2. Explain the view of National Policy on Education on Integrated Science
3. Enumerate the difference and similarities between general Science and Integrated Science.

How to Study this Unit

1. Read carefully through the unit
2. Take special notice of new concepts and definitions.
3. Attempt all activities and assignments.

3.0 Main Content

3.1 Philosophy and Nature of Integrated Science

The nature, philosophy and objectives of Integrated Science as stated in the Curriculum Development Newsletter No. 1 of STAN were in tune with that of the National Policy on Education which are expected to:

i. Prepare the children to become useful to themselves and their society and,
ii. Prepare children for higher education.

Secondary education should be able to:

a. Provide an increasing number of primary pupils with the opportunities for education of higher quality irrespective of sex or social, religion and ethnic background.
b. Diversify its curriculum to cater for differences in talents, opportunities and roles possess or open to students after secondary school.
c. Equipping students to live effectively in the modern age of science and technology.
d. Raise a generation of people who can think for themselves, respect, appreciate values, and live peaceably as good citizens (Ereuba, 1990).

Integrated Science as a foundational course at the primary and junior secondary schools should be properly taught to achieve the above aims. Therefore, Integrated Science as such should be introduced to learners with care and accuracy to teach what Science is all about and how scientists work. Children at this stage are curious, inquisitive and malleable. With ease, learners will be carried along if the appropriate strategies and activities are used to teach.

3.2 Objectives for Teaching Integrated Science

Projects and curriculum reforms in science education had been efforts to teach science in such a way as to increase scientific literacy in Nigeria. It was also geared toward becoming technological develop Integrated Science as a curriculum was a welcome development to attaining the set aims and objectives of a national yearn toward scientific advancement. When Sputnik was launched, there were global overhaul of science curricula from mere learning and memorizing of the laws and principles of science to doing science and enjoying its benefits.

Activity 4
Can you list out some of the benefits of science in and around you?
Imaging what life would have been without such benefits.

3.2.1 Some Objectives for Teaching Integrated Science

The major worldwide shift in emphasis in the teaching of science in the 60s led to the review of the science taught in Nigerian schools.

This led to STAN's review and revise of biology, chemistry, physics syllabuses of WAEC, which brought about the 'birth' of Nigerian Integrated Science Project (NISP).

It was to be taught as outlined by the National Policy on Education for Science Education. In conformity with the Nation's Philosophy, the objectives for Integrated Science therefore, are to:

i. Teach students how to tackle some of the questions that arise from observations of the environment.
ii. Sharpen the powers of the student
iii. Direct the attention of students towards matters, which are of significant to them, and to the society where they live.
iv. Continue the process of science concept building for acquiring science vocabulary, not only by definition but by experience.
v. Prepare the students for a take off into the exciting world of science later in their school careers.

The teaching of Integrated Science in Nigeria followed the USA process Approach Curriculum which emerged as innovations for building scientists. Nigeria Educational Research council adopted this same for developing new programmes in late 60s. The process curriculum inculcates into the young learners the science process skills, which outlined the way scientists works. By so doing, learners of Integrated Science acquire these skills.

Activity 5

1. Fill a beaker with water half way full.
2. Measure and record the volume of the water
3. Drop an Irish Potato inside
4. Measure and record the new level of water
5. Subtract first measurement from the one after dropping the Irish Potato.
6. Give a simple explanation to what happened with the volume of water. This serves to illustrate how scientists work.

3.3 General Science and Integrated Science

General science as seen in earlier units as the subject offered up to school certificate level as the only form of science. It was from it that science teaching in Nigeria took off and it had undergone several reforms to become what is known as Integrated Science today taught in the first nine years of the educational system. What differentiates general Science and Integrated Science can be seen in their characteristics as tabulated in Table 1.

Table 1: Comparison of General Science and Integrated Science

General Science	Integrated Science
1. Individual subject can be identified in compartments	The traditional science subject boundaries eliminated
2. Course does not have objectives stated	Course is taught towards the realization of certain definite learning outcomes
3. It has no logical sequence	Logical sequencing of them/concept discernible
4. No unifying theme	There are unifying themes around which concepts are treated
5. Contains no activities which make students only passive learners	Lots of activities which makes students actively involved as learners.
6. Teacher-centred methods which makes the teachers the ultimate	Teacher serves as facilitator and resource person who guides the class through meaningful interactions
7. Duplication of topics unavoidably in some cases e.g. electrolysis	It avoids duplication of content

Assignment 5

Identify five reasons for the teaching of Integrated Science in the Nigerian schools.

4.0 Summary

Highlighted in this unit, were the philosophy and nature of Integrated Science and the National Policy on Education objectives for Integration.

The difference between general science and Integrated Science were also learnt. Also the type of skills that are intended for learners of Integrated Science were mentioned.

5.0 References

Atadoga, M.M. & Onaolapo, M.A.O. (2008). *A handbook on science teaching Methods.* Zaria: Shola Press.

Bajah, S.T. (1983). *Teaching integrated science creatively*. Ibadan: Ibadan University Press.

UNIT 6: INTEGRATED SCIENCE AND THEMES

1.0 Introduction

In learning science under the process approach or any other strategy that is learner-centred, students must try to practice how the scientist works in his effort to acquire knowledge. Scientists use some skills and behave in a way that makes him calm and in the right frame of mind in order to bring his thoughts together. Also in this unit, you will understand the reasons why Integrated Science is a core curriculum and why in themes.

2.0 Objectives

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

i. Understand why integrated science is a core curriculum.
ii. Identify the themes of integrated science
iii. State the reasons why integrated science is a core curriculum
iv. Mention some scientific attitudes.

How to Study this Unit

1 Read carefully through the unit
2 Take special notice of new concepts and definitions.
3 Attempt all activities and assignments.
4 Try to identify some scientific attitudes you posses.

How to Study this Unit

1. Read carefully through the unit
2. Take special notice of new concepts and definitions.
3. Attempt all activities and assignments.

3.0 Main Content

3.1 Integrated Science as a Core Curriculum

When the Federal Government decided to adopt a National Policy on Education and one of the decisions was the 3-3 system of secondary education. There was an urgent need then to design core content curriculum for various subjects at the two levels of the secondary education. One of such subjects was Integrated Science.

To do this, the Federal Government commissioned some science educators to produce the draft curriculum, which, went through critique during a National Critique Workshop. Participants of this workshop included:

1. 2 participants from all State Ministries of Education one from State Ministry of Education and the other a classroom teacher with experience in Integrated Science.
2. One participant each from selected institutes and Colleges of Education in the Country.
3. Officers of the Federal Ministry of Education representing the Inspectorate, Schools and Educational Services Divisions.
4. Core group of Science Educators who had prepared the draft curriculum.

The product of this workshop is the core content curriculum of Integrated Science, which was presented to the Joint Consultative Committee on Education for review and was later submitted for approval by the National Council on Education.

The core curriculum for Integrated Science attempted at presenting topics, objectives, content and the activities in a particular structured teaching manner. The core curriculum thereby forms a such of guideline to the teaching of Integrated Science and it was developed to take care of the first three year of secondary education capable of preparing students for the exiting world of science at higher levels of education.

These learning experiences were set out under the following six themes:

Theme 1: You as a living thing
Theme 2: You and your home
Theme 3: Living components of the environment
Theme 4: Non-living components of the environment
Theme 5: Saving your energy
Theme 6: Controlling the environment

From these themes, you can see how the core curriculum is an attempt to present Integrated Science as a functional science showing how the world works.

For this to work, depends largely on the classroom teacher who has the great role of making Integrated Science both relevant and attractive to the learners.

Activity

i. Why is Integrated Science a core curriculum at the first three years of secondary education?
ii. Identify those that first made the draft core curriculum for Integrated Science

3.3 Scientific Activities and Integrated Science

In science, while we teach knowledge and skills, the realm of affective domain is not left out. Attitude just like interest and values forms part of affective domain. All what had been learnt in this module will help you put the processes in good perspective in future usage. When the learners use process skills, they appreciate how a scientist works and how they discover in science new information.

Attitude relate to the emotional aspect of a personality. It is the feeling and thinking of a person's mind which he holds towards an idea or an occurrence. When this relates to science, it is called scientific attitude.

It is an attribute of a scientist and is usually displayed while carrying out the processes of science. You can see that a kind of relationship exist between the processes and scientific attitudes when learning science. The way and manner scientific enterprise is carried on gives rise to scientific attitudes. Science as a way of finding out has gotten its own procedures, beliefs and ethical standards and as a scientist conduct his activities, he must exhibit a behaviour that conforms with these beliefs, ethics and he must follow scientific procedures. These behaviours are what is referred to as scientific attitudes.

Some of these attitudes display by scientist while working include:

Curiosity
Objectivity
Open-mindedness
Honesty
Humility
Empiricism
Skepticism
Parsimony etc.

Any student who is learning must also cultivate these attitudes if he is to learn science well and understand the way scientists works.

Let us briefly learn more about these attitudes and what they entail.

Curiosity

Before any scientist starts on a project, he must have been curiosity about that relationship or phenomenon. So he becomes eager to find out about that phenomenon. The urge to find out is what is called curiosity, Examples, if you wake up one morning

to find many insects among the flowers planted around your home, you would want to investigate the cause; that is curiosity.

Open-Mindedness
Scientists carry out investigations in science without personal bias or prejudice. The results of his investigations are never predetermined.

He is objective about the outcome of his investigation. Just as you investigated about the insects in your home, were based on only what you observed and your conclusions was not biased.

Empiricism
This is finding out by doing. The products of science such as laws, results, conclusions, theories etc were arrived at based on evidence gotten directly or indirectly from experiments.

During investigation, students are encouraged to record their observations and results correctly and accurately.

Scepticism
In the work of the scientist, the result gotten and the generalization made are held as tentative truth. In science, there are no absolute, permanent or final truth, as current results are held until further evidence indicating otherwise are obtained.

Parsimony
In explaining a phenomenon, the least complex or accurate model is usually taken. It can be said that simplicity is preferred than complexity.

3.4 Basic Science Curriculum and Objectives

With the Federal Government's decision to introduce the 9 years Basic Education, the existing curricula for primary and junior secondary school were reviewed and re-structured. With the review, what we have now is Basic Science. The new basic science curricula was to start simultaneously in primary Lower Basic 1 (Primary 1) and Upper Basic1 (or JSS 1) classes by September 2007, such that by June 2010 the old JSS curricula would have been phased out and by 2015 the old primary curricula would have been phased out.

Its implementation was to start in 2008. However, by 2010 most schools are yet to start the implementation of the curriculum. The new curriculum is almost the same with the old integrated science curriculum, except for the following new themes that were infused into it:

1. Environmental education
2. Drug abuse education
3. Population and family life education

4. Sexually transmitted infection (STI) including HIV/AIDS (FGN, 2006).

Integrated Science has six themes while Basic Science has four (Duguryil, 2012). You and the environment in the basic science takes the place of you as a living thing, and controlling the environment in integrated science. Living and non-living things in basic science takes the place of living components of the environment and non-living components of the environment while you and energy takes the place of saving your energy. You, technology/science, and development in basic science take the place of controlling your environment in integrated science. With the exception of the newly infused topics, the basic science curriculum content is the same with that of integrated science.

In selecting the contents, three major issues, which are considered to shape the development of nations worldwide and influence the world of knowledge today, were identified. These are globalization, Information and Communication Technology (ICT) and Entrepreneurship Education.

The overall objectives of this curriculum are to enable learners to:

1. Develop interest in science and technology
2. Acquire basic knowledge and skills in science and technology
3. Apply their scientific and technological knowledge an skills to meet societal needs
4. Take advantage of the numerous career opportunities offered by science and technology
5. Become prepared for further studies in science and technology

In order to achieve the stated objectives, the thematic approach to content organisation was adopted. Hence, four themes covered knowledge, skills and attitudinal requirements. These are;

1. You and Environment
2. Living and non-living things
3. You and technology
4. You and Energy

At the upper basic level however, theme 3 “you and technology” was changed to “science and development”. The topics under each theme were sequenced in a spiral form beginning with the simple to the complex across the 9- years of basic education.

The question then is how are the objectives of integrated science different from that of basic science? Table1 is a comparison of the objectives of integrated science and basic science.

Table 1

The objectives of Integrated Science and Basic Science Curricula for Upper Basic School

Objective	Integrated science	Basic science
Why the curriculum	Adoption of 6334 system	Continuation of 6334 system and the introduction of the universal basic education
Source of the curriculum	Global shift in science technology	Millennium development goals (MDG's) and national economic empowerment and development strategies (NEEDS)
Basic objectives of the curriculum	1. Observing carefully and thoroughly. 2. Reporting completely and accurately what is observed. 3. Organizing information acquired 4. Generalizing on the basis of acquired information 5. Predicting as a result of the generalization 6. Designing experiments (including controls where necessary to check prediction). 7. Using models to explain phenomena where appropriate 8. Continuing the process of inquiring when new data do not conform to predictions	1. Develop interest in science and technology 2. Acquire basic knowledge and skills in science and technology 3. Apply their scientific and technological knowledge and skills to meet societal needs. 4. Take advantage of the numerous opportunities offered by science and technology 5. Become prepared for further studies in science and technology
Structure	**Thematic**	**Thematic**
philosophical foundation	The child is scientific and should be exposed to science activity	The child should be made to develop self and society
Psychology foundation	Involve discovery learning problem solving, open ended and open laboratory exercise	Use of guided inquiring method of teaching and learning
Sociological foundation	The prevailing socio economic factors in Nigeria	Globalization information/communication technology and entrepreneurship

Source: Dung and Nsikak-Abasi, 2010 in Duguryil 2012

From Table 1 integrated science and basic science curriculum seem to have much in common; however, the basic science curriculum under sociological foundation is specific on globalisation, ICT and entrepreneurship while the integrated science curriculum is on the prevailing socio economic factors in Nigeria. In the area of methodology, the basic science curriculum emphasises a shift to inquiry method as against the discovery and problem solving in integrated science. Some integrated science process skills are also missing in the basic science. The integrated science

curriculum has well-stated philosophy which is missing in the basic science curriculum.

Activity

1. Recall the activity on the observation of insect around your home as related under the scientific attitude of curiosity. List out other scientific attitudes required and how?
2. List five scientific attitudes you have learnt.
3. What is the commonest science process skill you use often

4.0 Summary

You learnt in this unit that:
Some Science Educators commissioned by the Federal Government designed the core content curriculum for Integrated Science.

The draft curriculum was critiqued during a national critique workshop by all stakeholders in education.

The content of the core curriculum for Integrated Science Attempted at presenting the subject in a particular structured teaching manner. Science process skills and attitudes are procedures and ways of a scientist must possess to arrive at his results and conclusions. In addition, that these attitudes and skills are what you use every day.

Assignment

1. What do you understand by scientific attitude?
2. Take block of ice and place it on a plate. Record what happen after ten minutes.
   Remove the ice block and put it in a pot on fire, record your observation after ten minutes.
   Identify what process skills and attitudes used in carrying out this simple experiment
3. What are the basic differences and similarities between Integrated Science curriculum and the current Basic education curriculum in terms of the themes, nomenclature, organization/structure and objectives?

References

Atadoga, M.M. & Onaolapo, M.P.O. (2008). *A handbook on science teaching method.* Vol. 1. Zaria: Shola Press.

Bajah, S.T. (1983). *Teaching integrated science creatively*. Ibadan: Ibadan University Press.

Duguryil, P. A. (2012). *Effect of cognitive reasoning ability and exposure to content on Junior Secondary School two students' achievement and retention in Integrated Science*. PhD Thesis in the Department of Curriculum and Teaching, Benue State University, Makurdi.

Federal Republic of Nigeria (2006*).Universal Basic Education Commission. Universal Basic Education Programme. A flag tip programme of the Federal Government of Nigeria* Abuja: Federal Government Publication

UNIT 7: CONCEPT OF INTEGRATION

CONTENT

1.0 Introduction

In this unit you will learn about science curriculum project of an integrated nature which is a presumption that the whole universe is a piece. Moreover, that everything and anything can be restructured for instructional purpose in science.

You will learn on how to break down the themes in Integrated Science to modules, which are the unit of learning where the subject boundaries had been phased out.

2.0 Objectives

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

i. identify the relationship between theme, modules and units
ii. explain the modules that are contained in a theme.
iii. define integration in your own words and understanding.

How to Study this Unit

1. Read carefully and thoroughly through the unit
2. Study and understand the figures in the unit
3. Make careful observations as you carry out the activities and assignment.
4. You will require a set of Integrated Science textbooks to check through as you study this unit.

3.0 Main Content

3.1 The Concept of Integration

Integration you learnt earlier in this module is that the learning experience where the subject boundaries are phased out. Where science is studied as a whole in such a way that students gain the concept of the fundamental unit of science.

The integrating principles therefore, are intended to produce a course which:

i. Relevant to students' needs and experiences,
ii. Stresses the fundamental unity of science
iii. Lays adequate foundations for future careers in specialists study and
iv. Adds a cultural dimension to science education.

Integrated Science has been offered as a way to:

i. increase scientific literacy,
ii. understand the processes of science
iii. increase interest in science
iv. meet learner's needs
v. maintain flexibility and
vi. show the relationship of science and society.

The goals and objectives of Integrated Science as mentioned above, are different from those of Chemistry, biology and physics. The major aim of Integrated Science is to expose everyone to the exciting world of science in its simplest form thereby making everyone scientific literate.

Integrations is necessitated by the fact that the universe is not differentiated into compartments but viewed as a whole. Integration help to minimize premature stress on any distinctive discipline. It also emphasizes the science process skills in which scientists are continuously engaged in search for explanation and order in the universe.

By integration, Integrated Science is presented to non-specialists in simple form and provides satisfaction to young curious learners whose logic differ from that of single subject disciplines.

Activity
What do you understand by the concept "Integration"? List out the aims of teaching Integrated Science.

3.2 Themes and Scheme of Work

In Unit 5, we had learnt and Integrated Science and themes. Integrated Science emphasizes the organization of learning experiences around a theme. It is this unification of concepts around a theme that makes it unique. In the Curriculum Development Newsletter No 1 which contains the philosophy of STAN Integrated Science, the learning experiences and concepts are organized around four themes: Energy, Life, matter and society.

The organization of concepts around common themes is a successful way of consciously removing the subject matter boundaries. The theme makes Integrated Science to have its own unique characteristics which are unifying.

This general theme now forms the basis of building up of modules. A module can be defined as a learning package where there can be the interplay of ideas from biology, chemistry and physics relating to a central theme in the module.

Each module deals with a theme and can have other sub-concepts. A teacher teaching a module will find it difficult to isolate certain areas belonging to one discipline.

The following figures show the development of modules from the four themes: Life, Energy, Matter and Society.

A.

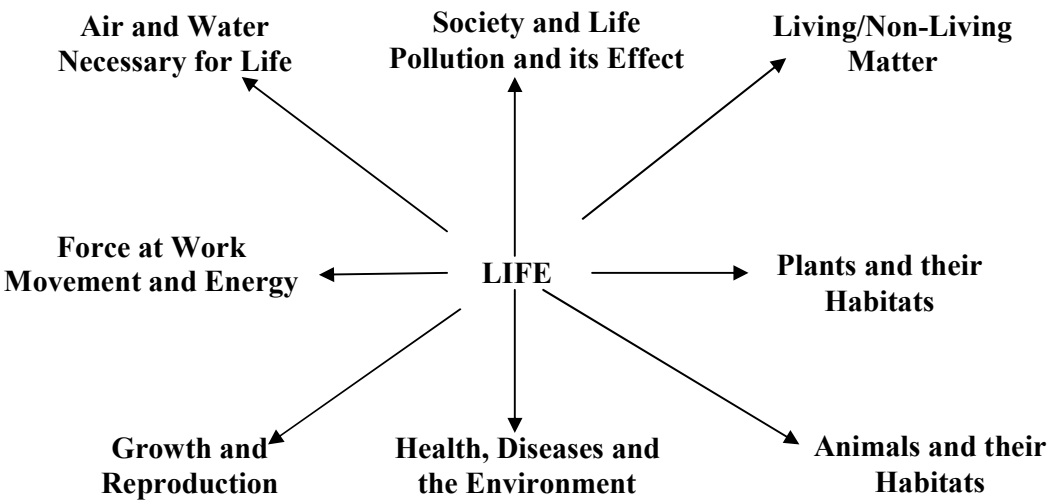


Fig 1: Modules on Life

B.

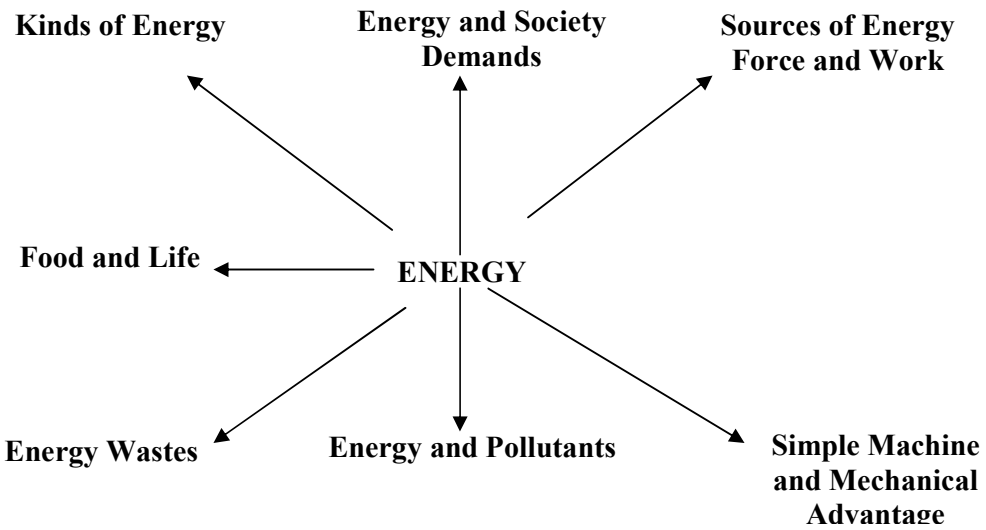


Figure 2: Modules on Energy

C.

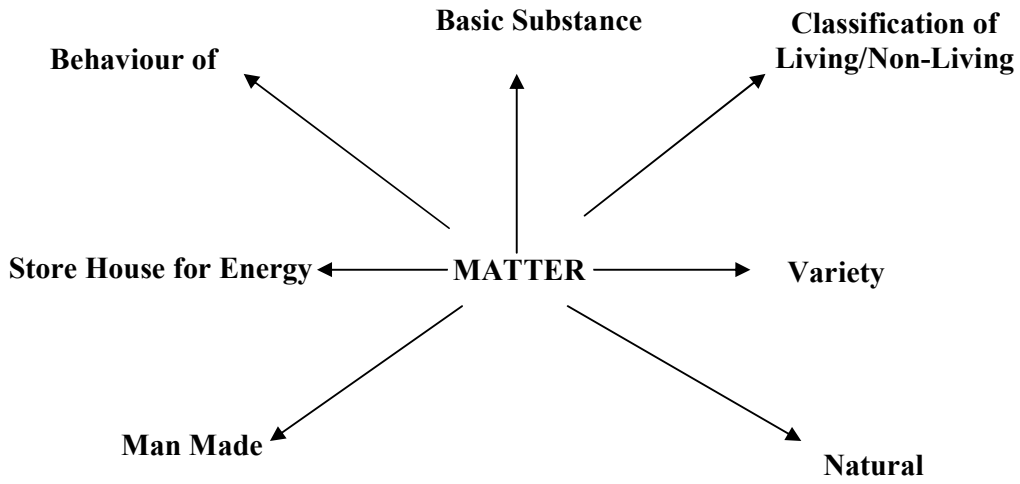


Fig. 3:Module on Matter

D.

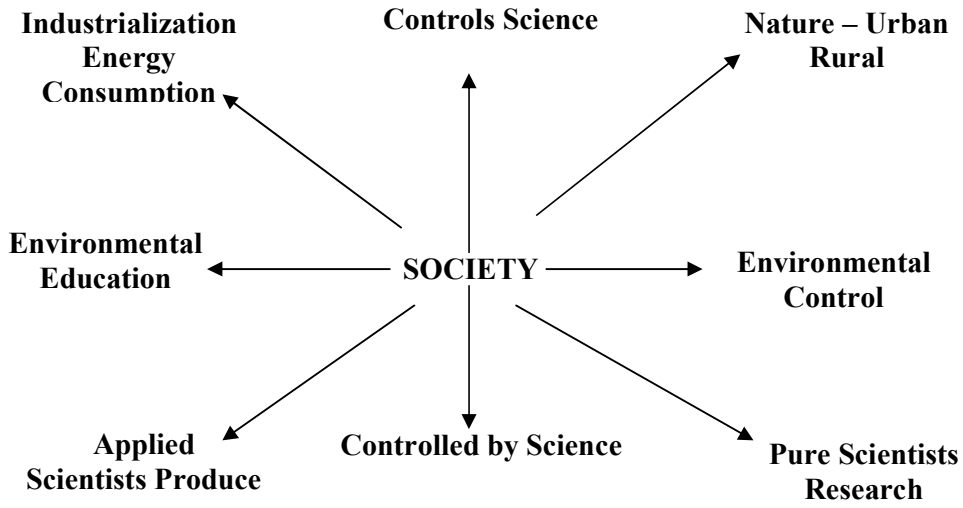


Fig 4: Module on Society

From the figures (1-4) a module can be seen as a biology component because life can be only seen from the perspective of biology. In this scheme of nature, the relationship between science and society is apparent. Therefore, for teachers of

Integrated Science, it must be seen as a discipline of its own requirements. Integrated Science must be taught using activity-based approaches, which must inculcate process skills and scientific attitudes into the learners. It must also be learner-centred. Learners must be seen doing science as scientists do.

Activity

1. Suggest some modules from the four major themes of Integrated Science
2. Identify some modules that still carry the characteristic features of physics and explain why this is so.

4.0 Summary

- You learnt in this unit the concept of integration and how this makes Integrated Science unique in its own way. The integration principles and objectives of Integrated Science were also highlighted.

- In the unit you learnt how STAN came up with four themes and how each can be broken down to modules for each learning experiences in which subject matter boundaries had been eliminated.

Assignment

1. Identify the four STAN themes of Integrated Science
2. Pick one of these themes and break it into modules

5.0 Reference

Bajah, S.T. (1983). *Teaching integrated science creatively*. Ibadan: Ibadan University Press.

UNIT 8: PREPARING FOR INTEGRATED SCIENCE TEACHING

CONTENT

1.0 Introduction

In this unit, you will learn how to prepare to enter the classroom to teach. The factors to consider before planning for your lesson, which will include; what unit or topic to be covered, age of the learners, class etc. The instructional teaching materials available to you and duration of the lessons.

2.0 Objectives

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

i. arrange the number of course units for the class your are teaching
ii. identify the ingredients of a good lesson plan
iii. write the behavioural objectives
iv. determine the appropriate instructional materials to use

How to Study this Unit

1. Read the unit carefully.
2. Learn new concepts and terminologies
3. Identify the whole idea of preparing for teaching
4. Carryout the whole idea of preparing for teaching
5. Carry out the activities and assignment

3.0 Main Content

3.1 Choosing what to Teach (Content)

In any educational setting, there must be a curriculum, which is a progrmme, designed to provide planned and guide learning experience to a particular group. And a curriculum has to be for a particular function and has four interrelated components (Kerr, 1968). These are;

i. What is the end product of instruction – 'objectives'?
ii. What is studied – 'the content or subject matter' of instruction?
iii. How are the study and teaching done – 'methodology' of instruction?

iv. How the results of teaching are assessed – 'evaluation'?

These four components influence the others as shown in Fig 1.

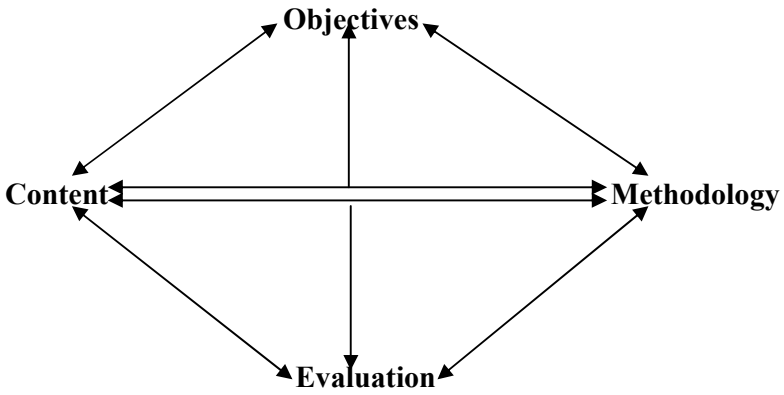


Fig. 1: Interrelated Components of Curriculum

The meaning of the diagram in Fig. 1 is that the objectives determine the selection of content, while the methodology adopted for instruction is based on the content, the objectives set and the type of evaluation needed.

The contents of the curriculum are influenced by:

a. Changes in the society
b. New innovations in academic discipline
c. Needs of the learners
d. The general purpose of education
e. Learning theories and
f. Research results and current innovations

The curriculum differs from discipline to discipline and from level to level. For instance, the curriculum for Integrated Science is not the same with that of English while that of primary school differ from that of secondary level and so on.

3.2 Integrated Science Syllabus

Syllabus is a guide to academic work designed for a particular level of learners in a given period usually, for a year or in a term. It is the general outline of units or topics in a subject arranged in a logical manner meant for coverage within that period. It is meant to be geared towards passing an examination e.g. National Common Entrance Examination or secondary School Examination, etc.

There can be a teaching syllabus and an examination syllabus. WAEC's syllabus indicates topics to be covered without arranging the content in order while teaching syllabus is an outline of the work planned to be carried out in a course of term or one

year in each class in each subject. Unlike examination syllabus, the topics are arranged in a logical sequence for every class and subjects.

In the most effective teaching syllabus spells out:

1. What topics to cover with a specified period
2. The scope or depth of coverage
3. The sequence of treatment indicating the units or topics which will require more time than others.
4. Guidelines for method of instruction
5. Reference and materials needed for each unit or topics.

3.3 Scheme of Work for an Integrated Science Course

A scheme of work is drawn up to facilitate the coverage of syllabus. The scheme of work contains what the teacher will cover in each week of the academic year. The syllabus is fist divided into three terms of the academic year, which the scheme is divided into the number of weeks in the term. The scheme can be revised from time to time according to the progress of the learners.

The syllabus and scheme of work are guides to learning activities and the way things should run. The scheme of work shows the units or topics to be covered within a stipulated time. To draw a scheme from a syllabus, the following have to be put into consideration of the:

1. Need for logical sequence
2. Age, ability range and previous knowledge of learners
3. Amount of time required by each topic
4. Scheme should be prepared in line with the number of effective weeks of learning in a term or year.
5. Number of science period per week including practical periods.
6. Resource and materials for each topic.

Therefore, scheme of work is handy for science teachers because it fulfills the following functions:

a. It directs attention to major topics of the course
b. It facilitate careful and meaningful planning on the part of the teachers
c. It allows for greater flexibility in the implementation of a course syllabus.

Activity

1. What are the difference between syllabus and scheme of work?
2. Identify the types of syllabus in education.

4.0 Summary

In this unit you learnt about syllabus and scheme of work. The types of syllabus that are in operation. Factors and functions for scheme of work. Also the factors you borne in mind when drawing a scheme of work were treated. You are now ready to teach!

Assignment

1. List out what to bear in mind when drawing out your scheme of work for the year.
2. In a diagram, illustrate the interrelations among the four components of curriculum

References

Abdullahi, A. (1982). *Science teaching in Nigeria*. Ilorin: Atoto Press Ltd.

Dienye, N.E. & Gbamanja, S.P.T. (1990). *Science education theory and practice*. Zaria: Totan Publishers Ltd.

UNIT 9: LESSON PLAN IN INTEGRATED SCIENCE

CONTENT

1.0 Introduction

In this unit, you will learn about planning by choosing units from the scheme of work. Stating the lesson objectives and choosing the methods to achieve the set objectives. You will learn also how to write lesson plans.

2.0 Objectives

By the end of this unit, you should learn how to:

i. Identify the different types of objectives
ii. Choose the appropriate strategy or methods
iii. Identify a lesson plan that is good.
iv. Determine instructional materials that will meet the method chosen.

How to Study this Unit

1. Read thoroughly through the unit.
2. Carefully study each section and understand the main concepts.
3. Go over new concepts and try to generate your own.

3.0 Main Content

3.1 Planning to Teach Integrated Science

As an Integrated Science teacher, you must prepare the entire lesson to be taught. You must sustain the classroom dialogue with researched pieces of information. Therefore, to prepare a lesson properly, you must:

1. State the goals the lessons which are broad statements of intentions (what you want to do)
2. Breakdown this goal or aim into “behavioural objectives”. Objectives as used here more specific than goals. Active verbs that convey clear observable behaviors are used. E.g.

"By the end of this lesson, the students should be able to:
i. **Define** science in their own words
ii. **Extract** chlorophyll from green leaves
iii. **Determine** the average weight of the boys in the class
iv. **Measure** the numbers of bottles of oil in a 4 litre jerrycan.

3. Plan how you will start the lesson (introduction which should be able to arose the curiosity and interest of the learners to the new topic or unit.
4. What assumed knowledge do you expect the students to have relating to the topic/unit at hand?
5. Identify which activities will be carried out during the lesson that will best illustrate your points?
6. On the chalkboard, sequence the major points you intend the students to take away.
7. Assess the students by asking questions that are connected with the objectives set for the lesson.
8. End the lesson by going over the major points and allow the students to ask questions.

A lesson plan is an overall schematic representative of a lesson which covers a period of time which may be weekly or monthly. In most schools, lesson plans are supervised by senior master academics or other superior officers in the school. Whereas, a lesson note is a detailed day-to-day learning activity or you can say it is the teacher's detailed preparation containing the activities for the lesson.

3.2.1 Stating Lesson Objectives

After choosing a topic/unit for the lesson, the teacher states in measurable terms his/her expected behavioural changes are expressed using verbs like: perform, demonstrate, state, identify, measure, dissect, etc. Well-stated objectives have the following advantages;

1. Assist the teacher determines the appropriate teaching strategy to adopt for the effective lesson delivery.
2. Help the teacher to identify the scope to cover, so as to work within such.
3. Help the teacher determine the teaching learning materials require for the lesson.
4. Assist in purposeful learning and help the teacher to manage his/her time well.
5. Help the teacher determine the effectiveness of his/her objectives and the level of his/her attainment through the level of achievement by the students.

A well-planned lesson will help in developing appropriate lesson for various levels and ages.
The three domains of knowledge in lesson objectives

In teaching, the fundamental purpose is to change the behaviours of the learners through knowledge acquisition. Bloom (1956) broke knowledge down into three major domains commonly called bloom's Taxonomy, which are:

1. **The Cognitive Domain:** Which is the intellectual capacity of the learner and there are six different categories:
   a. **Knowledge:** This is the lowest level and it involves recall of information.
   b. **Understanding:** This requires higher level of activity beyond recalling. It is demonstrated when a learner translates material from one form to another.
   c. **Application:** This is the ability to use learnt material in new and concrete situation.
   d. **Analysis:** The ability to break down material into its components.
   e. **Synthesis:** This is been able to build upon new materials from a given part. Or the ability to assemble pieces into a whole new one.
   f. **Evaluation:** This is the highest level of knowledge in cognitive domain. Ability to make judgments.
2. **The Affective Domain:** This deals with value, beliefs, attitudes, interests, social relations, emotional judgment, habit and life styles. Interest is reflected by the learner's active participation in activities.
3. **Psychomotor Domain:** It involves manipulative skills and demand the use of the body. It is the ability to operate, carryout out, perform etc an operation using materials or objects.

3.2.3 Implications of the Three Domains of Knowledge in the Teaching of Integrated Science

In the statement of lesson objectives, it is advised that at least two of the domains must be in the behavioural objectives. Avoid the use of lower cognitive domains, which are easier. Therefore, the implications of these in the teaching of Integrated Science are as follows that science lessons objectives should:

i. Incorporate the intentions of the teachers for the learners to recall, define, design, identify, etc.
ii. Include how the learners would express their feelings, attitude etc under a given situation.
iii. Include the skills the teacher would expect learners to acquire during practical activities like handling of apparatus, operate machines, and demonstration of some manipulative skills.

Remember that action verbs are what you should use when stating your objectives. Such include: draw, dissect, define, perform, describe, label, demonstrate, illustrate, solve, identify, calculate, list, mention, state, etc.

Never use works like: Know, understand, comprehend, etc which do not have clear intentions and are not measurable.

Activity 1
List the importance of Bloom's Taxonomy of knowledge in the stating of behavioural objectives.

Examples of stated Integrated Science Lesson objectives.

a. By the end of the lesson, students should be able to: identify five sources of water.
b. By the end of the lesson, more than 75% of the students should be able to: demonstrate the dissection of a rodent.
c. By the end of the lesson, students should be able to: filter dirt out of water using cloth mesh.

Activity 2
State five behavioural objectives for a lesson plan for JSS I in Integrated Science.

3.3 Preparing Daily Lesson Plan

Daily lesson plans are expected from practicing classroom teachers so as to guide the set out strategy needed for effective transmission of knowledge for the learners as spelt out in the scheme of work.

It also aims at meeting the level of understanding of the learners as they interact with the instructional materials.
The daily lesson plan is developed from the unit plan which has the following components:

1. Title of the lesson
2. Objectives of the lesson; this expresses the intentions of the teacher for the learner. It includes the expectation of the teacher, what the learners should do, learn and the type of skills to be acquired by the end of the lesson.
3. Statement of class level
4. Duration of the lesson
5. Previous knowledge relating to the new topic (entry behavior)
6. Outline of the teaching activities which could be:

    i. Descriptive of teachers' and learners' activities.
    ii. List of instructional materials or teaching aids.
    iii. Summary information: where the major points are highlighted.
    iv. Evaluation of the lesson: Questions based on the set objectives for the lesson could form the basis for this, which could be 'formative' or 'summative'. The questions asked why the lesson is on is referred

to as formative evaluation while question asked at the end of a lesson is summative evaluation.

v. Follow-up activity: This could be take home assignment on the next unit.

In the teaching of Integrated Science, it would be good for teacher to evaluate himself or herself, analyze the effectiveness of the instructional materials, strategy used. Self-assessment helps teachers become better and more confident in oneself.

4.0 Summary

- The unit made you to understand the preparation needed before embarking on teaching. The last unit of this module explained the relationship between choosing content, methodology, objectives and evaluation go back and read unit 8 again.

- You also studied about the Bloom's Taxonomy and the need to state good behavioural objectives.

Assignment

1. Identify the components of a good lesson plan.
2. What is the difference between lesson plan and lesson note?

5.0 References

Aliyu, A. (1982). *Science teaching in Nigeria*. Ilorin: Atoto Press Ltd.

Atadoga, M.M. & Onaolapo, M.P.O. (2008). *A handbook on science teaching method.* Vol. 1. Zaria: Shola Press.

UNIT 10: CONSOLIDATION

CONTENT

1.0 Introduction

In this unit, you will learn revise and recall all that you had learned in units 1 to 9. In unit 1, all you learned about Curriculum Development Activities. In Unit 2 you studied History of Integrated Science in Nigeria. In Unit 3 you learned about Nigerian Integrated Science Project. In Unit 4, you learned the definitions and characteristics of Integrated Science. In Unit 5, you learned the nature and philosophy of Integrated Science. In Unit 6, Integrated Science and Themes were learnt. In unit 7 you learned concept of Integration. In Unit 8, you learned preparing for Integrated Science Teaching. In Unit 9, you studied Lesson Plan in Integrated Science.

2.0 Objectives

By the end of this unit, you will be able to:

i. Identify rationale for integration.
ii. Define Integrated Science
iii. List the Curriculum Development activities
iv. State the characteristics and uniqueness of Integrated Science
v. Discuss why Nigerian Integrated Science Project
vi. Differentiate between curriculum, syllabus and scheme of work
vii. Determine what behavioural objectives to state for any particular lesson.
viii. Identify instructional materials and strategies used to achieve your stated objectives.
ix. Develop your daily lesson plan.
x. Summarize what you have learnt in units 1-9.

How to Study this Unit

Use the brief summaries in this unit to evaluate yourself about all that you had studied from unit1-9.

3.0 Main Content

In this module, you have learned the following:

a. The Curriculum Development Activities that led to reforms and revise of what was mere acquisition of facts and principles when science was learnt as Nature Study to activities filled science course after the launching of Sputnik shuttle in Russia. This led to overhauling globally of science curricula especially in the USA, Europe and even Nigeria, which led to Nigerian Integrated Science Project (NISP). STAN committee with the Nigerian Child in mind developed this curriculum. The communiqué containing the philosophy, content, methodology, and method of assessment were contained in Curriculum Development Newsletter No. 1.
b. Integrated Science you learnt refers to way or approaches of presenting concepts and principles so as to express the fundamental unit of scientific thoughts without the stress on the distinctions of the various disciplines. Integration of ideas increases the potentials for problem solving and scientists. It is also able to satisfy the curious young learners whose logic differs from that of single subject disciplines.
c. The Nigerian Integrated Science Project (NISP) exposes the Nigerian Child to how scientists works and what science is by the use of child-centred and activity-based strategies to present scientific concepts and principles. Attitudes and scientific process skills are taught and used in problem-solving activities around the environment.
d. Definitions and characteristics of Integrated Science showing the uniqueness of this new science subject makes it easily acceptable by both specialists and non-specialists in science. It increased the level of scientific literacy in the society.
e. The potential teachers are able to comprehend the unique nature of preparation to enter into the profession well equipped to inculcate knowledge and show his/her competence in the learning process. You could differentiate, develop and identify scheme of work, lesson plans and stating objectives that can be attained during the lesson.
f. The set behavioural objectives are able to determine the content, methodology and kind of evaluation for the learning process. These have to do with which Bloom's Taxonomy one is interested to build in the learners.

Activity 1
Name the two types of syllabus and explain their differences

Identify the main components of a lesson plan.

Activity 2
List some scientific process skills and attitudes commonly used on daily basis. Comment on the reason for this.

Activity 3

Go back to unit 4 and review the various definitions for Integrated Science then define same in your own new understanding.

4.0 Summary

In this unit, you have revised what you learnt in unit 1 to 9. These include need for curriculum Development Activities, Integration and meaning of Integrated Science; reforms and global overhauling of science curricula leading to doing in science instead of learning of facts and principles; meaning of curriculum, syllabus and scheme of work; preparing lesson plans and stating behavioural objectives according to Bloom's Taxonomy and how to select instructional materials for teaching.

Assignment

1. Check through Integrated Science textbooks and learn how the units are arranged in book 1-3
2. Pick on some of these units and try to develop your lesson plans.
3. Practice stating objectives for practical class works.

5.0 References

Bloom, B.S. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain.* London: Longmans.

Dienye, N.E. & Gbamanja, S.P.T. (1990). *Science education :Theory and practice.* Zaria: Totan Publishers.

MODULE 2: MANPOWER AND RESOURCES FOR TEACHING INTEGRATED SCIENCE

UNIT 1: APPROACHES FOR THE TEACHING OF INTEGRATED SCIENCE

CONTENT

1.0 Introduction

In the last two units in module one, you learned about how to state behavioural objectives, select topic from the scheme of work and choose the appropriate strategy/approaches for the teaching. In this unit, you will come across various approaches to the teaching of Integrated Science

2.0 Objectives

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

i. Choose the appropriate approach to a selected concept.
ii. Determine whether to use one or two strategies in teaching a concept.
iii. State suitable behavioural objectives for chosen concept.
iv. Identify the right instructional materials to use.

How to Stud this Unit

1. Read and carefully follow every detail in the unit.
2. Understand every section in unit
3. Practice the prepared lesson plans.
4. Choosing another concept, write out your own lesson plan.
5. Read over again any portion you do not understand well.

3.0 Main Content

3.1 Various Approach/Methods used in the Teaching of Integrated Science

In science and Integrated Science in particular, there are various approaches, strategies and method used for the teaching of science involves various activities and concepts. In the classroom, no one method or approach is the best but mostly depends on many factors. But to achieve the best methods and approaches should be varied from time to time and concept to concept. There are various activities to teach Science concepts

and these include project work, demonstration, individual practical work, small group discussion, visiting museums or botanical gardens, building models, and host of others.

There are numerous approaches to these activities, and the choice depends on the objective of the activity. Any method or approach should be mixed with real life situations when using them. One of the objectives of teaching Integrated Science in schools is for it to be taught using child-centred approach and activity-based method (FME, 2013).

There are general rules, which can facilitate the selection of appropriate and adequate approaches of imparting knowledge or skills in learners. In the selection of approach or method for an integrated science lesson, the teacher must consider:

i. The learners' age, previous knowledge on the topic and their general abilities and that the class contain mixed abilities.
ii. The concept to be taught, its content must have been well understood by the teacher.
iii. Teachers should select method he/she can handle effectively.
iv. The timing of the lesson should be put into consideration. For example afternoon lessons should be of more activities, where the learners are actively involved.
v. Class size is a very important factor in the choice of strategy for teaching.
vi. Available human and material resources at the teacher's disposal will determine choice of method/strategy.

It is therefore, very clear that Integrated Science teacher's role in the classroom is one of a 'facilitator' of learning experiences. You are the one to guide and direct the learners' activities during the lesson. Your should be able to guide by asking questions, prompting and leading rather than by direct teaching, informing or explaining. Learners learn more by this.

There are several methods/strategies that Integrated Science teachers can employ to present scientific facts, principles, concepts or information. One or two can be involved in getting the best. Few among them:

1. Lecture or expository method
2. Demonstration method
3. Discovery/inquiry method
4. Discussion method
5. Project method
6. Field trip/excursion method
7. Class activity method etc.

Activity 1
Identify factors, which are determinants for the choice of a teaching strategy/method.

Lecturer Method

Lecture or talk and chalk or expository method refers to as didactic approach is the technique in which the teacher presents a spoken discourse on a particular subject (Dienye & Gbamanja, 1990). It is the commonly used method for elaborating, simplifying, discussing new materials to learners.

Scientific information or principles are communicated through lecture method. Eighty-five percent (85%) learners are passive while the teacher displays his/her expertise in the classroom. It helps the teacher cover a large volume of work (syllabus) and the class size does matter. In most of the times that lecture method is employed, the students are passive while the master of the teacher is demonstrated. It is useful during public lecture and when large audience is present, when large amount of materials could be covered in a very short while.

Shortcomings of lecture method are:

- The teacher as an authority of the subject matter controls and communicates only what he knows.
- The level of the teacher's knowledge is the maximum the learners can attain in that subject.
- The learners are passive meaning they cannot express themselves.
- The ability of the teacher to communicate his/her points determines what the learners get.
- There are no scientific processes or manipulative skills acquired during lecture method.

To overcome these shortcomings or limitations of lecture method, the teacher can adopt or create a situation where both him and the learners are actively involved in open-ended questioning technique. It can also be enriched by the introduction of some instructional materials.

Demonstration Method

Demonstration means display of something. It is a way of acquisition of skills in science because during demonstration, the how to do science is introduced. Demonstration method is usually required when new discovery is made, when materials or skills to be taught are dangerous or when the materials for teaching are inadequate.

During demonstration, the use of science approaches, illustrating a technique of manipulating equipments in order for learners to observe etc. the demonstration can be:

1. **Teacher Demonstration:** Teacher can demonstrate alone using the demonstration table to show innovations in science or display how to do or use some manipulative skills to carry out an activity.
2. **Student Demonstration:** Students can be grouped to perform an experiment or activity due to shortage of instructional materials. This act as a motivation for other students to part takes in such exercise.
3. **Teacher/Student Demonstration:** The teacher can invite students to help in carrying out an activity.
4. **Guest Demonstration:** A science teacher can invite other experts within or outside the school as an expert in a particular area to show the use of an equipment or apparatus which the class teacher do not know.

In adopting demonstration method for teaching Integrated Science, the following facts must be observed which are:

a. The teacher must have rehearsed the process or the activity before to find out the workability of the apparatus, equipment or activity.
b. The available space and the size of the class, how to divide them to manageable sizes etc.

Discovery/Inquiry Approach

These two are methods of teaching which are slightly different from the two previous ones. The teacher positions the students to solve a problem in discovery method which they predict the result and then make observation relating their investigation to previous work. But in inquiry, the students are allowed to formulate the problem, state the purpose, predict the result, identify the procedures and carry out the investigation.

Both discovery and inquiry involve instructed exploration in which students through mental processes such as observation, measuring, grouping, analyzing, synthesizing and evaluating comes to a conclusion from data gathered.

Discovery and inquiry methods can be guided or unguided which is either inductive or deductive.
Both guided and unguided inquiry involves finding out and requires the students to engage in some complex mental processes like:

i. Formulating problems for investigation
ii. Formulating hypothesis to guide investigation.
iii. Design experiment to collect data
iv. Making generalization from knowledge acquired
v. Developing certain scientific attitude like objectivity, curiosity, open-mindedness and honesty.

These two methods are student-centred and full of activities which allow the students learn many skills and scientific attitudes.

Discussion Method

This method simply means talking over concepts from various points of view, with the teacher acting as the moderator. The students should have been adequately prepared for this before time.

Project Method

Project method involves assigning individual or group to carry out a project. Students are given free hand to search for problem of special interests and finding solutions to them. The method provides for the needs of the students which enable individuals to exhibit his or her special abilities.

Topics for project vary and may be from sources including:

i. Observations in or around the environment
ii. Readings in scientific journals, books or goggling concepts on internet
iii. Discussions among themselves.
iv. Debate on specific concept or topic.
v. Reports on field trips and excursions to the dam, zoo, botanical garden etc.

Class Activity Method

The method involves work in the science laboratory which can be an exercise or an experiment. In Integrated Science, the concept laboratory has been extended to include any place science can take place. In carrying out experiments, there are specific procedure that must be followed and the method consists of:

- Identification of a problem
- Formulation of hypothesis
- Testing of the hypothesis with accompanying observations
- Concluding with respect to specific observations.
- Predicting and generalizing the ideas learnt.

In Integrated Science, simple activities are involved. The complex ones are for more advanced science classes. The experiments here are more flexible and be adapted with ease to all types of situations.

In the teaching of science, especially at the Junior Secondary School level, ‘laboratory experiments’ are used interchangeably with ‘laboratory exercises’. Many experiments at this level are little more than exercise because he end result known before carrying out the experiment. These are the types of instruction the teachers gives. But real laboratory experiments’ results are unknown until the end of the activity.

To conduct a good Integrated Science class activity, the teacher should bear the following in mind:

a. Selecting laboratory activities.

b. Giving directions for laboratory activities.
c. Providing materials for laboratory activities
d. The teacher's role during the laboratory activities
e. Use of data collected during the laboratory activities.

Activity 2

Identify the scientific skills and attitude the learners will acquire when discussion and project teaching methods are used.

4.0 Summary

In this unit, various methods/strategies for presenting Integrated Science were discussed. Strategies like demonstration, project, discovery/inquiry, class activities were examples but each have their shortcomings, and advantages. And as earlier discussed at earlier units, the content selected, objectives and the type of evaluations required determines the method or strategy chosen.

In a particular lesson, two methods can be used to teach integrated science.

Assignment

Compare and contrast demonstration project teaching method

5.0 References

Atadoga, M.M. & Onaolapo, M.P.O. (2008). *A handbook on science teaching,* Vol. 1. Zaria: Shola Press.

Dienye, N.E. & Gbamanja, S.P.T. (1990). *Science education :Theory and practice.* Ibadan: Totan Publishers Ltd.

UNIT 2: SAMPLE LESSON PLANS

CONTENTS

1.0 Introduction

In this unit, you will study sample lesson plans prepared for different concepts using various teaching strategies.

2.0 Objectives

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

1. Identify various ways lesson plans can be written
2. Differentiate the arrangement of learning processes as presented for different strategies.
3. Write lesson plans using different teaching strategies
4. Chose appropriate instructional materials for your strategies.

How to Study this Unit

1. Read carefully through the unit
2. Study the different lesson plans
3. Identify the major difference between the strategies
4. Practice writing your own lesson plans.

3.0 Main Content

3.1 Sample Lesson Plans Using Conventional Strategies/Methods

In preparing your lesson plan, remember that it is your daily guide to instruction for the learning activities. It provides the instructional order to be followed by the teacher so as not to forget any point of importance.

There is no rigid format or pattern for lesson plan that can fit into all situation but you can follow the suggestions in these examples.

Sample Lesson Plans

A

Name of School: Subject: Class: Date: Unit: Average Age: Time of Lesson: Duration: Instructional Materials:	JSS Bomo, Zaria Basic Science JSS II 13/9/2014 State of Matter 11 years $9^{40} – 10^{25}$am 45 minutes Ice cubes, beakers, Bunsen burner or stove, 2 petric dishes and a spoon.
Behavioural Objectives	By the end of this lesson, students should be able to i. Identify the cause of change of state of matter ii. Mention the 3 states of matter iii. Name the 3 states of matter iv. Convert from one state to another

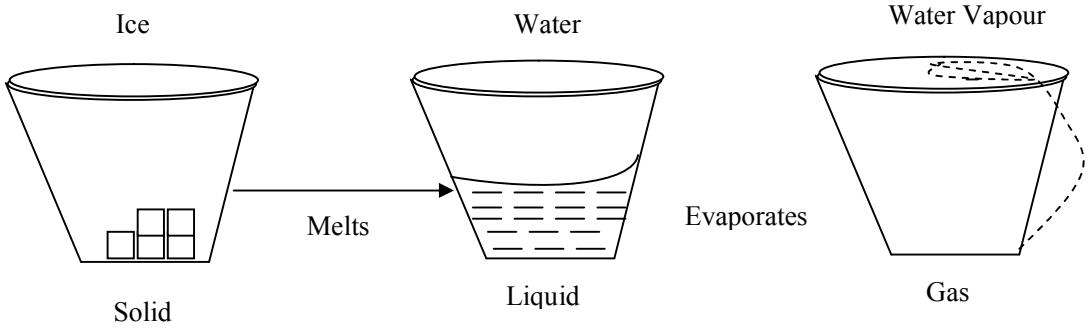
Time	Part of the lesson	Activity
$9^{40} – 9^{45}$	Introduction	Short quiz on previous lesson example of solid liquid and gas e.g land, sea and air. Questions of physical appearance of each.
9^{45}-10^{10}	Presentation	Step 1. Categorize matter into solid, liquid and gas 2. Demonstrate the interconversion of these states of matter using ice which is solid, can melt into liquid and can boil to produce gas 3. Explain their major differences and stating their molecular movements 4. Tabulate the general properties of solids, liquids and gases 5. State Charle's law, Boyle's law and Graham's law 6. Use kinetic theory of matter to explain these laws.
10^{10}-10^{15}	Summary	Highlight some of the important points on the chalkboard
10^{15}-10^{25}	Assignment (Homework)	The students should read textbooks in order to be able to define the following terms: Expansion, diffusion, density, pressure, volume and temperature.

B

School: Date: Subject: Class: Time: Title of Unit: Topic:	Gov't Sec. School, Kaduna 12th Sept, 2014 Basic Science JSS 1 1^{00}-1^{40} Living things Characteristics of living things
Behavioural Objectives:	At the end of the lesson, the students should be able to: 1. State what living things are and can do 2. List five characteristics of living things 3. Compare characteristics of human beings with those of other living things 4. Identify ten living organisms
Previous knowledge:	Students are familiar with the classification of things
Apparatus:	An uprooted flowering plant, some living animals in an aquarium, bean seedlings, slides and light microscope, stone, slide projector.
Introduction:	The teacher introduces the lesson by asking the students the following: 1. What are the observable difference between the mechanisms of movement in man and that of a car?
Presentation	Step I: The teacher leads the students on to the definition of living things and non-living things Step II: The characteristics of living things are given viz: ability to move, respire, feed, respond to external stimulus, grow, excrete and to reproduce. With short explanation from each. Step III: The students are briefly exposed to short explanation of growth using bean seedling, grown at different times showing different stages of growth. Step IV: Students will be allowed to watch animals movement using the animals in the aquarium.
Evaluation:	Students will be asked to (i) Identify the difference between a stone and a grasshopper (ii) list five living things and five non-living things giving reasons.
Summary:	Living things include all plants, animals and microorganisms. All living things possess the following characteristics: - Cell which are the smallest living unit, each consisting of a nucleus and cytoplasm. - All can move, respire, feed, respond to stimuli, grow, excrete and reproduce. - Movement or locomotion is more.
Conclusion:	The lesson will be concluded with the students allowed to ask questions which the teacher will answer.

C

Name of School Subject: Class: Date: Unit: Average Age: Time of Lesson Duration:	Premier Primary School, Ibadan Basic Science Primary 5 20/9/2014 Following up the ice cube race 9 years 8^{30}-9^{10}am 40 minutes
Teaching aids:	Ice block, glass cups, burners, pencils, sheets of paper and stop watches.
Behavioural objectives	By the end of this lesson, you would have: • Encouraged and supported pupils as they carry out their own science investigations (inquiry based learning) • Explored with pupils, different ways to communicate the result of their investigations • Explored the change from one state to another of water.
Previous knowledge:	Pupils are familiar with ice and water in their homes nad around the school
Introduction:	The teachers asks the pupils to discuss the changes they see as ice 'disappears'. Questions like the following will be asked: i. How does solid ice change (melt) to liquid water and eventually disappear (evaporates) into invisible vapour? These are called 'changes of phase'
Presentation:	Teacher's activity – Group the pupils into maximum of five around a table where there are a glass of ice block, burner, and paper for recording. A leader and a recorder are nominated.
Pupil's activities:	The following quiz are to be answered by the pupils after carrying out the activities. 1. List the things you can do to speed up the process of getting solid ice to change into liquid water 2. What is the scientific term to describe the change from a solid to a liquid? 3. List the things that speed up the process of turning liquid into gas like water vapour? 4. What word do we use for this change from liquid to gas?



Factors that affect melting and evaporation are:

- Heat
- Size and shape
- Moving air
- Pressure

The teacher goes round the groups to see what they are going and put in a word or two where necessary.

Evaluation: each group leader would be called to report their answers to the quiz

Conclusion: The teacher concludes by supplying the correct words for the activities and summarizes the activity on the chalkboard.

Lesson Plan on Radioactivity

Date: 20/08/2012
Class: Upper Basic 3
No. in Class: 32
Average Period: Single (80 Minutes)
Subject: Basic Science
Topic: Energy : Radioactivity
Instructional Strategy: Concept Mapping
Instructional Materials: Lead Block, Radium, Concept map.
Behavioural Objectives: At the end of the lesson, students should be able to draw a concept map linking natural and artificial radioactivity, types of radiation, properties of radiation and some radioactive elements on their own. And from the concept mapping knowledge they should be able to:

a) define natural radioactivity
b) mention various types of radiation from radioactive substance
c) discuss the various properties of radiations
d) state some radioactive elements
e) Name effects and uses of radioactivity

Previous Knowledge: Students were asked whether they have heard about radioactivity before and to say whatever they know about it (8Mins)

Presentation

Steps	Facts to be taught	Time	Teacher's activities	Students' activities	Progressive evaluation
Step 1	Concept mapping on radioactivity	20 mins	-Displays the concept map brought to class -Draws a concept map along with students: Radioactivity= Natural + artificial radioactivity= radioactive elements + examples =Decay + Disintegration= particles + rays + properties= their effects + uses. See concept map attached	-Note technical points on how to draw concept map -practice on how to draw simple concept maps	-Draw a concept map linking radioactivity, types of radioactivity and their properties. -Radioactive elements, radiations, properties of radiations
Step 2	Definition of natural radioactivity	10 mins	the teacher leads the students to define the term "Natural radioactivity" as the spontaneous decay or disintegration of the nucleus of the atom of an element during which it emits α, β particles or ϒ rays or a combinations of any or all the three, and energy.	-Students define "Natural radioactivity" -Examine their relationship in the map	Define Natural radioactivity in your own words
Step 3	Types of radiation	10 mins	the teacher helps the students to mention types of radiations as Alphas (α) particles, Beta (β) particles and Gamma (ϒ) rays using their maps	-Students mention the various types of radiation -Try to note their position in their maps	List the various types of radiation
Step 4	Discussion of the	15 mins	The teacher assists the students to demonstrate radioactivity by placing	Students discuss the properties	Discuss the properties of radiations

	properties of radiations		radium at the bottom of a small hole drilled in a block of lead. The rays emitted were subjected to a strong magnetic field place at the side of the narrow beam which emerges from the radium. The A photographic plate at appropriate side showed that the paths of some rays were sent to the right (N pole) some to the left (S. pole) and some went straight on. Electrically charged plate placed at the side of the beam showed that some rays bent towards the negative electric plates, these were called Alpha (α) particles; some deflected towards the positive plate, these were called Beta (β) particles; and the other rays went undeflected, these were called Gamma (γ) rays i.e they have no charge.	of radiations & list them	
Step 5	Radioactive elements	5 mins	The teacher helps the students to state some radioactive elements as polonium, radium, thorium, radon and ionium. Reference made to the concept map	Students were able to state radioactive elements	Mention some radioactive elements

Evaluation

1. Define the term Natural radioactivity
2. Mention the various types of radiation.
3. Discuss the properties of radiations.
4. State some radioactive elements you know.

5. Name effects and uses of radioactivity
   (12mins)

Assignment:
Write short notes on how energy from radioactivity can be useful and destructive to man

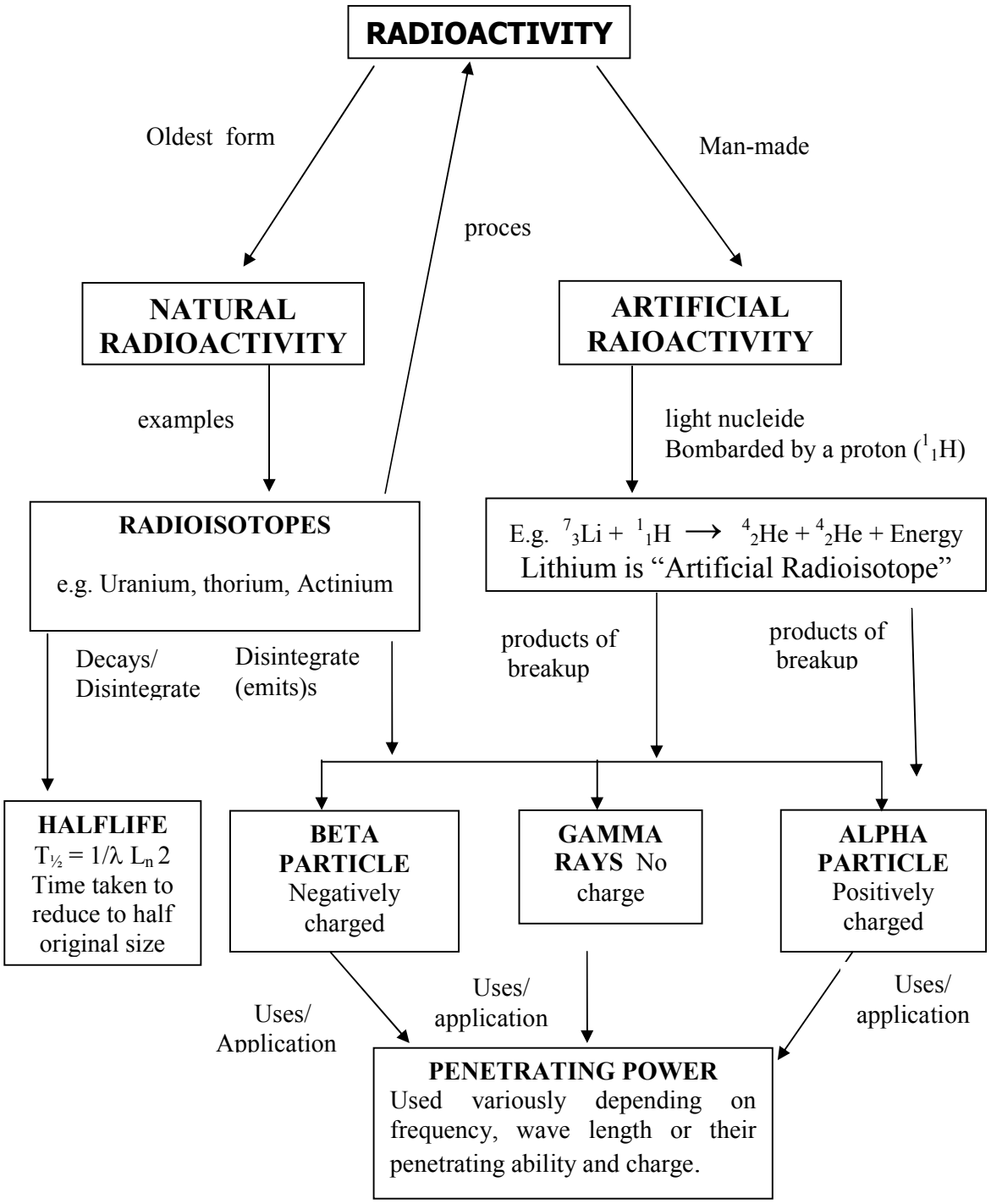


Figure1: Concept Map on Radioactivity (Achor, 2012)

4.0 Summary

From the different lesson plans, you can see that various strategies and method can be used to get knowledge across to the learners. It is left to the teacher to choose the one that best suits his/her at a particular time.

Assignment

Prepare a lesson plan for a class of thirty choosing your own strategy to teach the topic 'sources of water' to primary 4.

5.0 Reference

Abdullahi, A. (1982). *Science teaching in Nigeria*. Ilorin: Atoto Press Ltd.

Achor, E. E. (2012). Using concept mapping and traditional methods to teach radioactivity in physics. In R. M. O. Samba & J. O. Eriba (Eds*.), Innovative approaches in teaching difficult science concepts (*142-148). Makurdi: Destiny Ventures.

TESSA (2009). *Supporting teachers to achieve Education for All Science*. NTI. Kaduna.

UNIT 3 RESOURCES AND MANPOWER FOR TEACHING INTEGRATED SCIENCE EFFECTIVELY

CONTENTS

1.0 Introduction

One basic assumption made in developing Integrated Science is that formal laboratories and traditional science equipment would not be necessary for teaching the subject. It is against this background that, material resources for teaching Integrated Science shall be dealt with in this unit. As stated earlier on in this course, the teacher plays a central role in the effective teaching of Integrated Science. The teacher is the manager of all affairs that goes on within the science classroom or science laboratory. He also manages a number of things outside his science classroom and laboratory. In line with this, resources for the teaching of Integrated Science can be categorized into two major parts. These are:

(i) Material/non-human resources
(ii) Human resources.

These two resources shall be extensively dealt with in this unit.

2.0 Objectives

After studying this unit, you should be able to:

1. Discuss the central role of the teacher in the effective utilization of resources for teaching integrated science
2. List the two major resources for teaching integrated science.
3. Give detailed explanation on each of the resources available for the teaching of integrated science.

HOW TO STUDY THIS UNIT

1. Read the whole unit
2. Reflect on the issues raised through the unit
3. Read the unit again step by step to get deeper understanding of the unit
4. Carry out the suggested activities

5. Review and summarise the main ideas of the unit

3.0 Main Content

3.1 Non Human/Material Resources

Both the human and non-human resources at the Integrated Science teacher's disposal are inseparable. The reason(s) for this is not farfetched. Science is an experimental subject, which involves the use of materials, equipment and apparatus. Let us now examine these material resources in much more details.

(i) Integrated Science Classroom

Integrated Science like other science subjects could be handled in the laboratory or the conventional classroom depending on the situation. This means that integrated science will just be one of the subjects taught in the classroom. Then there is the need for proper attention to be given to the structure of the classroom. Wherever available, classroom for teaching integrated science should be large enough and spacious enough to allow free movement of learners in the classroom. There would be frequent needs for students to leave their seats to collect pieces of equipment/apparatus from the teacher's demonstration table. There would also be a frequent need for the integrated science teacher to move round the classroom to supervise students' work either as individuals or in groups.

(ii) Classroom Furniture

Desks, benches and tables usually constitute the furniture in the classrooms. Learners' desk tops should be of reasonable area, flat tops and horizontal but not slacking. The desks should be movable and detached from the benches. This is necessary so that it would be possible to put such desks together into groups of two or four students or more as occasion may demand. Thus, it is important to provide good working situation because group work would dominate most of integrated science teaching strategies.

(iii) Service point

There are two important service points in an integrated science classroom. These are:
(a) Water tap service point
(b) Burners (Bunsen burners)
There should be at least four water taps in a classroom to accommodate forty students. Where there are no pipe borne water, there should be at least four plastic buckets of water in the classroom; and placed on tall stools or stands. There should also be four Bunsen burners with movable gas cylinders in a class of forty students. These gas cylinders should always be operated by the integrated science teacher or the laboratory assistant or his assistant. More preferably, the gas cylinder should be located on the sides of the classroom and very close to the windows. Students'

attention should however be drawn to the danger inherent in the use of gas in the classroom.

(iv) Teacher's Demonstration Table

Teacher's demonstration table is very important in the teaching of integrated science. The teacher demonstration table should therefore be located / constructed on a high platform in the
classroom. This has the following advantages:
(i) it enables the students participate fully in the lesson or what the teacher is demonstrating;
(ii) it will prevent unusual overcrowding of anxious students round the demonstration table;
(iii) it enhances effective classroom management and control;
(iv) it enforces safety precautions during a demonstration.

3.1.1 Equipment and Apparatus

(i) Fire Fighting Equipment
If all safety precautions are taken, it is unlikely to have fire outbreak in an integrated science classroom. However, it is usually advisable to keep in the classroom a fire extinguisher.
Where a fire-extinguisher could not be procured due to its high cost, it is advisable to have a bucket of dry sand placed in an accessible position in the classroom in place of conventional fire extinguisher. There should also be at least two exits from the classroom especially when there is need to rapidly evacuate students from the classroom in the occasion of fire outbreak.

(ii) Glassware (or Plastic wares)
Glassware – test tubes, beakers, wash glasses are essential tools in the teaching of integrated science. Glasswares no doubt can be expensive, most especially where breakages is high. Nowadays there has been move to replace glasswares with plastic wares especially if no direct heating in an open fire is required. Below is a list of some basic pieces of glasswares or plastic apparatus necessary for the teaching of integrated science.

(a) Test tubes
(b) Measuring cylinders
(b) Boiling tubes
(d) Petri dish
(e) Watch glasses
(f) funnel
(g) Flat bottomed flask
(h) round bottomed flask
(i) Stirring rods
(j) delivery tubes
(k) Beakers

(l) volumetric flasks
(m) Thermos flasks
(o) Dropper bottles
(n) Reagent bottles
(p) Specimen bottles
(q) Photometer
(r) conical flasks
(s) Trough
(t) basins

The number and sizes of the apparatus are to be determined by the integrated science teachers. This is necessary so that it would be possible to put such desks together into groups of two or four students or more as occasion may demand. Thus, it is important to provide good working situation, because group work would dominate most of integrated science teaching strategies.

3.1.2 Need for Improvisation of Instructional Materials Locally Available Materials / Apparatus

A number of useful pieces of materials are now readily obtainable in our environment (especially in open markets). Of particular interest is the range of plastic materials which are manufactured locally. For instance, plastic basins, buckets, cups and receptacles can now replace troughs, beakers, Petri dishes etc. Here the teacher needs to apply his 'native wigg' or 'personal discretion' as to which of these locally available materials can be brought into the teaching of integrated science. Occasionally, too, teachers can bring useful pieces of discarded equipment and utensils from home. Some of these useful discarded pieces of apparatus can be requested for from non-integrated science teachers. Hence, cooperation between the home and school could be a useful way to enhance an effective teaching of integrated science.

Examples of local sourced science equipment/materials using the concept of discarded tools

Science apparatus and equipment can be improvised for use in the classroom through the use of discarded materials around the environment. Such equipment as magnifying glass, beakers, funnels, electro-magnets, metre rule, concave and convex mirrors, test tube holders and temporary magnets are all materials that can be used to improvise useful primary science equipment in classroom. It is important to note that some science equipment cannot or should not be improvised. Complicated or precision instruments may not be improvised due to their costs and complicatedness. Some of the equipment are listed below:

(1) **Test tube holder:** Discarded binding wire or short fresh wood split into Y-shape could be used as test tube holder.

(2) **Magnifying glass:** An expired filament bulb can be carefully opened up at the head with pliers. Water is then put into the empty bulb and placed free on a table. The water in the open bulb acts as a magnifying glass.

(3) **Concave and convex mirrors:** By cutting open an empty discarded insecticide cylindrical can at the base, the curved bottom acts as both concave and convex mirrors from both sides of the cut out bottom.
(4) **Temporary magnets:** A flex wire wound round a 2" nail can be connected to the top and bottom of a dry touch light battery with both ends of the flex wire to top and bottom. The connection will turn the nail to a temporary magnet.
Practical experiment shall be done in the class in the course of teaching.
All the above among many are scientific materials that can be improvised for use in the classroom.

Activity 1

1. Write down a list of glassware available for the teaching of Integrated Science.
2. Give an account of what an Integrated Science classroom should look like.

3.2 Human Resources

In consideration of the human resources available for teaching Integrated Science, two major resources stand out. These are:
(i) Qualified Integrated Science teacher
(ii) Laboratory staff and other support staff.

(i) Qualified Integrated Science Teachers

It is no news that there is problem of teacher supply and demands. It appears as if integrated science is facing a special type of problem. There is currently insufficient number of integrated science specialists. No teachers, even the NCE and University graduates want to be known as integrated science specialists. Rather, they prefer being single subject specialists or at best two subject specialists (especially at NCE level). This situation has created the present scarcity of integrated science teachers at all levels of Education in Nigeria. Suffice it to say however, that the situation is currently being addressed. More Colleges of Education and Universities are now running programmes leading to the award of Nigerian Certificate in Education, NCE (either as single or double major) and at first degree level. A number of Universities also offer higher degrees in Science Education even up to Doctoral level. With this move in the positive direction, non-availability of integrated science teachers will soon be a thing of the past. With the three / four year education programme in Colleges of Education and Universities, it is now possible to train and prepare specialist integrated science teachers. However, it is worthy of note to state that, integrated science at the junior secondary school level should and in fact must be handled by science education graduates who are knowledgeable enough in both the **'content'** and **'processes'** of the subject.

For the single science subject graduates who might be interested in teaching integrated science, opportunities are now available for them to undergo in-services training courses. Graduate science teachers should take the advantage of such

vacation courses to update themselves with the philosophy and approaches to the teaching of integrated science. There is also the need for various Ministries of Education and school principals to support such teachers to attend such courses.

(ii) Laboratory Technicians

In a standard laboratory, provision should be made for laboratory staff such as laboratory technicians/laboratory technologist. They constitute a vital component of the teaching force. But the most unfortunate thing with our education system is that, school administrators are yet to see the need for these all-important support staff for effective teaching of not only integrated science alone but all the sciences. This lukewarm attitude of school administrators towards their employment has often put a lot of burden on the teacher. This category of support staff usually renders useful assistance for the integrated science teachers in effective handling of his or her lesson. The absence of qualified laboratory technicians in most of our schools can make the job of the teacher of integrated science very difficult, but as the situations are now, the integrated science teacher has to cope with the problem. Most school systems do **employ laboratory assistants** or **attendants** to help the science teachers. The problem with such assistants or attendants is that most of them are not specially trained to work in a laboratory. It then behoves on the teacher to take up the responsibility of training such support staff anytime they are employed to assist him or her. The integrated science teacher should also make laboratory 'assistant' or **attendant** to be interested in science. It is also the responsibility of the integrated science teacher to recommend his untrained laboratory assistants for the many in-service courses run by the various Ministries of Education etc.

4.0 Conclusion

It has been established in this unit that, an array of resources is available for effective teaching and learning of integrated science at any level of education. The resources were broadly classified into two groups viz: the human and non-human resources. Teachers of integrated science should harness these abundant human and non-human resources to achieve the national goal for teaching integrated science.

5.0 Summary

In this unit, you have learnt about the following:

1. that there are two main kinds of resources available for teaching of integrated science
2. that the resources could either be materials/physical or human resources; that physical/non-human resources include the science classroom, science laboratory, service point, equipment/apparatus, glasswares/plastic wares, time and time table, integrated science curriculum/syllabus, scheme of work etc.
3. that human resources include the integrated science teachers themselves, laboratory technologist, technicians, laboratory assistants and laboratory attendants.

4. that the resources are at the disposal of the integrated science teacher who would need to harness all for the attainment of goal of science education;
5. that in all, the teacher plays a central role.

6.0 Assignment

Write a detailed but concise essay on the teacher as a manager of learning environment or learning experience.

7.0 References/Further Readings

Bajah, S.T. (1983). *Teaching integrated science creatively.* Ibadan: Ibadan University.

Raimi, S.M. (2000). *Science Education III. Unpublished mimeograph.* Oyo State College of Education, Oyo. 24 – 29.

National Open University of Nigeria (2006). EDU 740 Subject Methods (Integrated Science).

UNIT 4: METHODS FOR ASSESSMENT IN INTEGRATED SCIENCE

CONTENTS

1.0 Introduction

One of your main duties as an integrated science teacher is to promote the learning of the fundamental facts and principles of integrated science and to develop in the integrated science students abilities and skills needed to engage in scientific processes. However, as the acquisition of scientific knowledge is the ultimate criterion, it is imperative to regularly evaluate students' progress in their learning of integrated science. Your role as an integrated science teacher in evaluation is very important and crucial. Thus, you should be well equipped for the performance of this task. In this unit, you will be exposed to one of the commonly used methods of evaluation, which is teacher's test. The tests may take different forms. But the science teacher's concern is to monitor the progress of learning among his/her students. Therefore tests in integrated science class serve a variety of functions, which shall be discussed in this unit.

2.0 Objectives

After studying this unit, you should be able to:

1. Define test and assessment;
2. Discuss the functions of the classroom tests;
3. List and discuss the forms of assessment in science;
4. State the merits and demerits of all the forms of 'paper and pencil' tests;
5. Discuss the principles of test construction in science teaching with particular reference to integrated science;
6. Describe a marking scheme;
7. Describe how to prepare marking schemes for essay type and objective type examinations.

HOW TO STUDY THIS UNIT

1. Read the whole unit
2. Reflect on the issues raised through the unit
3. Read the unit again step by step to get deeper understanding of the unit
4. Carry out the suggested activities
5. Review and summarise the main ideas of the unit

3.0 Main Content

3.1 Meaning of Test and Assessment

According to test experts (Obe, 1977&Folagbade, 1988), teaching/learning processes are incomplete without clearly identifying the processes of determining students learning outcomes. The experts further said that the most reliable method available to practicing teachers for assessing students' learning outcomes is the use of tests.According to Obe (1977), a test is defined as a series of activities purposely designed to measure learners abilities in the area of recall of facts, recognition of facts, understanding of concepts, thinking capabilities and manipulative skills.

Activity 1

What will you consider as good suggestions by the test experts to the practicing teachers?

The test experts implored the practicing teachers and those educators involved in assessing learning outcomes to learn how to select test items, which are relevant and would give balanced representations of the traits to be assessed at a given time.

3.2 Functions of Tests

Findley (1963) categorized the functions of the classroom tests under three major groups which are:

1. instructional
2. guidance
3. administrative

3.2.1 Instructional functions of a test

1. Testing of students progress in the science class provides the science teacher with the information on the students' rate of learning. This will enable the teacher to provide more appropriate instructional guidance.
2. Test construction reminds the science teacher of the objectives of the course. The process of test construction at times helps the science teacher to redefine the course objectives in clearer terms.

3.2.2 Guidance functions of tests

1. Information obtained from tests can be useful in the counselling process especially on matters relating to choice of career.
2. Test can be used to discover pupils special abilities and aptitudes.

3.2.3 Administrative functions of tests

1. Tests serve as a quality assurance for schools. Because it provides a mechanism not only for maintaining standard for a school system but also for individual standards
2. Tests assist in the grouping or placement of students for teaching/learning processes. This is based on the ability as indicated by the scores of the students in the tests.

3.3 Forms of Assessment used in teaching/learning processes

There are different forms of assessment with great potential for determining students' progress in teaching/learning processes. These are:

1. Oral form
2. Written (essay and objective) form
3. Project form.

3.3.1 Oral form of Assessment

Activity 2

What is the usefulness of this form of assessment in integrated science teaching?
This involves the student's ability to describe or narrate in his/her own words the steps involved in a given task. The confidence displayed in such situations by student in the presence of an expert, his/her communicative ability, his/her use of the appropriate expressions as well as the commanding presence give a clear picture of a good mastery of what has been learnt. Without any bias or sentiment, the assessor can easily classify the student as either excellent, good or average, below average or poor.

3.3.2 Written form of assessment

Activity 3

How often do you as an integrated science teacher encourage the use of this form of assessment when teaching integrated science?

This form of assessment is one that involves the students putting down in writing the processes taken such as observation, recordings, calculating and interpretation. Written assessment is usually in the form of "paper and pencil" test, which could be in anyone of the following kinds:
(i) essay type test
(ii) objective type test
(iii) performance (practicals) type test
(iv) problems (quantitatives questions) type test.

3.3.3 Project form of assessment

Activity 4

What form of assessment will you as an integrated science teacher use in assessing your teaching?

There is a difference between the project form of assessment and any of the two forms of assessment earlier mentioned. In science class with particular reference to integrated science, theory or practical work are assessed by either of oral or written forms of assessment. In the case of project, what is to be assessed is real and there is a permanent end product which can be physically displayed for all to see, appreciate, comment on and finally assessed.

3.4 Essay type test

This is used as a means of evaluating the qualitative aspects of verbal instruction. The test items require the student to compose a response of some length, usually by integrating materials from a variety of sources.

Activity 5

As a science teacher, when will you say the essay type test is required?
The essay type test is used especially when the test requires:

1. explanation, description and prediction of processes and structure; description of instruments, apparatus, etc.
2. exposition of theoretical knowledge;
3. interpretation of experimental and numerical data;
4. discussion of results of experiments and solution of problems.

Activity 6
Construct **four** essay type questions in integrated science for JS1students on the concept of work.

3.4.1 Merits and Demerits of Essay Type Test

The merits of essay tests are:

a. It promotes better study habit;
b. It reduces the possibility of cheating;
c. It requires a high degree of thinking rather than rote learning;
d. It demands recall rather than identification

The demerits of essay tests are:

ϕ. It is difficult to draw up good questions for the essay test;

It is difficult to score because it takes a great deal of the teacher's or scorer's time; Scoring of essay test is highly subjective because the scorer tends to carry impressions from one paper to another; The result of scoring is often less reliable because of the scorer‘s mood and its subjectiveness

3.5 Objective Type Test

An objective test is one in which the test items are so framed that there is only one correct answer to each question the answer is predetermined and the test will give the same score for each item for
Since individual since the marks cannot be influenced by the biases and prejudices of the teacher.

Activity 7
List the forms of objective test.
In objective test, subjectivity in scoring or marking is eliminated, thus the answers to the questions can be marked by an individual who has no knowledge of the subject matter using the pre-prepared model answers marking scheme. There are various forms of objective test and their classification depends on the type of response which is being sought. There are four classes of objective test that are commonly used in the school setting. These are:

1. short answer items or completion test multiple choice items
2. matching items
3. true false items.

3.5.1 Short answer items or completion test

This test is not like other types of objective tests. Completion test items are not objective enough to allow anybody working solely from a key or a machine to score the test. It has the advantage that it reduces guessing to a minimal level and demands recall rather than recognition. Some of the demerits of this type of test are:

a. it encourages rote learning;
b. it is more difficult to construct; and
c. scoring is relatively more tedious.

Activity 8
Construct five short answer items on a chosen topic in integrated science for JS1 class. In this type of objective test, the students supply answers which are always in short sentences:

1. The outer layer of an animal cell is ….……...
2. The vacuoles of animal cell may contain ……...
3. The cell wall of a plant cell is made of a substance called ……
4. Living things can be divided into …… and……
5. Animals that eat grass only are called ……...…….
6. Living organisms without backbones are called ……
7. Plants can be classified into …….. and …….
8. Animals with backbones are called ……
9. Another name for backbone is ……
10. Most animals move about, while plants remain in …….

3.5.2 Multiple choice items

This is the most widely used objective test because of its adaptability and wide application. In the multiple choice test, each test item may start with an introductory question or an incomplete statement together with a number of alternative answers of which one is correct and the remaining are incorrect.

Activity 9
What are the merits and demerits of this type of test?
This type of test often requires the students to select response, which is correct for a particular question from a given list of options. The merits of this type of test which may convince science teachers of the versatility of this type of objective test are:

1. it allows for a large sample of test items
2. there is complete objectivity in scoring
3. it reduces the factor of chance success
4. it can be used with a wide variety of material

Some of the demerits of multiple-choice tests are:

1. it is prone to cheating
2. it aids recognition rather than recall
3. it is generally difficult to construct.

Examples of multiple choice test on integrated science are:
1. All living things are made up of ……..
   A. cellulose
   B. one or more cells

C. no cell
D. less cell
E. more or less cells

2. The activities of the cell in either plant or animal is controlled by……
A. vacuole
B. membrance
C. cytoplasm
D. nucleus
E. cell wall

3.Which of the following group of animals are carnivores?
A. goat and cow
B. cow and cat
C. cat and dog
D. goat and cat
E. cat and man

4. Which of the following is NOT an example of a vertebrate?
A. snake
B. frog
C. lion
D. centipede
E. bird

3.5.3 Matching items

This type of objective test is essentially a series of multiple choice items, each item in the first column is to be paired with an alternative in the second column. Every test item is made up of two parallel lists: One containing stimulus (words or phrases), the other containing response alternative. The students are required to match the items on the two lists.

Activity 10

When is the matching item useful in teaching / learning process?

When the learning of a particular integrated science concept requires the association of two things in the student's mind, this type of test items comes into play. In integrated science, matching items are used to gain knowledge of terms, definitions, laws, tools and their uses, illustrations, charts, diagrams etc. Examples of matching items in integrated science are:

Instruction: Match items on Column A against statements in Column B.

A
Chloroplast
B
A rigid structure which supports the body and is important in movement
A
Omnivores
B
Skeleton

A
The substance that make the plant cell more rigid than an animal cell
B
Small green objects which give plants their characteristic green colour.
A
Cellulose Animals that feeds on both plants and flesh.

3.5.4 True – False Items

Of all types of objective items, true/false item is the most susceptible to guessing. It is worthy of note that, this type of testing has become less useful as a means of assessing student's learning outcomes. This type of test is usually used for testing factual recall and definitions of terms. An inherent weakness of this testing technique is that it is difficult to find good true/false items as it is not easy to find many statements, which are true or false. Examples of true/false items on integrated science are:
T F -
TF- All living things are made up of one or more cells.
TF- Animals that are made up of one cell only are called unicellular
TF- Animals that feed on plants only are called carnivores
TF- Spiders, scorpions and mosquitoes are vertebrates
T F - The followings are characteristics of living things: Movement, Feeding, Reproduction, Dancing, and Sleeping etc.

3.6 Principles of test construction in science teaching

Beside the expertise advice given by the test experts at the beginning of this unit, it is also important to take note of the following points when constructing objective tests in science subjects.

1. Identification of major concepts to be tested.
2. Identification of the different cognitive levels at which the concepts are to be tested.
3. Decision on the number of test items to be included in the test.
4. Preparation of a table of specification to guide you as a science teacher on the selection of test items to be used.

3.6 Marking schemes for grading essay type and objective type in Integrated Science

Activity 11

What is a marking scheme?
A marking scheme is a model solution prepared by an examiner with marks distributed proportionately across the different sections of test items in the essay type examinations. In the case of objective test, the marking scheme required correct

responses. All correct responses carry equal marks despite the varying degrees of difficulty associated with different test items.

SELF ASSESSMENT EXERCISE 12

List the factors that can make the marking of essay type questions subjective.

In preparing a marking scheme for essay type questions, the examiners are expected to provide solutions to the questions posed section-by-section. For instance, if a typical essay type question attempts to test knowledge, understanding and application of a given scientific concepts. In preparing the marking scheme for such an essay question, solution provided must reflect knowledge, understanding and application of the concepts tested.

Activity 12

How will you carry out the mark distribution for an essay type question on integrated science concept that attempts to test the first three cognitive levels? In distributing marks to the different levels of cognition tested, applications of concepts are expected to carry more weight (i.e. more marks) than comprehension (i.e. understanding) while knowledge of facts in most situations should carry least marks.

4.0 Conclusion

In this unit, you noticed that evaluation in teaching/learning processes should be a continuous process and an integral part of curriculum development and classroom instruction. As an integrated science teacher, you need to pay more attention to assessment of integrated science students' learning outcomes in both theory and objective type examinations.

5.0 Summary

In this unit, you learnt that:

The most reliable method for assessing students' learning outcomes is the use of tests. Test is a series of activities purposely designed to measure learners abilities in the area of cognition and psychomotor assessment is the process or method of finding out about students progress the three major functions of tests are:

A. Instructional
B. Guidance
C. Administrative

The three forms of assessment in teaching/learning processes are:

1. oral form
2. written (essay and objective) form
3. project form

The forms of objective type test used in school setting are:

1. short answer items
2. multiple choice items
3. matching items
4. true -false items

Steps to consider while constructing objective tests in science:

A. identification of major concepts to be tested
B. identification of the different cognitive levels at which concepts are to be tested
C. decision on the number of test items to be included in the test preparation of a table of specification to guide you on the selection of test items to be used.

6.0 Assignment

1. What is item analysis in science tests?
2 How would you ensure content validity of integrated science test set for first year students of junior secondary level?
3. List the characteristics of a good integrated science test items.

7.0 References/Further Readings

Abdullahi, A. (1982). *Teaching science in Nigeria.* Ilorin: Atoto Press.

Bishop, G. (1985). *Curriculum development. A textbook for students.* Macmillan Publishers Ltd.

Raimi, S.M. (2000). *Teaching methods for business, languages, sciences, social sciences and technical education*. In J.A.Ayelagbe (Ed.) Andrian Publication Series, 223 – 226.

STAN (1999). *Nigerian Integrated Science Project, Pupils' Textbook 1.* Heinemann Educational Books (Nig.) Ltd. Pp. 44 – 51.

National Open University of Nigeria (2006). EDU 740 Subject Methods (Integrated Science).

UNIT 5: CHALLENGES OF LARGE CLASSES

CONTENT

1.0 Introduction

Integrated Science now taught as Basic Science and Technology in the primary school and Basic Science at Junior Secondary School is a core subject that is compulsory for all students. The population, therefore, in each class becomes overwhelmingly more than what the teacher can handle with ease, and the instructional materials are inadequate. Although the recommended number of pupils per class is between 35-40. In large classes they could be as many as 200 per class. In addition, the classroom may lack adequate seats. Besides there are students with varying aptitudes, abilities, interest, e.t.c. How can the integrated science teacher achieve the set objectives in such situation? In an ideal class there should also be a science corner which contains products of class activities or environment where pupils can view and think about them. This unit discusses large class and teaching for handling large classes.

2.0 Objectives

At the end of this unit, you should be able to:

1. identify appropriate teaching methods for handling large classes effectively;
2. state the competencies required for teaching large classes
3. determine activities that could be used for skill acquisition in large basic science class

HOW TO STUDY THIS UNIT

1. Read the whole unit
2. Reflect on the issues raised through the unit
3. Read the unit again step by step to get deeper understanding of the unit
4. Carry out the suggested activities
5. Review and summarise the main ideas of the unit

3.0 Main Content

3.1Teaching Methods and Strategies

The recommended methods or strategies for teaching Basic Science and technology encourage lots of child-centered activities that provide first-hand experiences that allow the pupils to develop some process, manipulative, and social skills. The

strategies listed below are found to be effective in teaching basic science and technology concept in general:

- projects (individual and group)
- Demonstration
- Class activities (individual and group)
- ICT application
- Team teaching
- Active Learning Strategy
- Investigation/Exploration of the school/home environment by pupils

Some of these strategies have been discussed in previous sections of this module. But how practicable are all of these in large classes, where the teacher is expected to ensure that every child participates, whether in group or as individual? How does one arrange the pupils in such a way that everyone sees the demonstration table or the teacher clearly, in a learge class? These and many other questions may be answered in the following ways:

- Class activities can be used to effectively manage large classes. For example in a large class, pupils can be grouped into groups of four, eight or ten to carry out the activity as shown below:
- Using candles, plam oil, small stove, pan, a metal lid, match sticks, glass cup, stop watch, kerosene, and alcohol or spirit, group pupils into ten each group having a set of the items listed above. Ensure that in each group there is equal number of male and female pupils where possible and that each group has a leader. Move around to assist where necessary.
- Assign each of the 8 groups the following activities. Each group is to observe and record what happens after carrying out its activity.

3.2 Procedure

Step 1 Stand on a flat surface and it
Step 2 Allow the candle to burn for a minute or so, then cover it with a glass cup
Step 3 Record what you observe
Step 4 Now heat a small quantity of oil in a pan on the stove until it catches fire
Step 5 Carefully cover it with the lid, and record what happens
Step 6 Carefully add few drops of water into the hot oil, record what happens.
Step 7 Gather small pieces of sticks, wood and cloth add few drops of kerosene and lit, drop it first on the wood, then the cloth and then pieces of paper
Step 8 Repeat step 7 with palm oil and record your observations

Based on their observations, they answer the following questions
What did they observe?

1. When they light the candle?
2. When the candle was covered with a lid?
3. When the candle was covered with a cup?

4. When drops of water added to the boiling oil?
5. What they observe in step 7 and when it was repeated with palm oil?

3.3 Questioning In A Large Class?

1. Which of the fuel produced good burning?
2. Which of the fuel produced least burning?
3. Which fuel produced smoke?
4. Explain why the teacher did not lift up the pan with the boiling oil from the stove.
5. Explain why the candle was extinguished when covered with a cup
6. Explain why it is not proper to pour water into a boiling oil.

Whole Class Interactive Discussion

Groups/Observations	Candle when lit	Candle when covered	Oil when covered	Oil when drops of water was added
Group 1				
Group2				
Group 3				
Group4				
Group 5				
Group 6				
Group 7				
Group 8				
Group 9				
Group 10				

3.3.1 knowledge/Skills/Attitude Acquired from the activities carried out

1. We do not carry hot oil from fire or stove
2. We do not pour water into boiling oil nor do we cover it it a lid.
3. We learnt that burning reduces when air is limited.
4. We can put out light from burning candles by covering them with a cup to exclusive air.

Activity

After cooking with stove in the kitchen at home what do you do?

4.0 Conclusion

Large classes have too many students, while overcrowded class have too many pupils for small space. Either of these poses a challenge to the teacher of Integrated Science, for effective teaching and management of large or overcrowded class relevant instructional strategies have to be adopted. The teacher also needs to vary the strategy used which should depend on the availability of instructional materials and their safety.

5.0 Summary

In this unit, we have learnt what a large class is, the various strategies of that can be used to successfully handle a large class and still record some results in achieving the objectives of active participation of every member of the class without stress. The suggested strategies include demonstration, projects, and the active learning strategies.

Tutor Marked Assignment

1. Discuss two strategies for managing large classes in integrated science class.
2. State 5 advantages of teaching in a large class.

References/Further Reading

Adeyanju, T. K. (2004). Revitalizing Education in Northern States. Kaduna: NERP Arewa House .

Basic Science and Technology (2010): *An NTI-TESSA Integrated Manual for the Re-training of Primary School Teachers (MDGs) Project*. Kaduna: NTI Press.

UNIT 6: INTEGRATED SCIENCE AND MULTIGRADE CLASSES

CONTENT

3.0 Introduction

Most teachers have been train to work in single-grade/mono-grade classrooms. Their knowledge of teaching method is based on whole-class instruction and occasionally, small group instruction. Thus when placed in a multi-grade setting, they discover that the time requirement and skills needed to teach effectively are not part of their prior training and experience. Teaching science in multi-grade school requires serious, ongoing teacher re-training and commitment to hard work. Some rural schools in Nigeria have multi-grade classes due to economic constraint and shortage of teachers. However, even the mono/single-grade classes are overcrowded and have the characteristics of multi-grade classes. This unit will help you organize your science class for meaningful instructional activities.

2.0 Objectives

By the end of the unit, you should be able to;

1. Explain the meaning of multi-grade teaching and characteristics of multi-grade schools
2. Differentiate between mono-grade and multi-grade teaching approaches
3. Enumerate the benefits of multi-grade teaching
4. Outline the procedure for the utilization of the multi-grade teaching approach

HOW TO STUDY THIS UNIT

1. Read the whole unit
2. Reflect on the issues raised through the unit
3. Read the unit again step by step to get deeper understanding of the unit
4. Carry out the suggested activities
5. Review and summarise the main ideas of the unit

3.0 Main Content

3.1 Meaning of Multi-grade Teaching

In the conventional school system, classes are described as mono-grade where pupils in a particular grade occupy one class and are taught by one or more teachers. The pupils are of similar characteristics in terms of age. This arrangement seems easier for the teacher to handle. In some circumstances, particularly due to the poor enrolment of

pupils in some school locations, the mono-grade method cannot be used. Thus, two or more grade levels have to be pulled together to give rise to a multi-grade situation or class. A multi-grade classroom therefore refers to that classroom that has two or more grade levels in one particular class and is taught by a single teacher. It goes by several names in different countries such as mixed-age class, family-grouped class, double class, aptitude grouping and make-shift schooling. The nature of the multi-grade class is that, the pupils differ in their number, ages, and ability but are taught by one teacher in one classroom.

3.2 Characteristics of Multi-grade schools

Multi-grade schools have the following characteristics;

1. Multi-grade schools are more commonly found in remote rural communities with low population density.
2. Multi-grade schools have low enrolments. The total numbers of pupils are between 30 to 150. In spite of the low enrolments some of them run full primary schools cycle i.e., from primaries 1-6.
3. Such schools have very few teachers-a minimum of one and a maximum of four teachers. In most cases, one teacher is assigned to more than one class, including those classes without teachers.
4. Multi-grade schools are not easily accessible by both pupils and teachers because of the difficult terrain, with no good roads. This makes teachers transferred to such schools to reject such transfers.
5. Multi-grade schools lack basic facilities – inadequate classrooms and classroom blocks; no staff offices , classroom block are not built to specification, most classrooms are small size often without chalkboards, classrooms furniture are usually grossly inadequate or completely absent; no basic instructional materials.
6. Pupil's drop-out rates are very high in multi-grade school because of the constraints mentioned above. The schools are characterized by poor attendance which can be worst in certain seasons of the year. Poor school attendance and high drop-out rates could also be as a result of poor teaching (or none at all), because most, if not all the teachers, have not been trained to handle multi-grade situation in schools.

Figure1. A teacher in the classroom (source: UNICEF, 2013)

3.3 Benefits of Multi-grade Teaching

In-spite of the daunting challenges facing the multi-grade teacher, there are some benefits accruable to multi-grade schooling:

1. It is a very cost-effective way of providing education for children in remote rural environment. Cost is saved through the most prudent deployment of personnel, improvisation of instructional resources, and sharing facilities /instructional materials which can be re-used over and over again.
2. It promotes individual self-study and independent learning thus enhancing pupils' self-esteem and self-reliance.
3. It encourages flexible learning progression rather than automatic promotion or repetition as is the case with mono-grade teaching/learning situation.
4. It leads to high levels of cooperation between different age groups and very positive attitude towards assisting each other.
5. Younger children seem to learn quickly in a multi-grade setting because they are able to 'absorb' knowledge from the older pupil to work harder to stay ahead of their younger classmates as they work together. They also gain self-confidence as they are occasionally given responsibilities to assist younger and slower pupils in the class.
6. For a dedicated and enthusiastic teacher, he gradually becomes more aware of the development and learning styles of pupils. He can therefore pace his children's learning.

Figure2: A Multi-grade Classroom (source: UNICEF, 2013)

3.4.1 Procedure for Utilizing Multi-grade Approach in Teaching Integrated Science

1. Creating an enabling classroom environment

The usual arrangement of students in rows does not encourage effective interaction between them. Some of the suggested steps of what to do in creating an enabling environment are as follows:

a. Maximizing classroom space by drawing pupils into groups with seats re-arranged in circular or semi-circular form. Thus creating physical space that makes pupils comfortable and want to enter into discussion or group situation. Grouping enables them to work together and share ideas with each other. To maximize space you can remove unnecessary furniture to reduce the feeling of overcrowding and to facilitate movement.
b. Use of space outside the classroom. the school ground can also be a rich resource for learning and they can serve as an enjoyable complement to crowded multi-grade integrated science classrooms. In the scheme of lower basic science and technology curriculum, emphasis is laid on the study of the environment. Themes ‘ You and Your Environment”, “Living and Non-living Things”, “You and Energy” keep reoccurring at intervals with increasing depth in content coverage. Thus, the immediate environment outside the classroom is an important and appropriate site for pupils to study living and non-living things and to develop socially and cognitively. They also learn cooperation, sense of belonging, respect and responsibility. Each group in a multi-grade class can be assigned specific task or activities appropriate for it to carry out outside the classroom.. for example, identifying living and non-living things around the school compound, gathering, sorting and classifying objectives.
c. Displaying pupils’ work creatively. Space is needed to display students’ work. rather than display boards or tables which take up space

2. Teaching Strategies for multi-grade Classes

The most frequently used approach is to teach groups in a multi-grade class separately, with one receiving instruction, while the other undertakes individual or group work, the instructional strategies used for teaching basic science and technology in mono-graded classes, can also be used in teaching multi-grade class. One of the methods is the co-operative learning strategy. To manage both the number pupils and their range of ability, grouping strategies have been used consistently. You consider the needs of both individuals and group, and organize children into small groups, triads, pairs and children working individually. You choose grouping strategy which is appropriate to the situation and which facilitates optimum learning. The composition of groups affects not only how and what they learn, but also the way children feel about themselves and how they relate to each other. Heterogeneous (mixed-ability) grouping is the most effective way to maximize pupils' success.

3. The Self-Directed Learning (SDL)

a. Self-directed or autonomous learning is when the pupils themselves take independent steps to help themselves through learning tasks, rather than relying on the teacher. This however, purely depends on the ability of the teacher to nurture self-direction in the pupils. Self-directed learning **(**SDL) goes beyond the ability to take initiative. It includes;

- The ability to realize that human beings should be responsible for their own lives;
- Recognizing that their behaviour is a function of the decision they make, not the conditions of their lives;
- They have both the initiative and the responsibility to make things happen.

What the teacher does in this regard includes encouraging the pupils to set their own goals for personal development and instructional improvement, and planning ways to achieve the goals. This is premised on the fact that when pupils are working on the goals they have set for themselves, they are more motivated and efficient, and they achieve more than when they are always working on the goals that have been set by the teacher. Therefore, the term SDL or autonomous learning implies that learners are responsible owners and managers of their own learning process, by integrating self-management. In SDL, control gradually shifts from the teacher to the pupils who exercise great deal of independence in setting learning goals and deciding what is worthwhile learning as well as how to approach the learning task within a given framework. The teacher, however, models learning strategies and sometimes works with the pupils so that they can develop the ability to use the skills on their own. This makes SDL highly collaborative, but more pupil-pupil than teacher-pupil collaboration Self directed learning is beneficial to both the multigrade teacher and pupils. To teacher:

- SDL provides the opportunity to engage the pupils in productive activities while attending to the needs of other grades or groups in the classroom. It also helps the teacher to promote active participation in learning.
- SDL creates opportunity for them to demonstrate greater awareness of their responsibility in making learning meaningful.
- It challenges their curiosity thereby encouraging and motivating them to try new knowledge and skills.
- Pupils exposed to SDL conditions do not see challenges as problems but opportunities, which they tackle with self-confidence and self-discipline.
- It prepares them for future leadership roles.

b. Self –Directed Learning

SDL entail ability to manage time and follow schedules. It also extends to ability to source the needed information and resources to tackle a challenge or an assignment, and stay on the task from the beginning to the end. Also involved is the ability to monitor success which enables them to recognize what has not been mastered in the process of executing the task. This way, self-directed learners come to the awareness of their strengths and weaknesses.

Self Directed Learning (SDL) Techniques

The following are examples of SDL techniques and how they are handled:

i. Exploratory and Inquiry Technique
ii. Project Method

Exploratory and Inquiry Technique

Exploratory technique is that which enables pupils to find things out for themselves with minimal prompting by the teacher. They learn by doing; observing; classifying and analysing. By so doing they learn to infer, predict and apply the knowledge and skills they have acquired. For example, in a Basic science and technology lesson on "Things that float and things that sink", the teacher may follow the following steps to inculcate in pupils the skill of finding out new information for themselves:

1. The teacher introduces the lesson on these and instructs pupil to go out and pick objects like stones, nails, sticks, corks, chalk, paper and leaves in the school premises. A bowl of water is then provided.
2. He/She instructs them experiments to drop each object into the bowl of water and observe which floats or sinks. The activity should last for two minutes for each pupil. While activities one and two are on, the teacher engages other pupils.
3. The pupils record their observation on a card drawn on the chalkboard, thus taking care of the criteria of predicting, experimenting, observing, recording and classifying.
4. The next step is to cater for the skills of analysing and inferring by asking the pupils to give the reasons for what they have observed so far, the pupils suggestion are recorded in another card drawn on the board.

5. The teacher He takes another step to inculcate the skill of problem solving, by providing a bowl with soapy water. He asks the pupils to repeat the experiment to find out if there would be a difference in the number of things that sink or float.
6. The pupils are now asked to compare the results. The purpose of the sequence of steps taken by the teacher is to gradually prepare the pupils to be able to carry out similar exercises by themselves, as time goes on without waiting for the teacher.

Value of exploratory technique:

It is important to note that in exploratory technique, the pupils should find things by themselves. The value of the method is to be derived from this concept. Thus, the value includes:

- Especially in science, it helps to demystify scientific concepts. It helps to reduce the fear that pupils harbour about certain subjects.
- When the pupils see the outcome of the experiment collectively carried out, they experience increased self-esteem, self-confidence and a sense of achievement.
- The teacher too is happy that the progress being made by the students can be quantified, assessed, and evaluated.
- In almost every subject area, the chats, diagram generated from exploratory technique of teaching in multi-grade classrooms can be brought together as a pool of instructional materials for the general use of the classroom or school.

Project Method

The project method is a type of inquiry method of teaching used in multi-grade teaching. It is about what you ask your pupils to do. It requires a lot of preparation time, but you will find that it stimulates interest and encourages learning because it will allow your pupils to develop their own ideas and interests. A project might also be developed based on a particular theme: Examples of such themes include: air, water, shapes, numbers, animals, etc.

Procedure of Project Method:

- You might choose a topic that is relevant to a work being done during the term.
- Brainstorm ideas with your pupils
- Plan graded activities with your pupils that make provision for investigation and study for pupils of different abilities.

Role of the Multi-grade Teacher in the Project Method

The teacher's major role in the multi-grade project method is to facilitate the process. However the pupils are supposed to carry out the activities themselves.

- The teacher should move around the class to monitor the project as the pupils carry out their activities.
- He may or may not comment on observed lapses until the task is completed. Where he does, it should be in form of progress evaluation.
- He should receive feedback from the team leader on the level of co-operation being enjoyed from the team.

The teacher must avoid any situation that may endanger the lives of children. Multi-grade project method of teaching promotes independence, curiosity, spirit of do-it yourself', spirit of collaboration/co-operation, covers different subject areas in a short time, it encourages the development of health and inter-personal relationship. Promotes community spirit

Implication of Project Method for Multi-grade Teacher
Among the implications are:

1. It enables the teacher to find out where there is a problem in the process of educating the children for example; can they see relationships between what is going on in the school and what is going on in the wider society? Having discovered where the problem lies, he makes effort to address them as much as possible.
2. Project method promotes the sharing of experiences among pupils. Project method also helps the teacher to inculcate communal spirit in the pupils. They are expected to grow to appreciate and contribute to the development of the community.

   In spite of positive implications of the project method to the teacher, it can be time consuming and demanding. Whatever the shortcoming of the technique however, project method is still of great benefit to the pupils, teachers, school and community.

4.0 Conclusion

A multi-grade classroom therefore refers to that classroom that has two or more grade levels in one particular class and is taught by a single teacher. It goes by several names in different countries such as mixed-age class, family-grouped class, double class, aptitude grouping and make-shift schooling. The nature of the multi-grade class is that, the pupils differ in their number, ages, and ability but are taught by one teacher in one classroom. There are various strategies for effective teaching of science in multi-grade class.

4.1 Summary

In this unit we have learnt about the meaning, characteristics of multi grade classroom and how it can be used in integrated science/basic science and technology classroom. We have also discussed some of the procedures in utilizing multi-grade approach to teach science.

Assignment

(i) In what circumstances would you advise the use of multi-grade teaching approach?
(ii) How can economic disadvantage be a reason for the choice of multi-grade teaching approach?
(iii) Why is the multi-grade teaching approach necessary for teaching science?
(iv) Identify and describe any five characteristics of a multi-grade school?

5.0. References/Further Reading

Basic Science and Technology (2010): *An NTI-TESSA Integrated Manual for the Re-training of Primary School Teachers (MDGs) Project*. Kaduna: NTI Press.

UNICEF (2013). *Manual for the Training of Nomadic Teachers on Multi-grade Teaching Methodology*. Kaduna: NCNE

UNIT 7: CONSOLIDATION

CONTENT

1.0 Introduction

In this unit, you will learn revise and recall all that you had learned in units 1 to 6. In unit 1, all you learned about the difference approaches to teaching integrated science concepts. In unit 2 you have learnt how to prepare a lesson plan. In unit you acquired knowledge of the resources including man power for teaching integrated science, in unit various forms of assessment techniques, they can be used, their advantages and disadvantages were also discussed. Unit5 discussed challenges of teaching a large class and strategies for dealing with the challenges. While in unit 6 teaching of integrated science in multi-grade class was thoroughly discussed.

2.0 Objectives

By the end of this unit should be able to:

1. integrated science in multi- Choose approaches that are appropriate for teaching integrated science concepts..
2. Prepare a lesson plan for teaching integrated science
3. Select and use appropriate resources for teaching integrated science
4. Select and use appropriate assessment tools in integrated science teaching
5. Overcome the challenges of teaching integrated science to a large class.
6. Teach grade class.

How to study this unit

Review units 1 through 6 and carry out all the suggested activities.

3.0 Main Content

3.1 Approaches appropriate for teaching integrated science concepts.

The various approaches/strategies for presenting Integrated Science concepts to students were discussed in unit 1. Strategies like demonstration, project, discovery/inquiry, class activities were examples but each have their shortcomings, and advantages. And as earlier discussed at earlier units, the content selected, objectives and the type of evaluations required determines the method or strategy chosen. In a particular lesson, two methods may be used to teach integrated science concepts.

3.2 Lesson Plan

In preparing your lesson plan, remember that it is your daily guide to instruction for the learning activities. It provides the instructional order to be followed by the teacher so as not to forget any point of importance.

There is no rigid format or pattern for lesson plan that can fit into all situation but you can follow the suggestions in these examples.

Sample Lesson Plans

A

Name of School: Subject: Class: Date: Unit: Average Age: Time of Lesson: Duration: Instructional Materials:	JSS Bomo, Zaria Basic Science JSS II 13/9/2014 State of Matter 11 years $9^{40} – 10^{25}$am 45 minutes Ice cubes, beakers, Bunsen burner or stove, 2 petric dishes and a spoon.
Behavioral Objectives	By the end of this lesson, students should be able to i. Identify the cause of change of state of matter ii. Mention the 3 states of matter iii. Name the 3 states of matter iv. Convert from one state to another

Time	Part of the lesson	Activity
$9^{40} – 9^{45}$	Introduction	Short quiz on previous lesson example of solid liquid and gas e.g land, sea and air. Questions of physical appearance of each.
9^{45}-10^{10}	Presentation	Steps: 1. Categorize matter into solid, liquid and gas 2. Demonstrate the interconversion of these states of matter using ice which is solid, can melt into liquid and can boil to produce gas 3. Explain their major differences and stating their molecular movements 4. Tabulate the general properties of solids, liquids and gases 5. State Charle's law, Boyle's law and Graham's law 6. Use kinetic theory of matter to explain these laws.
10^{10}-10^{15}	Summary	Highlight some of the important points on the chalkboard
10^{15}-10^{25}	Assignment (Homework)	The students should read textbooks in order to be able to define the following terms: Expansion, diffusion, density, pressure, volume and temperature.

3.3 Resources for teaching integrated science

There are two main kinds of resources available for teaching of integrated science.

The resources could either be materials/physical or human resources; that physical/non-human resources include the science classroom, science laboratory, service point, equipment/apparatus, glass wares/plastic wares, time and time table, integrated science curriculum/syllabus, scheme of work etc. Human resources include the integrated science teachers themselves, laboratory technologist, technicians, laboratory assistants and laboratory attendants.

The resources are at the disposal of the integrated science teacher who would need to harness all for the attainment of goal of science education; and in all, the teacher plays a central role.

3.4 Assessment in integrated science teaching

The most reliable method for assessing students' learning outcomes is the use of tests. Test is a series of activities purposely designed to measure learners' abilities in the area of cognition and psychomotor assessment is the process or method of finding out about students' progress the three major functions of tests are:

A. Instructional
B. Guidance
C. Administrative

The three forms of assessment in teaching/learning processes are:

1. oral form
2. written (essay and objective) form
3. project form

The forms of objective type test used in school setting are:

1. short answer items
2. multiple choice items
3. matching items
4. true -false items

Steps to consider while constructing objective tests in science:

a. identification of major concepts to be tested
b. identification of the different cognitive levels at which concepts are to be tested
c. decision on the number of test items to be included in the test preparation of a table of specification to guide you on the selection of test items to be used.

3.5 Teaching large classes

Large classes have too many students, while overcrowded classes have too many pupils for small space. Either of these poses a challenge to the teacher of Integrated Science, for effective teaching and management of large or overcrowded class relevant instructional strategies has to be adopted. The teacher also needs to vary the strategy used, which should depend on the availability of instructional materials and their safety. The strategies include demonstration, projects and active learning techniques.

3.6 Multi-grade class

A multi-grade classroom therefore refers to that classroom that has two or more grade levels in one particular class and is taught by a single teacher. It goes by several names in different countries such as mixed-age class, family-grouped class, double class, aptitude grouping and make-shift schooling. The nature of the multi-grade class is that, the pupils differ in their number, ages, and ability but are taught by one teacher in one classroom. There are various strategies for effective teaching of science in multi-grade class.

4.0 Conclusion

The resources and man power for teaching integrated science encompasses so many things. These include teachers' capability in selecting appropriate approaches for teaching concepts; ability to develop a lesson plan; identify and prepare resources that are appropriate for teaching a given topic for particular class; skill in overcoming the challenges of large and overcrowded classes; and knowledge of various strategies for teaching multi-grade classes.

5.0 Summary

In this unit, we have reviewed all the topics covered in units 1 through 6. These are approaches to teaching integrated science, lesson plan, resources for teaching integrated science, assessment techniques and tools, large and overcrowded classes, and multi-grade teaching.

Assignment

1. Select a topic from JSS Basic Science curriculum and
   a. Prepare a lesson plan for teaching the topic to JSS2 class
   b. Select with reasons an approach that is appropriate for teaching the topic.
2. Compare and contrast the objective and essay tests.
3. Enumerate the factors that a teacher should consider in selecting instructional materials.
4. What is difference between a large class and an overcrowded class?
5. What benefits of teaching integrated science in a multi-grade class?

References/Further Reading

Adeyanju, T. K. (2004). Revitalizing Education in Northern States. Kaduna: NERP Arewa House .

Basic Science and Technology (2010). *An NTI-TESSA Integrated Manual for the Re-training of Primary School Teachers (MDGs) Project*. Kaduna: NTI Press.

UNICEF (2013). *Manual for the Training of Nomadic Teachers on Multi-grade Teaching Methodology*. Kaduna: NCNE

National Open University of Nigeria (2006). EDU 740 Subject Methods(Integrated Science).