NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF EDUCATION

COURSE CODE: SED 826

COURSE TITLE: CURRICULUM DEVELOPMENT IN SCIENCE EDUCATION

SED 826: CURRICULUM DEVELOPMENT IN SCIENCE EDUCATION

COURSE GUIDE

NATIONAL OPEN UNIVERSITY OF NIGERIA

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COURSE OUTLINE

Module I Goals of Education

- National Policy on Education
- Educational Objectives
- The emerging concept of the curriculum
- Science for all curriculum

Module II Curriculum Development Design & Processes

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8 Stages in curriculum development
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Module III Foundations of the Science Curriculum

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Module IV Curriculum Integration

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12 Justification of curriculum Integration
13 Problems of curriculum Integration

Module V Curriculum Evaluation & Research

- Curriculum Evaluation
- Curriculum Research

INTRODUCTION

In many countries and Nigeria today, the curriculum is continuously being developed, expanded, integrated or reviewed.

The National Policy on Education (NPE) (1998) on the other hand has stated in clear terms the goals and objectives expected from any curriculum. And researchers have emphasized the difference in students needs and experience as regards learning at various levels.

As graduate students, this course will expose you to the expectations of the National Policy on Education for the various educational stages, curriculum development, design, processes, curriculum integration and finally evaluation and research of the curriculum.

This course is a 3 credit unit course divided into five models:

- Goals of Education
- Curriculum Development
- Foundations of the Curriculum
- Curriculum Integration
- Curriculum Research and Evaluation.

Each of these modules contains 2 – 4 units. You will be expected to go through each of the units carefully attending to all built in exercise. You will also be expected to submit a tutor-marked assignment after each unit. Most of these assignments involve your use of the library since they are research oriented. This will help you with your future research work and remember your assignments are as important as your examination as they carry equal weightings.

Course Guide

The course guide tells you briefly what the course is about, what course materials you will be using and how you can work your way through these materials. It suggests some general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully. It also gives you some guidance on your tutor-marked assignments. Detailed information on tutor-marked assignments is found in the separate Assignment File, which will be available to you. There should be some seminar classes arranged for this course where you can present your research reports. The locations time for these seminars will be communicated to you.

What You Will Learn In This Course

As a postgraduate student in this course, you must have been exposed to curriculum concept at the undergraduate level. So the overall aim of SED 826: Curriculum Development in Science Education is to introduce you to curriculum development design, integration, evaluation and research. Also the foundations of the curriculum are discussed. So should you be in a position to develop or review an existing curriculum – this course comes handy.

Course Aims

The aim of the course can be summarized as follows: This course aims to introduce you to the curriculum, its foundation, development, integration, design and processes.

This will be achieved by aiming to

- introduce you to the National Policy on Education
- explain the purpose of the education objectives in the classroom
- introduce you to curriculum development
- justify the reason why curriculum should be integrated
- teach you the on-going research style
- introduce you to the types of curriculum evaluation
- appreciate the foundations of the curriculum.

Course Objectives

To achieve the aims set above, the course sets overall objective. In addition, each unit has specific objectives included at the beginning of a unit. You may want to refer to them during your study of the unit to check on your progress. You should always look at each unit objectives after completing a unit to be sure you have done what was required of you in the unit.

Set out below is wider objectives of the course as a whole. By meeting these objectives you should have achieved the aims of the course as a whole.

On successful completion of the course you should be able to

- advance reasons for the need for the National Policy on Education
- advance reasons why the primary level is seen as a determinant of success or failure of the whole educational system
- differentiate between educational and behavioural objectives
- relate the hierarchy of educational objectives provided by Wight (1963) to their present programme

- make a critique of some definitions of the curriculum
- list areas of the curriculum affected by gender
- trace history of curriculum development in Nigeria
- draw the wheelers model of curriculum development
- list the four stages involved in curriculum development
- evaluate any presently used curriculum materials for deficiencies
- state the need for pilot-testing before installation of the card
- list some of the problems involved in implementing the curriculum
- list some of the great scientists and philosophers and their achievement
- summarize some of the philosophers' contributions to philosophical foundations of science
- list some of the psychological factors affecting the curriculum
- justify why the curriculum should be integrated
- list the various types of curriculum evaluation
- summarize the on-going curriculum research styles trends.

Course Materials

Major components of the course are

- Course Guide
- Study Units
- Journals and textbooks
- Assignments file
- Presentation schedule

Study Units

There are sixteen units in this course as follows:

Unit 1 - National Policy on Education
Unit 2 - Educational Objectives
Unit 3 - The Emerging Concept of the Curriculum
Unit 4 - The science for all curriculum
Unit 5 - Curriculum Development and Design
Unit 6 - Stages of Curriculum Development
Unit 7 - Curriculum Processes
Unit 8 - Historical Foundations of the Curriculum
Unit 9 - Philosophical Foundations of the Curriculum
Unit 10 - Psychological Foundations of the Curriculum
Unit 11 - Curriculum Integration
Unit 12 - Levels of Integration
Unit 13 - Justification of Integration

Unit 14 - Problems of Integration
Unit 15 - Curriculum Evaluation
Unit 16 - Curriculum Research

The first four units constitute module one, which is on the National Policy on Education. The next 3 units constitute module two, which is on curriculum development. Next set of 3 constitutes module three and this is on curriculum foundations. The next set of units is for module four, which has four units and the last set has 2 units on curriculum evaluation and research. This constitute module five.

Each of these units is designed to take you for a minimum double period of two hours. Where you are expected to go to the library for your tutored-marked assignment, you are likely to take more time. But as research students you have to learn to do this within a stipulated time.

Set Textbooks And Journals

Any textbook on curriculum studies will be appropriate for this course. More importantly are recent journals on this topic.

Assignment File

There are sixteen assignments in this course. That is, one assignment per unit. This is to be sure you really understood the unit. In this file, you will find all the details of the works you must submit to your tutor for marking. Remember your assignments are as important as the examinations as they carry equal weightings (50%).

Presentation Schedule

The presentation schedule included in your course materials gives you the important dates in the year for the completion of tutor-marked assignments and attending tutorials. Remember that you are required to submit all your assignments by the due date. You should guard against falling behind in your work.

Assessment

There are two aspects to the assessment of the course. First, are the tutor-marked assignments; second, is the written examination.

In tackling the assignments, you are expected to apply information, knowledge and techniques gathered during this course. The assignments must be submitted to your tutor for formal assessment in accordance with deadlines stated in the Presentation

Schedule and the Assignment file. The work you submit to your tutor for assessment will count for 50% of your total course mark.

At the end of the course, you will need to sit for a final written examination of not more that three hours' duration. This examination will also count for 50% of your total course mark.

Final Examination And Grading

The final examination for SED 826 will not be more than three hours' duration and have a value of 50% of the total course grade. The examination will consist of questions which reflect the types of self-testing, practice exercises and tutor-marked problems you have previously encountered. All areas of the course will be assessed.

Use the time between finishing the last unit and sitting the examination to revise the entire course. You might find it useful to review your self-tests, tutor-marked assignments and comments on them before the examination.

Tutor-Marked Assignments (Tmas)

Assignment questions for the units in this course are contained in the Assignment File. You will be able to complete your assignments from the information and materials contained in your set books, reading, studying units and the Internet. However, it is desirable in all degree level education to demonstrate that you have read and researched more widely than the required minimum. Using other references will give you a broader viewpoint and may provide a deeper understanding of the subject.

When you have completed each assignment, send it, together with a TMA (tutor-marked assignment) form, to your tutor. Make sure that each assignment reached your tutor on or before the deadline given in the Presentation Schedule and Assignment File. If, for any reasons, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances.

There are sixteen (16) tutor-marked assignments in this course. You only need to submit 10; this carries 5 marks each making up your 50% continuous assessment.

The final examination covers information from all parts of the course.

Course Marking Scheme

The following table lays out how the actual course marked is broken down

Assessments	Marks
Assignments 1 – 16	16 assignments, best ten out of 16
Final examination	50% of overall course marks
Total	100% of course marks

Table 1: Course marking scheme

Course Overview

This table brings together the units, the number of weeks you should take to
complete them and the assignments that follow them

Unit	Title of Work	Weeks	
	Assessment	Activity	(end of unit)
1.	- National Policy on Education	4	1
2.	- Educational Objectives	3	2
3.	- The emerging concept of the curriculum	4	3
4.	- The science for all curriculum	3	4
5.	- Curriculum development and design	2	5
6.	- Stages of curriculum development	5	6
7.	- Curriculum processes	3	7
8.	- Historical Foundations of the Curriculum	3	8
9.	- Philosophical Foundations of the	3	9
10.	Curriculum	2	10
11.	- Psychological Foundations of the	4	11
12.	Curriculum	3	12
13.	- Curriculum Integration	2	13
14.	- Levels of Integration	1	14
15.	- Justification for Integration	5	15
16.	- Problems of Integration	2	16
	- Curriculum Evaluation		
	- Curriculum Research		

How to Get the Most from This Course

In distance learning the study units replace the University lecture. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best.
Think of it as reading the lecture instead of listening to a lecture. In the same way

that a lecturer might set you some reading to do, the study units tells you when to read your set books or other materials, and when to undertake computing practical work. Just as a lecturer might give you an in-class exercise, your study units provide exercises for you to do at appropriate points.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives allow you to know what you should be able to do by the time you have completed the unit. You should use these objectives to your study. When you have finished the unit, you must go back and check whether you have reached the objectives. If you make a habit of doing this you will significantly improve your chances of passing the course.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or from a reading section. Some units require you to undertake some work in the library. You will also be directed when you need to use a computer and guide through the tasks you must do. The purpose of the computing work is twofold. First, it will enhance your understanding of the material unit. Second, it will give you practical experience of using programs, which you could well encounter in your work outside your studies. In any event, most of the techniques you will study are applicable on computers in normal working practice, so it is important that you encounter them during your studies.

Activities in form of Self-tests are interspersed throughout the units, working through them will help you to achieve the objectives of the unit and prepare you for the assignment and the examination. You should do each self-test as you come across it in the study unit. There will be some examples given in the study units; work through these when you come across them too.

The following is a practical strategy for working through the course. If you run into any trouble, telephone your tutor or post the question to him. Remember that your tutor's job is to help you. When you need help, don't hesitate to call and ask your tutor to provide it.

Read this course guide thoroughly.

- Organise a study schedule. Refer to the 'Course overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information e.g. details of your tutorials, and the date of the first day of the semester will be made available to you. You need to gather together all this information in one place, such as your diary or a wall calendar.

Whatever method you choose to use, you should decide on and write in your dates for working on each unit.

- Once you have created your own study schedule, do everything you can to stick to it. The major reason that make students fail is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.

- Turn to Unit 1 and read the introduction and the objectives for the unit.

- Assemble the study materials. Information about what you need for a unit is given in the 'Overview' at the beginning of each unit. You will always need both the study unit you are working on and one of your set books on your desk at the same time.

- Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.

- Keep an eye on the course information that will be continuously posted there.

- Well before the relevant due dates (about 4 weeks before due dates), take the Assignment File and your next required assignment. Keep in mithat you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the examination. Submit all assignments not later than the due date.

- Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study materials or consult your tutor.

  When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

ϕ When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When an assignment is returned, pay particular attention to

your tutor's comments, both on the tutor-marked assignment form and also the one written on the assignment. Consult your tutor as soon as possible if you have any question or problems.

ϕ After completing the last unit, review the course and prepare yourself for the examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this Course Guide).

Tutors and Tutorials

There are 20 hours of tutorials (ten 2 hour sessions) provided in support of this course. You will be notified of the dates, times and location of these tutorials, together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible
Do not hesitate to contact your tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary. Contact your tutor if:

- You do not understand any part of the study units or the assigned readings
- You have difficulty with the self-tests or exercises
- You have a question or problem with an assignment, with your tutor's comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

Summary

SED 826 intends to introduce you to Curriculum Development in Science Education. Upon completing the course, you will be equipped with basic knowledge of developing a curriculum.

Among others, you will be able to answer these kinds of question

- What is curriculum?
- Why do we need to refer to the National Policy in Education in developing the curriculum?
- What are the foundations of the curriculum?
- Why integrate the curriculum?
- Is it the breadth or depth that is more important in the curriculum?
- What is the on-going research style?
- When can a research be replicated?
- What are the types of curriculum evaluation?

SED 826: CURRICULUM DEVELOPMENT IN SCIENCE EDUCATION

COURSE GUIDE

NATIONAL OPEN UNIVERSITY OF NIGERIA

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COURSE OUTLINE

Module I Goals of Education
- National Policy on Education
- Educational Objectives
- The emerging concept of the curriculum
- Science for all curriculum

Module II Curriculum Development Design & Processes
- Curriculum development and design
- Stages in curriculum development
- Curriculum processes

Module III Foundations of the Science Curriculum
- Historical Foundations of Science Curriculum
- Philosophical Foundation of Science Curriculum
- Psychological Foundation of Science Curriculum

Module IV Curriculum Integration
- Curriculum Integration
- Levels of curriculum Integration
- Justification of curriculum Integration
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Module V Curriculum Evaluation & Research
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INTRODUCTION

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This course is a 3 credit unit course divided into five models:

iv. Goals of Education
v. Curriculum Development
vi. Foundations of the Curriculum
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viii. Curriculum Research and Evaluation.

Each of these modules contains 2 – 4 units. You will be expected to go through each of the units carefully attending to all built in exercise. You will also be expected to submit a tutor-marked assignment after each unit. Most of these assignments involve your use of the library since they are research oriented. This will help you with your future research work and remember your assignments are as important as your examination as they carry equal weightings.

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- summarize the on-going curriculum research styles trends.

Course Materials

Major components of the course are

- Course Guide
- Study Units
- Journals and textbooks
- Assignments file
- Presentation schedule

Study Units

There are sixteen units in this course as follows:

Unit 1 - National Policy on Education
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Unit 9 - Philosophical Foundations of the Curriculum
Unit 10 - Psychological Foundations of the Curriculum
Unit 11 - Curriculum Integration
Unit 12 - Levels of Integration
Unit 13 - Justification of Integration
Unit 14 - Problems of Integration
Unit 15 - Curriculum Evaluation

Unit 16 - Curriculum Research

The first four units constitute module one, which is on the National Policy on Education. The next 3 units constitute module two, which is on curriculum development. Next set of 3 constitutes module three and this is on curriculum foundations. The next set of units is for module four, which has four units and the last set has 2 units on curriculum evaluation and research. This constitute module five.

Each of these units is designed to take you for a minimum double period of two hours. Where you are expected to go to the library for your tutored-marked assignment, you are likely to take more time. But as research students you have to learn to do this within a stipulated time.

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Use the time between finishing the last unit and sitting the examination to revise the entire course. You might find it useful to review your self-tests, tutor-marked assignments and comments on them before the examination.

Tutor-Marked Assignments (Tmas)

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There are sixteen (16) tutor-marked assignments in this course. You only need to submit 10; this carries 5 marks each making up your 50% continuous assessment.

The final examination covers information from all parts of the course.

Course Marking Scheme

The following table lays out how the actual course marked is broken down

Assessments	Marks
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Final examination	50% of overall course marks
Total	100% of course marks

Table 1: Course marking scheme

Course Overview

This table brings together the units, the number of weeks you should take to
complete them and the assignments that follow them

Unit	Title of Work	Weeks	
	Assessment	Activity	(end of unit)
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5.	- Curriculum development and design	2	5
6.	- Stages of curriculum development	5	6
7.	- Curriculum processes	3	7
8.	- Historical Foundations of the Curriculum	3	8
9.	- Philosophical Foundations of the	3	9
10.	Curriculum	2	10
11.	- Psychological Foundations of the	4	11
12.	Curriculum	3	12
13.	- Curriculum Integration	2	13
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How to Get the Most from This Course

In distance learning the study units replace the University lecture. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as reading the lecture instead of listening to a lecture. In the same way that a lecturer might set you some reading to do, the study units tells you when to read your set books or other materials, and when to undertake computing practical

work. Just as a lecturer might give you an in-class exercise, your study units provide exercises for you to do at appropriate points.

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The following is a practical strategy for working through the course. If you run into any trouble, telephone your tutor or post the question to him. Remember that your tutor's job is to help you. When you need help, don't hesitate to call and ask your tutor to provide it.

Read this course guide thoroughly.

1.0 Organise a study schedule. Refer to the 'Course overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information e.g. details of your tutorials, and the date of the first day of the semester will be made available to you. You need to gather together all this information in one place, such as your diary or a wall calendar.

Whatever method you choose to use, you should decide on and write in your dates for working on each unit.

2.0 Once you have created your own study schedule, do everything you can to stick to it. The major reason that make students fail is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.

- ϕ Turn to Unit 1 and read the introduction and the objectives for the unit.

- ϕ Assemble the study materials. Information about what you need for a unit is given in the 'Overview' at the beginning of each unit. You will always need both the study unit you are working on and one of your set books on your desk at the same time.

- ϕ Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.

- ϕ Keep an eye on the course information that will be continuously posted there.

- ϕ Well before the relevant due dates (about 4 weeks before due dates), take the Assignment File and your next required assignment. Keep in mithat you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the examination. Submit all assignments not later than the due date.

- ϕ Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study materials or consult your tutor.

  When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

- ϕ When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When an assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and

also the one written on the assignment. Consult your tutor as soon as possible if you have any question or problems.

- After completing the last unit, review the course and prepare yourself for the examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this Course Guide).

Tutors and Tutorials

There are 20 hours of tutorials (ten 2 hour sessions) provided in support of this course. You will be notified of the dates, times and location of these tutorials, together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible
Do not hesitate to contact your tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary. Contact your tutor if:

You do not understand any part of the study units or the assigned readings

You have difficulty with the self-tests or exercises

You have a question or problem with an assignment, with your tutor's comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

Summary

SED 826 intends to introduce you to Curriculum Development in Science Education. Upon completing the course, you will be equipped with basic knowledge of developing a curriculum.

Among others, you will be able to answer these kinds of question

- What is curriculum?
- Why do we need to refer to the National Policy in Education in developing the curriculum?
- What are the foundations of the curriculum?
- Why integrate the curriculum?
- Is it the breadth or depth that is more important in the curriculum?
- What is the on-going research style?
- When can a research be replicated?
- What are the types of curriculum evaluation?

SED 826: CURRICULUM DEVELOPMENT IN SCIENCE EDUCATION

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MODULE 1

GOALS OF EDUCATION

Introduction

The National Policy of Education (1998) has spelt out in clear terms the philosophy and goals of the educational system in Nigeria and the need for any curriculum to be relevant and geared towards these goals.

In this module therefore, you will be exposed to the National Policy on Education, Educational Objectives and the Curriculum. As science students, particular attention will also be focused on the "Science for all" curriculum. So the module is divided into four units:

Unit 1 - National Policy on Education
Unit 2 - Educational Objectives
Unit 3 - The emerging concept of the Curriculum
Unit 4 - "Science for all" Curriculum.

UNIT 1

NATIONAL POLICY ON EDUCATION

1.0 Introduction

Before commencing this course of Curriculum Development in Science Education, it is important for all the graduate students to have a copy of the National Policy on Education which spells out in clear and unequivocal terms the philosophy and objectives of the education system in Nigeria. For in developing curriculum it must be relevant to the needs, aspirations and goals set for that level.

So in this unit, the broad aims and goals set for all the education levels you might be involved in as science educators will be considered which will subsequently help you in the preceding units.

1.1 Objectives

After studying this unit, you should be able to:

- Advance reasons for the need for the National Policy on Education
- State 2 broad aims of primary education and how the government intends to achieve it.
- State 2 broad aims of secondary education and how they are to be achieved
- State at least 2 broad aims of tertiary education.
- Advance reasons why the primary level is seen as a determinant of success or failure of the whole educational system
- Define primary, secondary and tertiary education according to the National Policy on Education.

1.2 Primary Education

What is Primary Education?

Primary Education is referred to in the National Policy of Education (1998) as education given in institutions for children within the age of 6 to 11 plus. It is the key to the success or failure of the whole educational system since other systems are built on it.

Activity 1.0:

Check your National Policy and write down the first three aims of primary education listed.

Others are:

- Mould the character and develop sound attitude and morals in the child.
- Develop in the child the ability to adapt to his changing environment.
- Give the child opportunities for developing manipulative skills that will enable him to function effectively in the society within the limits of his capacity.
- Provide the child with basic tools for further educational advancement, including preparation for trades and crafts of the locality.

Activity 1.2:

In order to achieve the above goals list three curricula for primary education as indicated in National Policy on Education.

You will find that Science and Mathematics are some of the subjects listed under the curriculum. So as a science teacher, the broad aims/goals of primary education should be your guide in developing the curriculum at this stage.

1.3 SECONDARY EDUCATION

This is the education children receive after primary education before tertiary education.

Most of you might be teaching at this level. Have you ever considered what the National Policy on Education says on the goals of secondary education? The broad goals of secondary education stated in the National Policy of Education (1998) are:

- ϕ Preparation for useful living; and
- ϕ Preparation for higher education.

To achieve the stated goals, the secondary education is operated in two tiers with each lasting three years. The first year is the Junior Secondary School (JSS) while the second tier is the Senior Secondary School (SSS).

Activity 1.3:

List some of the subjects in the curriculum for JSS and SSS

You will find that mathematics and science are compulsory core subjects at both levels. So should you need to develop curriculum materials at this level, the broad goals should be your guide.

1.4 Tertiary Education

What is tertiary education?

According to the National Policy on Education, this is the education given after secondary education in colleges of education, monotechnics, polytechnics, universities including those institutions offering correspondence courses.

The goals of tertiary education include:

- Contribute to national development through high level relevant manpower training.
- Develop and inculcate proper values for the survival of the individual and the society.
- Develop the intellectual capability or individuals to understand and appreciate their local and external environment.
- Acquire both physical and intellectual skills, which will enable individuals to be self-reliant and useful members of the society.
- Promote and encourage scholarship and community service
- Forge and cement national and international unity; and
- Promote national and international understanding and interaction.

These stated goals shall be achieved through:

- Teaching
- Research and development
- Virile staff development programmes
- Generation and dissemination of knowledge
- A variety of modes of programmes including full-time, part-time, block-release, day-release, sandwich etc.

- Access to training funds such as those provided by the Industrial Training Fund (ITF)
- Students Industrial Work Experience Scheme (SIWES)
- Maintenance of minimum educational standards through appropriate agencies
- Inter-institutional co-operation
- Dedicated service to the community through extra-moral and extension services.

The curriculum in the tertiary institutions cut across various disciplines in most cases with not less than 60% allocated to science and science-oriented courses. So should you find yourself involved with the curriculum at tertiary institutions, let the goals or aims be your guide.

1.5 Conclusion

In this unit, you have been exposed to the National Policy on Education and broad aims/goals as it affects the primary, secondary and tertiary institutions. These are levels you might be involved in as regards the curriculum. So make sure you always have your own copy of the National Policy on Education.

1.6 Summary

In this unit you learnt that:

- Since in Nigeria is an instrument 'Par Excellence", the National Policy on Education spells out in clear and unequivocal terms the philosophy and objectives that underlie its investment in Education
- The primary level is the key to the success or failure of the whole system since others build on it.
- Science and Mathematics are also core subjects at both junior and senior secondary school levels.
- Not less than 60% of places in most tertiary institutions are allocated to science and science-oriented courses.
- The broad aims/goals of all the levels provide a guide in developing the curriculum.

1.7Tutor-Marked Assignment

In specific terms how does the government intends to achieve the broad aims/goals of secondary education?

1.8References

National Policy on Education (1998) Federal Republic of Nigeria. 3rd Edition NERDC Press.

UNIT 2

EDUCATION OBJECTIVES

2.0 Introduction

As a teacher you must have been used to writing your lesson plans for each of your lessons. If you can remember, an important aspect of the lesson plan is to write down the objectives.

Activity 2.1:

Think of a topic and write down the objectives related to that topic.

For any teacher, one of the first things to be considered is what he would want the pupils/students to achieve at the end of the course and lessons. These outcomes can be referred to as objectives. It is after the objectives have been determined that other aspect of learning such as content selection, procedures and the methods relevant to the objectives would be examined. For this unit, you will be introduced to the educational objectives.

2.1 Objectives

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

- Define an objective
- Differentiate between educational and behavioural objectives
- State five functions of education objectives
- Relate the hierarchy of educational objectives provided by Wight (1963) to their present programme.

2.2 Definition Of Objectives

Different authors of textbooks on curriculum have various ways of defining the objectives. Let us examine Taba (1962) and Tuckmans (1975) definitions.

Educational (aims) objectives is the statements of the expected or desired outcomes (Taba, 1962)

Objectives is defined as an intended outcome stated in such a way that its attainment (or lack of it) can be observed and measured". There are many other definitions for objectives but with the intended outcomes for a learner in common.

2.3 Educational/Behavioural Objectives

Activity 2.2:

Why do some authors interchange educational objectives for behavioural objectives?

Educational objectives should be descriptive. They should describe the behavioural pattern or the learner thus providing what the learner should be able to do at the end of each lesson, course or programme. This means that when educational objectives are stated in behavioural terms with measurable attributes that can be observed it is called behavioural objectives. This makes it impossible to determine whether or not programme/course, lesson is meeting its objectives.

So at the beginning of the course or each unit, you have a list of objectives. This would usually start with the statements "on successful completion of the course, or after studying this unit or by the end of the unit" – you should be able to:

Activity 2.3;

Now check through this course units and list the descriptive verbs used under your objectives.

This includes:

Perform, Measure, Explain, Design, Illustrate, State, Describe, Demonstrate, Identify, Read, Discuss, Compare and so on. These verbs above for instance can easily be measured.

Activity 2.4:

Now compare the following objectives

By the end of this unit, the learner should be able to;

- State the Boyle's law
- Know the

Boyle’s law

As soon as the student states the Boyle's law correctly, the objective is achieved but it is difficult to measure the second one. That is when can the teacher draw the line that the student has 'known'. This is neither specific nor behavioural and so objectives need to be well defined.

2.4 Functions of Educational Objectives

Some functions of the educational objectives can be stated as follows:

- Educational objectives help in defining the areas to be emphasized in the educational programme. It sorts to provide a focus to the area of coverage.
- They help in the selection of desirable learning experiences, when the teacher is aware of the objectives he directs learning experiences accordingly.
- They help to define the directions and keeps the teacher 'on track' throughout the lesson.
- They serve as statements of values, which help distinguish good educational behaviour from bad ones.
- They illuminate the learning. That is, sort to shed light on what is expected to be learnt.
- They serve as valued statements incorporated into behaviour. For an achievement of the objectives should be seen in the behaviour terms
- They help to define the scope of the educational program. An objective set for a unit in this course for instance, tends to limit the scope of material coverage of the teacher to the specific objectives stated.
- They help in the evaluation of the degree of students performance in the manner desired. The evaluation of any programme for instance depends on its objectives.

2.5 Hierarchy Of Educational Objectives

As a teacher, you should be aware of the relationship that exists between what is learnt by your students and the societal needs. This relationship was made explicit decades ago by Wright (1963) in the construction of hierarchy of educational objectives. This stated from the highest level of broad purpoe objectives to the daily lesson objectives. Each of these is illustrated below:

- Broad purposes of education: This is usually stated by the National or Federal Government as we have in the Policy of

Education (1981, 1998) in Nigeria. It reflects the type of education desirable in the country.

- Statement of aims by local school system: The National objective here is made applicable to the local/state and school systems in the light of the prevailing conditions.
- Objectives of subject matter: From the objectives stated at the institutional/state levels. The various departments set their objectives based on areas of specializations. Teachers in the same department work together to state objectives considering suggestions made by national professional organisation in the subject or field.
- Course objective: From the departmental objectives, the various courses or programmes set their objectives. Look through the objectives for this course, SED 725 Curriculum Development in Science Education stated in your study guide to remind you of the course objectives
- Unit/block objectives or daily lesson objectives. Related units could be taken together as a block with their objectives before they are splitted into units. Where each units makes the lesson for the day, then the objectives could be referred to as the daily lesson objectives.

2.6 Conclusion

In this unit, you were exposed to the educational/behavioural objectives, the functions and the hierarchy. In the next unit you will see how these objectives can be classified into the educational domains.

2.7 Summary

In this unit, you learnt that:

- Well-stated objectives help in the selection of content, procedures and evaluations.
- Although there are various ways of defining objectives but with the intended outcomes in common.
- For every objective there is an expected or desired outcome.
- The need to write objectives in behavioural terms.
- There should be a link between what the students learn and what the society needs.
- Action verbs which are observable or measurable should be used in stating the behavioural objectives.

- Objectives help in defining areas to be emphasized, provide the scope, focus, direction and illuminate the learning.
- There is the hierarchy in educational objectives starting from the highest level of broad purpose objectives to the daily lesson objectives.

2.8 Tutor-Marked Assignment

Relate the hierarchy of educational objectives provided by Wright (1963) to your present programme. Put this in a hierarchy form from the highest level to the lowest level.

2.9 References

Gana R.W. (1981) Curriculum organisation and evaluation. Educational objectives as determinants of evaluation of curriculum and instructions. A paper presented at post-graduate seminar, Faculty of Education, ABU, Zaria.

Taba H. (1975), Curriculum development, theory and practice. Macmillan.

Tuckman B. W., (1975), Measuring educational outcomes fundamentals of testing. Harcourt Bras Inc.

Wright, J. R., (1963), Secondary school curriculum. Charles Memiln Books Inc.

UNIT 3

THE EMERGING CONCEPTS OF THE CURRICULUM

3.0 Introduction

The term curriculum needs to be clarified as it has been used in various ways in the past depending on who is involved. In this unit, you will be exposed to the concept as it relates to students, teachers or the head, the school and education.

3.1 Objectives

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

- Make a critique of some students' definitions of the curriculum
- Make a critique of the curriculum concept to the teacher
- Differentiate between the curriculum, the school and education
- Make a critique of the various stated definition of the curriculum
- Defend your own definition of the curriculum.

3.2 The Curriculum, the School And Education

There is the need to differentiate between the school and education in order to get a clearer picture of the curriculum concept. For there has been a mix up.

Activity 3.1

From your concept of the school, education and curriculum, are there some meeting points?

While education is seen as the sum total of all the interactions that a child has as he/she develops and matures, schooling is the total interactions within a special environment. Thus, schooling according to Romberg (1963) has 3 components – planning, learning and assessing. While planning is the process of deciding how to carry out the desired interactions, learning is the child's process of interacting and assessment is the process of finding out the degree of congruence. Curriculum then comes in as the product of the planning process. The latter will be made clearer in the next section.

3.1 Curriculum Concept and Student

Activity 3.2

- As a student what did the term 'curriculum' meant to you?
- Ask other students around and write down their definitions below.

Curriculum to the student is usually what he/she perceives to be intended for him in his/her courses or classes. These might include assignment, reading, homework, exercises, and field trips and so on.

- But is this all about the curriculum?

- Write below other things that should have been included.

3.4 Curriculum Concept and The Teacher (Head)

Activity 3.4

Most of you taking this course are already teachers. What does the term curriculum mean to you as a teacher?

As far back as three decades ago, Curriculum to the teacher (Romberg 1963) is what he intends for the student. A perceived mean for changing his student's behaviour.

And where the teacher is an administrator or head, it could be the whole body of courses or planned activities offered by the institution which apart from the courses of study include organized play, athletics, drama clubs and other programmes

We could see from the perspective of these characters – the student, the teacher or the head that their concern is within the end product in the form of intended learning.

3.5 The Emerging Concept Of The Curriculum

Curriculum is often defined as the planned experiences offered to the learner under the guidance of the school (Wheeler 1967, Adaralegbe 1973, and Onyike 1981). This definition of the curriculum encompasses all the subject offered in the school as well as co-curriculum design which according to Urevbu (1985) organised the Curriculum into a variable number of subject each of which purportedly represents a specialized and homogenous body content.

In Igelegbai (1981) curriculum was also defined as follows:

- A sequence of learning experience set up in the school
- The contrived activity and experience, organized, focused, systematic that life unaided would not provided
- Human activity taking place in school which is concerned with the realization of education purpose
- Goal, objective, content, processes, resources and mean of learning experiences planned for pupils both in and out of school and community through classroom instruction and related programmes.

Activity 3.5

Now let us take a cursory look at some of the definitions of the curriculum above – which definitions will you prefer and why?

You are free to adopt any of the definitions as long as you can defend it but since we are science educators let us adopt Whitfield (1971) definition as used for the curriculum analysis component of the Second International Science Study (SISS) which is taken to be "all the experiences for learning, that are planned and organized by the school" (Whitfield, 1971). This is taken since it involves the sum total of the activities both the process and product organized by the school.

3.6 Conclusion

In this unit, we have looked at curriculum concept from various perspective – the student, teacher or the head, the meeting point as it relates to the school and education.

3.7 Summary

In this unit, you learnt

- clearer picture of the curriculum emerges with understanding of the school and education
- the teacher, student or administrative heads might perceive the concept of the curriculum differently.
- there are various definitions of the curriculum and one should be able to defend which is considered more appropriate.

3.8 Tutor-Marked Assignment

Take any of the definitions of the curriculum and make a critique of it.

3.9 References

Adaralegbe, A. (1972). A philosophy for Nigeria Education Ibadan, Heinemann Educational Books Nigeria Limited.

Igelegba, G. O. (1981). Patterns of curriculum organisation. Paper presented at M.Ed Curriculum Instruction seminar Faculty of Education, ABU, Zaria.

Ing, M. (1973). Psychological issue in Iowton et al (Eds). Theory and Practice of Curriculum studies. London Routledge and Vegan Paul; 29 – 34

Onyike, I. O. (1981). Steps in curriculum development in Onwuka U. Curriculum Development in Africa. FEP Publishers Ltd.

Romberg, T. A. (1963). Survey research; Guidelines for status studies, Arithmetic Teacher 15, 639-641

Urevbu, A. (1983) Curriculum studies, Ikeja, Longman Nig. Ltd.

Wheeler, D. K. (1960) Curriculum process. London Hodder and Stoughton 1967.

Whitefield, T. (1971). Curriculum Theory: New York: Harper and Row.

UNIT 4

'SCIENCE FOR ALL' CURRICULUM

4.0 Introduction

From the National policy on Education as discussed in Unit 1 the need for science for all levels of the educational system was clearly stated. The unit considers issues concerning the role and purpose of the science curriculum and ways of providing suitable content for the "science for all" curriculum.

4.1 Objectives

After studying this unit, you should be able to:

- Explain the epistemological issues in the science curriculum.
- List 2 areas of the science curriculum affected by gender.
- Advance 3 reasons why there is gender disparity in science.
- List some effects of culture on science education.
- Differentiate between acculturation and enculturation.

4.2 Gender Issues

Activity 4.1

- What science class are you teaching?
- What is enrolment of males to females in the class?
- Why the disparity if any?

In many countries of the world and Nigeria today, programmes including all the main sciences are increasingly being offered to all students through the years of compulsory schooling..

In Sjoberg's (2000) research findings on 20 countries, he was able to show that children differ in their needs and in their experiences that might contribute to the learning of science. He showed that the interest in science varies considerably both between the developed world and the developing world and between genders. His evidence would suggest that the interests

of the two genders are still largely and universally stereotypically divided and that the science curriculum has failed to address the issue.

In Sjoberg's (2000) research work – detail files were collected from 21 countries and some of the results are indicated below. A comparison of girls and boys involved in some science activities were analysed.

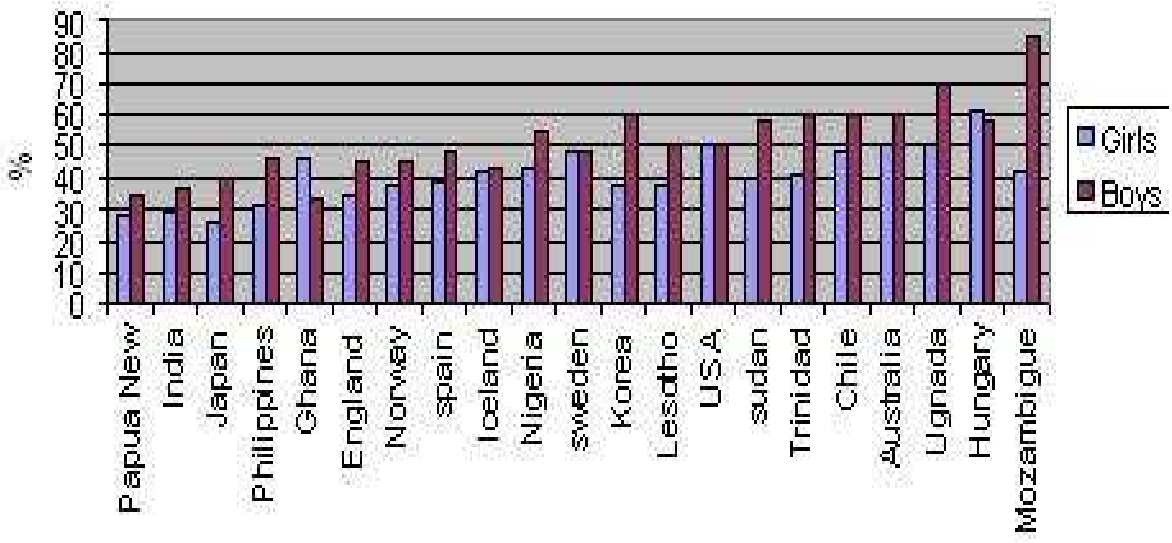

Fig. 1 - % of each country, indicating the children that have made to us from wire, wood or another materials.

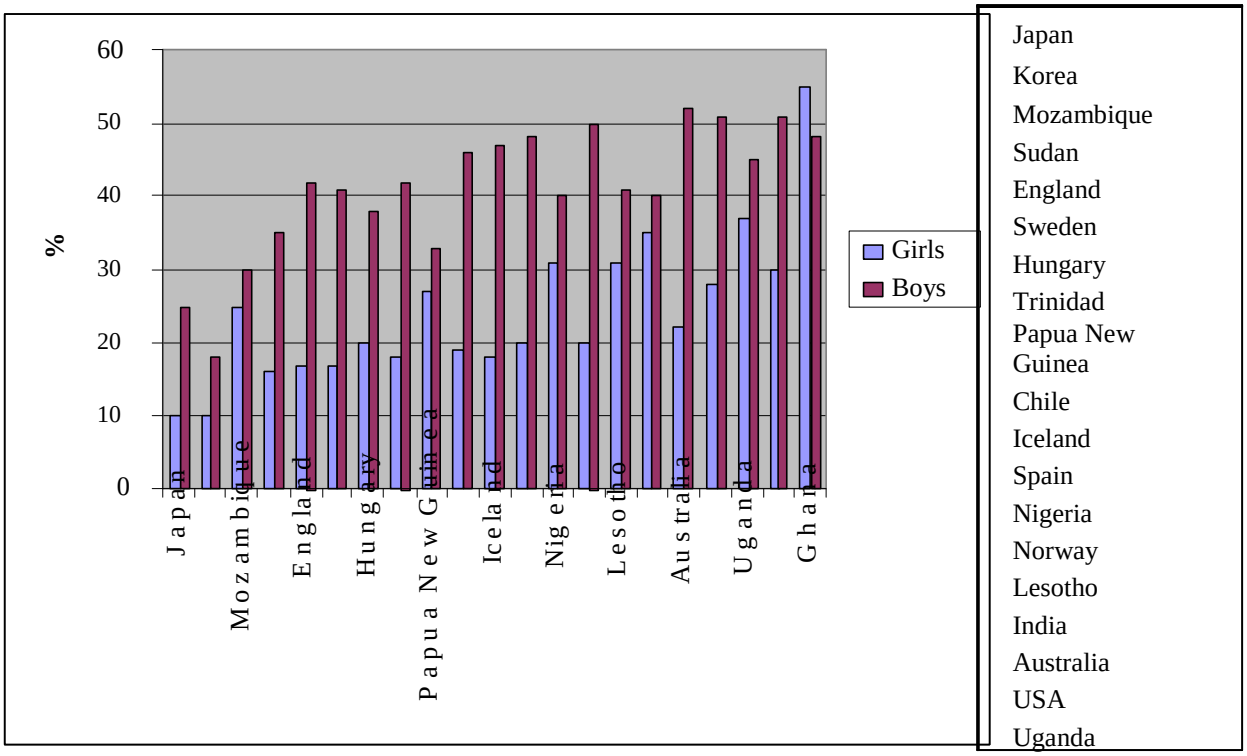

Fig 2: % who indicated they have used rope and pulley mechanisms to lift heavy things.

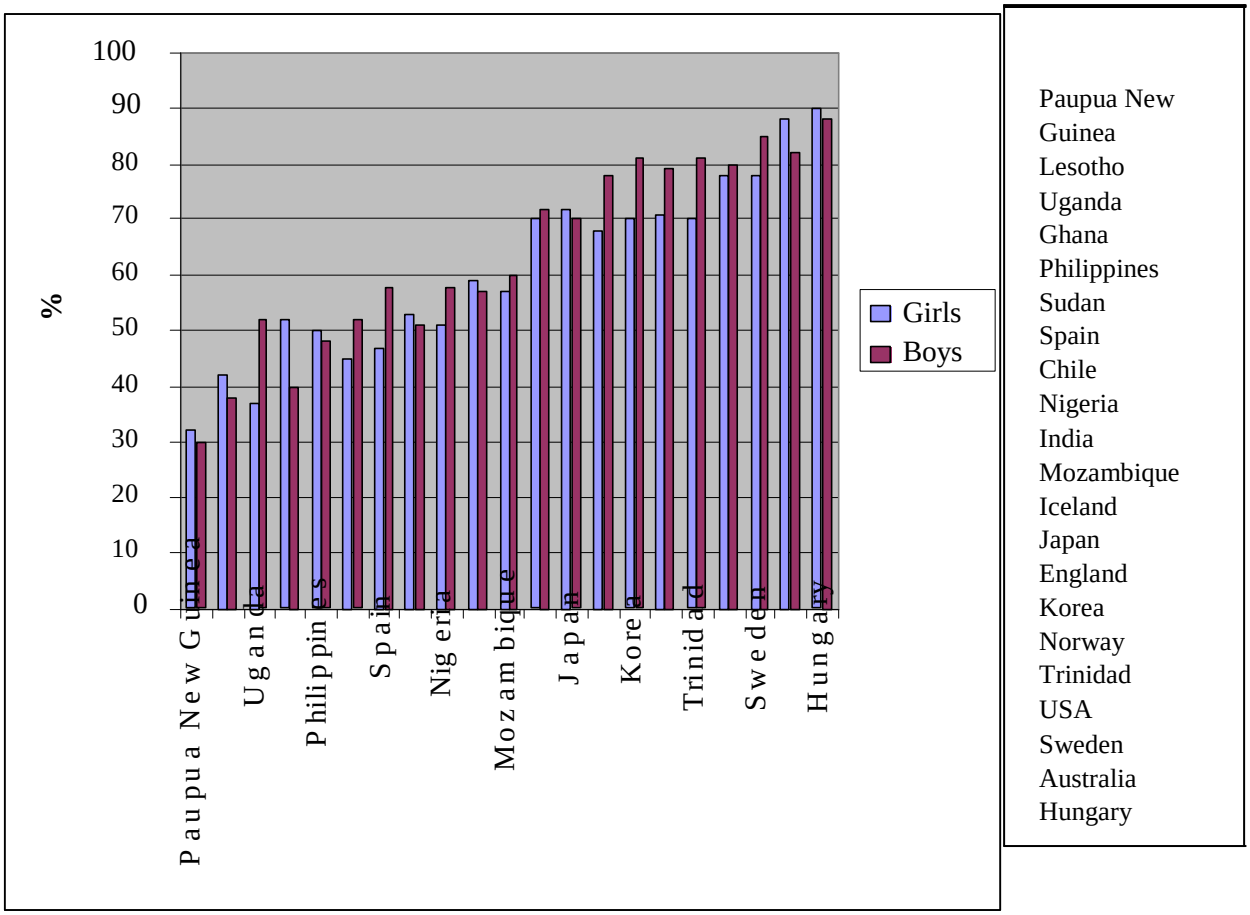

Fig. 3: % who indicated that they had played with building kits (lego).

In all these, it could be seen clearly that the boys have more experience in these science related activities than the girls.

He emphasized that although 'science for all' may have become more prevalent across the globe, it is still essentially a subject whose convert is biased against the interest of the girls. Using this data, Sjoberg (200) shows how rewriting the science curriculum from a frame that relates to girls' interest can dramatically change that potential interest in the learning of science. His work has important message for any future curricula if girls and women were not to remain the "missing half" in science.

4.3 Epistemological Issues

These are issues concerned with the nature of science. Duschi (200) focused on the notion of epistemic goals arguing that science should seek to develop

understanding not only of what is known but also of how we have come to know it.

For if science is epistemically priviledged as many scientist claimed, then a science education that ignores the social, cognitive and epistemic practices of science leaves its pupils with an incomplete understanding of science. So the need according to Duschi (2000) to focus on the data 'texts' of science and the manner in which they are used to develop scientific ideas. From his own research, he was able to show how changes in the design of instructional sequences and learning environment could promote the refinement and understanding. This revolution however requires a fundamental change on the nature of activities undertaken in the science classroom.

4.4 Cultural Issues

Activity 4.2

List two effects of culture on the learning of science

Aikenhead (2000) develops the notion of science as a cultural boarder crossing. Although, science education should be a process of enculturation into science. Many young people still grow up in a culture where the ideas and discourse of science seem foreign and unfamiliar. Infact culture and tradition in some societies impedes the knowledge of science.

So a curricular response to this is to seek to develop meanings and understandings in some depth, so that students assimilate the models and ideas of western science but this also has the disadvantage of the students loosing the value of their own cultural identity.

Aikenhead (2000) therefore argued for a situation in which science education is seen as a culture making process. For the exposure to the subculture of science is one of the several ways of encouraging students to see ideas about the world as cultural constructions.

With such an approach, recognizing the value and importance of western science, also helps the student to appreciate the legitimacy and value of other ways of knowing.

So your role as the teacher becomes that of a cultural negotiator engaged in a process of acculturation – helping the child to recognize the strengths and weaknesses of western science in comparison to other ways of knowing rather han enculturation into a singular dominant worldview. (Millar, Leach and Osborne, 2000).

4.5 Conclusion

In this unit, we learnt that although "Science for all Curriculum" has been continuously emphasized, there are so many issues including gender, epistemology and cultural issues impeding this.

4.6 Summary

In this unit, you learnt that:

- Students' interest varies considerably with gender.
- Some cultural values impedes on science
- There is need to incorporate culture into the science
- Science curriculum should be continuously reviewed to take care of gender, cultural and epistemological issues in order to achieve science for all curriculum.
- The difference between acculturation and enculturation.

4.7 Tutor-Marked Assignment

More girls can be directed into science (Discuss).

4.8 References

Aikenhead. G. (2000). Renegotiating the culture of school science chapter in improving science education.

Duschi, R. (2000). Making the nature of science explicit in improving science education. Open University Press, Philadelphia.

Millar, R., Leech, J. and Osborne, J. (2000). Improving science education. Open University Press. Bukingham – Philadelphia.

Sjoberg, S. (2000), Interesting all children in "Science for all" in improving science education. Open University Press. Bukingham – Philadephia

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MODULE 2

CURRICULUM DEVELOPMENT, DESIGN AND PROCESS INTRODUCTION

In Module 1 you learnt of the importance of having a curriculum that is geared towards the goals and needs of the society.

In this module, you will be introduced to the various models and stages of designing and developing the curriculum.

The module is therefore divided into three units as follows:

Unit 5 - Curriculum development and design
Unit 6 - Stages in curriculum development
Unit 7 - Curriculum processes

UNIT 5

CURRICULUM DEVELOPMENT AND DESIGN

5.0 Introduction

Curriculum development on various programmes has been on the increase within the education sector in Nigeria today. This unit therefore exposes you to the history of curriculum development in Nigeria and how curriculum programmes in the sciences can be developed.

5.1 Objectives

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

- Trace the history of curriculum development in Nigeria
- List five phases in the curriculum process according to Wheeler's Model.
- Compare Wheeler's and Ehindero's models of curriculum development
- Draw in a cyclic form the Wheeler's model of curriculum development.
- List four of the stages involved in the so called "project management stages in curriculum development.

5.2 History of Curriculum Development In Science Education In Nigeria

As science teachers, have you thought of how curriculum programmes in the sciences are developed?

Although between the period of 1956 and 1963, there was a vigorous science curriculum development in the United States of America and Britain in which curriculum programmes in Biology, Chemistry, Physics and Elementary Science were developed, this only got to Africa in the mid-sixties. Also in response to many programmes started being developed at the primary school level (Olarenwaju, 1995). In 1969, UNESCO also launched the Integrated science-teaching programme in response to requests for assistance from member state. It was this International trend coupled with efforts of the West African Examination Council (WAEC) to response to science syllabuses that influences the Science Teachers Association of Nigeria (STAN) to set up

curriculum committees in Biology, Chemistry and Physics. Later another committee was set up comprising members of the aforementioned committees to work on Integrated science and their deliberations marked the beginning of Integrated science in Nigeria (STAN Curriculum Development Newsletter 1970). The programme which was initially planned for two years was revised and modified to three years with the introduction of the 6-3-3-4 system of education in Nigeria. A core curriculum was then developed and designed for this category of students for Integrated science. Since the Integrated science tends to unify the sciences or cuts across the sciences, examples will be centered on this.

5.3 Curriculum Design

Activity 5.1

When you want to design a curriculum, what are the phases that should be involved?

Usually, in a science curriculum the objectives are stated, the contents are selected and the methods of teaching and education are also specified. It is described as child or learner-centered. Since their interest was taken into consideration although they were not consulted in the designing of the curriculum.

Let us now take a look at other people's model with particular reference to Nigeria situation of the curriculum process.

5.3 Wheeler's Model

In 1967, Wheeler came up with a cyclic model of curriculum process going through five phases:

- Aims. goals and objectives
- Selection of learning experiences
- Selection of content
- Organisation of integration of learning
- Experiences and content
- Evaluation

Activity 5.2

Can you draw Wheeler's model in a cyclic form?

5.5 Ehindero's Model (Nigeria)

Ehindero in 1986 attempted to modify Wheeler's cyclic model.

Elements of Ehindero's model are:

- Aims, goals and objectives
- Organisation of content and learning experiences
- Instructional facilities and strategies
- Tests, assessments and evaluation.

Activity 5.3

Now take a look at Wheeler and Ehindero's model above, could you see any missing gap, list them.

3.4 Project Management In Curriculum Development

Both models appear to have left out the processes of trying out or
implementation. Balogun on his own in 1983 described ten stages in what he called Project management in curriculum development. These stages are:

- Organising the curriculum team
- Systems study
- Choice of subject matter
- Material development
- Personnel development
- Formative evaluation
- Modification of materials
- Installation of materials
- Summative evaluation

- Revisionary cycle

This so called "Project Management" stages were used in the development of core-curriculum for JSS Integrated Science (Balogun 1983). Olarewaju (1987 however, remarked that three of the project management stages have been omitted. These are personnel development, formative evaluation and modification of materials. The remaining seven stages will be discussed in details. These are:

- Organising the curriculum team
- Selection of aims and objectives
- Choice and organisation of subject matter
- Personnel development
- Pilot testing and revision
- Installation
- Evaluation

5.7 Conclusion

In this unit, you have been exposed to brief history of curriculum development and of the curriculum development process but with some stages or phases in common. Curriculum development itself should be a continuous process but with some stages or phases in common. Curriculum development itself should be a continuous process and the last stage – evaluation helps to determine if there is need for a review or not of the whole programme. If the former, then the cycle according to Wheeler starts again from the first stage. A detail of these stages with examples in Integrated science will be provided for you in the next unit.

5.8 Summary

In this unit, you learn that:

- Curriculum programmes can be developed depending on the societal needs and national aspirations.
- There is always the need to revise or modify any curriculum programme found to be deficient.

- There are various phases in curriculum development process.

- Curriculum development is a continuous process. The last stage (evaluation) determines the continuation of the cyclic model as stated by Wheeler's 1967.

- There are so many curriculum development models but with common phases or stages.

5.9 Tutor-Marked Assignment

Draw the Wheeler's model in a cyclic form indicating the direction of the arrows.

6.0 References

Balogun, T. A. (1983). Strategies of Education change and the implementation of Integrated science teaching special reference to Nigeria. Journal of Research in Curriculum 1 (1), 22-40

Ehindero, S. (1986). Curriculum foundations and development for Nigerian Students, Lagos, Concept Publications Ltd.

Olarewaju, A. (1987). Some problems identified in implementing the core-curriculum for Integrated science. Journal of STAN, 25 (2), 61-69.

Olarewaju, A. (1995). The design and development of the core curriculum for Junior Secondary School Integrated science. In Integrated Science Teaching in African Schools. UNESCO, Dakar.

STAN, (1970). Curriculum development Newsletter

Wheeler, D. K. (1967), Curriculum process. London: Hoddes and Stoughton.

UNIT 6

STAGES IN CURRICULUM DEVELOPMENT

6.0 Introduction

From unit 5, you learnt about the various model in curriculum development process. In this unit, the seven stages described by Olarewaju 1995 will be discussed in details with examples relevant to the Nigerian situation.

6.1 Objectives

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

- List the seven stages discussed on curriculum development
- State the need for putting together a curriculum team
- Advance reasons why the choice and organisation of subject matter should be child focused.
- State the need for pilot-testing before installation of the curriculum
- Evaluate any presently used curriculum materials for deficiencies
- Advance reasons for periodic evaluation of the curriculum

6.2 Stages Of Curriculum Development

As mentioned in unit 5, the process of curriculum development is a continuous one and it goes through various phases.

Activity 6.1

Can you list 4 of the phases mentioned under Wheeler's model?

Olarewaju (1995) suggested some stages, which were used for the Integrated science curriculum. These include:

- Organising the curriculum team
- Selection of aims and objectives
- Choice and organisation of subject matter

- Personnel development
- Pilot testing and revision
- Installation.
- Evaluation

6.3 Selection of Aims and Objectives

After the organisation of the curriculum team, there is need to define the broad aims and the specified objectives of the programme that is what is the expected outcome from such a curriculum programme to be written. An example with the integrated science programme provided by Olarewaju 1995 should help you with this.

For instance, if the aim of the Integrated science programme is to teach students what science is and how a scientist works. Thus the content of the programme should

- Be relevant to the child's need and learning experiences
- Stress the fundamental unity of science
- Lay adequate foundations for subsequent special study and
- Add a cultural dimension to science education.

6.4 Choice and Organisation of Subject Matter

Activity 6.2

Observe the following chosen topics in the Integrated science

- You as a living thing
- You and your home
- Living component of the environment
- Controlling the environment

What Can You Notice?

You will observe that the child is the central focus in these themes. The child is able to understand himself. What makes him a living thing, able to see the relationship between himself and others, know about his environment, his health and other things? All these are aimed at making learning relevant to the everyday needs of the child and thus foster learning.

So in the choice and organisation of any subject matter; the child must be put in focus.

6.5 Personnel Development

The effective development of any curriculum requires competent hands and the right attitude to work. It involves professionals, experts with experience who will be willing to explore various techniques of the curriculum without being afraid of failure.

Experience as regards various teaching strategies would be important. According to the designers of the core-curriculum for JSS Integrated science; the following teaching strategies were recommended:

- Use of discovery teaching factors. This may be broadly defined, as children should arrive at scientific knowledge and scientific understanding as a result of their own observations.
- The inclusion of problem-solving activities
- The involvements of students in "open-ended" field or laboratory exercises (STAN, 1970)

Activity 6.3

What do you understand by pilot testing?

In any curriculum development process, there is need to test the success of the curriculum on a small scale or sector before the installation. The loopholes observed would help towards a revision before the curriculum is put into place.

6.6 Installation

This is the stage where the curriculum is being used in school.

Activity 6.4

Some curriculum-developed materials are being used in your school for teaching various aspects of the sciences. List five of them in the space provided with the authors.

6.7 Evaluation

Activity 6.5

With your reference in using the materials listed under 3.6, have you noticed any deficiencies in the curriculum? If so, list them.

Olarewaju (1987) for instance conducted a study on the core-curriculum for JSS Integrated Science and found among others that:

- Teachers cannot cover all the topics specified for each year in the curriculum
- Teachers find topics not related to their areas of specialization difficult to teach. They also cannot perform activities related to such foreign areas.

Based on his findings, he suggested a revision of the curriculum with a view to reducing the content to match the available time.

This stage of evaluating the curriculum is usually the last stage and if there is need for a revision, the circle starts all over again. It is always important to subject the curriculum to evaluation periodically.

6.8 Conclusion

In this unit, we learnt about the seven stages in curriculum development process and how important it is for a curriculum to be learner-centered. The need to periodically evaluate each curriculum in line with its objectives was also emphasized.

6.9 Summary

In this unit, we learnt that

There are various stages involved in curriculum development

The choice and organisation of subject matter should be learner-
centered

There is need for pilot testing before a curriculum is installed.

Where there are deficiencies in any curriculum, the curriculum should be evaluated and revised.

There is need to involve respected and experienced professionals in curriculum development

There is need to define the broad aims and objectives of the programme.

6.10 Tutor- Marked Assignment

Get Junior Secondary Integrated Science textbooks 1-3 of STAN. Write down theme 1 and 2 for each of the years. What do you observe in line with the broad aims and objectives?

6.11 References

Olarewaju, A. (1987). Some problems identified in implementing the core-curriculum for integrated science. Journal of STAN, 25 (2), 61-69

Olarewaju, A. (1995) The design and development of the core-curriculum for Junior Secondary School Integrated Science. In integrated science Teaching in African schools. UNESCO Dakar

STAN (1970) Curriculum Development Newsletter No 1.

UNIT 7

CURRICULM DEVELOPMENT PROCESS

7.0 Introduction

Science teaching in Nigeria schools before and immediately after the independence was in the form of Nature Study, General science, Gardening, Health Science etc. But in the last two decades, there have been intensive activities at producing viable science programmes for the schools. In this unit, efforts of the various bodies in developing science curriculum for both primary and secondary levels of Education in Nigeria will be considered in line with the implementation problems**.**

7.1 Objectives

After studying this unit, you should be able to:

- List some of the organizers involved in curriculum development
- List some of the problems involved in implementing the curriculum
- Advance reasons why some curriculum materials developed do not pass through all the stages of development**.**

7.2 Organizations and Some Sponsors of Science Curriculum Development

Activity 7.1

Take two of the science text books that you presently used in the classroom. Write down the names of the authors.

Several efforts have been made by several states through their ministries to construct science curriculum for schools. Also higher institution (Universities, Institute of Education), parastatals like NERDC and Organizations like the Science Teachers Association of Nigeria has also attempted curriculum development of science materials. These efforts have been made possible in most cases through the generous financial and personal support by UNESCO, UNICEF, Ford Foundations, Federal Ministry of Education and other agencies.

Notable among previous efforts made are:

- The Nigerian Secondary School Science Project (NSSSP) by CESAC now NERDC.
- The Nigerian Integrated Science Project (NISP) by Science Teachers association Textbook, 1 – 3 of Nigeria (STAN).
- The Nigerian Integrated Science Project Workbook 1 – 3 by the Science Teachers Association of Nigeria (STAN).
- Primary Science Workbook 1 – 6 by STAN
- Basic Science for Nigerian Secondary Schools (BSNSS) by CESAC and STAN.
- Primary Education Improvement Project, Northern States Primary Science Project NSPSP by the Institute of Education, ABU Zaria.
- Science is Discovery: Mid-Western State Primary Science Project (MSPSP) by Abraka College of Education.
- The Ile-ife Primary Science Programme produced in English and Yoruba by Institute of Education, Obafemi Awolowo University, Ile-Ife, and others.

7.3 Evaluation Of Science Curriculum Programmes

In the previous unit, you learnt about the stages of curriculum development. Some of the different programmes listed previously can be reviewed against the ten stage process of project management. Let us now take a look at Balogun (1995) analysis of some of these pogrammes.

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CURRICULUM DEVELOPMENT PROCESSES	NPSP	PSPN	BSPSP	IPSP	BSNSS	NISP
1. Organizing curriculum team	+	+	+	+	+	+
2. Starting curriculum Objectives	+	+	+	+	+	+
3. Determining relevant subject matter	+	+	+	+	+	+
4. Analyzing goals and constructing prototype/materials	+	+	+	+	+	+
5. Involving teachers and training them	+	+	+	+	+	+

6. Pilot test (Formative evaluation)	+	+	+	+	+	-
7. Modification of materials	+	?	+	+	+	-
8. Installation of materials	+	+	+	+	+	+
9. Summative evaluation	-	-	?	-	+	+
10. Revisionary cycles	?	?	?	?	?	+

Fig. 1 Analysis of Steps taken in project management of some science Projects

+ = Yes

- = No

? = Position not clear

NPAP = Nigerian Primary Science Programme

PSPN = Primary Science Programme for Nigerian Northern States.

BSPSP = Bendel State Primary Science Projects

IPSP = Ife Primary Science Project

BSNSS = Basic Science for Nigerian Secondary School

NISP = Nigerian Integrated science Programme

Activity 7.2

What can you observe as regards the listed programmes Vis a Vis the curriculum development stages?

You will notice that all the listed programmes

- Organized their curriculum team
- Atated the curriculum objectives
- Determined relevant subject matters
- Analyzed goals and constructed prototypes materials

- Involved teachers and trained them
- Installed materials

But not all the programs

- Pilot tested
- modified the materials
- Conducted summative evaluation and there was no clear position for most programmes**.**

7.4 Curriculum Implementation Problems

Activity 7.3

List two (2) of the problems you consider could hinder the implementation of the problems.

Since science is a core subject at the primary and secondary level, and to teach it, there should be an element of imposition in the implementation strategy.

For instance, formerly, teachers are free to choose from the market any text material considered appropriate for the students. But lately, the ministries have taken it upon themselves to prescribe and even in some cases buy texts of their choice for the schools. So the limiting factors for effective implementation of any curriculum materials according to Balogun (1995) include:

- Deficiencies in the innovations itself which might be seen inform of syllabus overload or unrealistic goal setting on the part of the projects.
- Inadequate planning
- Lack of or insufficient training of Science teachers, there are still very few teachers trained to teach it.
- Lack of resources or ability to explore and use resources readily available in the environment.

- Incongruence with adopter's current practices and uses. The need to get the teachers to value clarification and re-orientation.
- Lack of commitment
- Lack of follow-up mechanisms - providing some monitoring systems to help with the follow up.

9.5Conclusion

In this unit, we have been exposed to efforts of some sponsors and organizations in developing some science curriculum. Also an analysis was provided of some of the developed curriculum vis-à-vis the stages of curriculum development. The problems of implementing this curriculum were also treated.

9.6Summary

In this unit, you learnt that:

- There are various organizations involved in curriculum development.
- Some of these organizations are sponsored by the federal Government or International Agencies.
- Some of the curriculum developed does not pass through all the stages of curriculum development.
- There are some problems hindering the implementation of such curriculum.

7.7 Tutor -Marked Assignment

You have been invited by the Science Teachers Association of Nigeria to help revise the Nigerian Integrated Science project – Textbook I. List the suggested stages you would expect.

7.8 References

Ayodele, E.A. (1995). The design and development of Nigerian Integrated Science curriculum. UNESCO, Dakar.

Balogun, T. (1995). The experience of ineterscience teaching in Nigeria, UNESCO, Dakar.

MODULE III

FOUNDATIONS OF THE SCIENCE CURRICULUM

Science has been described as one of the greatest weapons man has ever invented for leaping into the unknown, (Marx 1998). Infact, right from the time of creation, man was not only faced with the task of finding explanations to the vagaries of this universe but also with the task of finding answers to the myriads of problem encountered each passing day (Umeoduagu 2000). To do this, he has often times has cause to have recourse to rational thinking and logic. Also, historically, science as a discipline has its origin from philosophy. But its teaching and subsequent evaluation hinges on some historical, philosophical and psychological foundations. This module therefore focuses on these three basic foundations and is divided into 3 units:

Unit 8 Historical foundations of science curriculum

Unit 9 Philosophical foundations of science curriculum

Unit 10 Psychological foundations of science curriculum

UNIT 8

HISTORICAL FOUNDATIONS OF SCIENCE CURRICULUM

8.0 Introduction

Since science teaching hinges on some foundations, In this unit, the historical foundation of the sciences curriculum will be considered.

8.1 Objectives

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

- List some of the great scientists in history.
- Mention some of the achievements of the science scholars.
- Relate the achievement to the development of the science curriculum.
- Give a summary of the science curriculum from the historical perspective.

8.2 Some Great Scientists

Activity 8.1

List five names of the great scientists you have read about, that are different from the ones listed.

Some of the names include Plato, Aristotle, Guttenberg, Kepler, Gilbert, Archimedes, Euclid and so on.

Exercise 2

Mention the contribution of any of those listed above:

You will soon discover that each of these scientists made great impact on science, mathematics and technology education. Infact the origin of modern day science could be traced to some of these great scholars

8.3 HISTORICAL FOUNDATIONS OF SCIENCE CURRICULUM

Umeoduagu (2000) recently gave the historical perspective of science education. From the historical perspective, the origin of modern science could be traced to early Greek philosophers like Plato and Aristotle around the 5th and 6th Centuries BC. Plato used the application of mathematics, especially geometry, in the development of reasoning and acquisition of knowledge about the world. Aristotle had interest in the study of the natural world as well as ethics and metaphysics. His insights and dialogue with Plato must have laid the foundations of the philosophy of nature. In fact his writings during this period with influence up to the 17th Century provided significant foresight for the development of science. History has it that based on the theories put forward by Aristotle, with respect to chemical changes, Egyptian chemists developed the principles of alchemy, the precursor of modern chemistry.

Great mathematicians like Euclid and Archimedes came up at this time and during which studies in physiology and medicine became prominent. It is pertinent to note that science experiences subtle growth up to the period of the Renaissance. For example, in 15th century in Italy, there was the discovery of nature and the translation of scholarly Latin and Greek texts in sciences and other disciplines. In Germany, there was rapid development in mathematics, mining and metal technology. Guttenberg invented the art of printing and flourished textbook production and this boosted the teaching of science. Scholars from Poland, Belgium and Italy produced texts in astronomy, anatomy and mathematics. Other prominent discoveries included the explanation of the compass needle by William Gilbert (1600) in relation to the earth as magnet. Johannes Kepler , in 1609, discovered the natural orbits of the planet in relation to the sun. In England, William Harvey (1628) discovered the circulation of blood. Suffice to say that science, mathematics and technology advanced tremendously by the 19th and 20th Centuries AD. Research produced more scientific principles and theories applicable to technology for the development of society. The present millennium will witness some imminent and fascinating challenges to man.

8.4 Effect On The Science Curriculum

Activity 8.3

From the historical perspective given under 8.2, list three (3) of the subjects mentioned:

You will find out various science disciplines including mathematics and

technology were mentioned. Since these contribute to the economic well bring of any nation, their inclusion in the school curriculum has steadily

progressed in the years. This could be seen in the Nigerian National Policy of Education that laid emphasis on science right from the primary school to tertiary level of education. For every developing nation the study of science and technology should be the foremost in their curricula.

8.5 Conclusion

In this unit, the perspective of the science curriculum was viewed from the historical dimension. Great scientists and their achievements as it relates to the science curriculum have also been discussed.

8.6 Summary

In this unit, you learnt that:

- The science curriculum should be traced to some great scientists.
- The achievements of these scientists have great impact on the historical perspective of the science curriculum.
- The importance the national Policy on Education attached to the science is well deserving.
- There are some names of the great scientist that should be known.

8.7 Tutor-Marked Assignment

Get to the library and write on any of the great scientist in history. (5 pages).

8.8 References

Marx, G. (1988). Education for an unknown future. Lecture delivered at the British Council Course on Teacher Training for Science Education. Kings College, University of London.

Umeodwagu, S.N. (2000). Evaluating Science, Technology and Mathematics Education: Some Historical Consideration. 40th Annual Conference Proceedings STAN 2000.

UNIT 9

PHILOSOPHICAL FOUNDATIONS OF SCIENCE CURRICULUM

9.0 Introduction

Philosophy has been a subject that most students dread and would rather avoid. Infact some of the students complained of its "dry and abstract nature".

Well, in this unit, you will be introduced to philosophy and science education from the philosophical perspective as summarized by Umeoduagu (2000). This should bring you closer to the concept.

9.1 Objectives

After studying this unit, you should be able to:

- List some great philosophers in science education
- Summarize their contributions to the philosophical foundation of science.
- Differentiate between philosophy and science.
- Describe some philosophical theories associated with science.

9.2 Philosophy and Science

Activity 9.1

Write in two (2) sentences below, your understanding of philosophy and science.

Philosophy has been described not in ordinary sense of the phrase: a body of knowledge but rather an activity of criticism and clarification (Yunusa, 2000), whereas, science is the systematic study of nature and how natural world works.

So the philosophy of science is that aspect of philosophy, which seeks to explain how science on its own works.

In other words, philosophy of science seeks to explain the procedures involved in the process of scientific inquiry such as observation, calculations, presumptions and even patterns of arguments or reasoning. This might

explain why in the early days of science, one could hardly draw a line between science and philosophy as the observed events in science could be explained to be mainly placed on philosophical principles, while science is methodologically analytic, because we can only learn "bits" of the whole at the time, the ultimate aim of doing science is really to discover and provide a unifying view (synthesis) of the world. Therefore, science teaching should reflect the true nature of science (Balogun, 1995).

9.3 Some Great Science Philosophers

As early as 600 BC, philosophers had made attempts to offer a rational explanation of nature instead of relying on mythological beliefs, although most of their arguments were based on epistemic grounds and could not make a lasting impact.

Activity 9.2

Write two (2) sentences each of two (2) of the science philosophers you have read about.

For instance, Plato argued that numerical and geometrical assumptions could be used to explain the events of nature – this laying a precise postulation for mathematical methodology in the study of nature.

Aristotle on the other hand, agreed on the contrary that natural phenomena could not be explained by abstract mathematics principles but by empirical observation from which deductions could be made. Perhaps the original arguments of Plato and Aristotle could offer a more precise hearing even though they were a mixture of ontological, epistemological and empirical approaches. These arguments centered on individual preoccupation and are both intelligible and contemplementary which is the more reason why contemporary philosophies of science could be traced to their original postulations.

9.4 Some Philosophical Theories About Science

After the discovery of the scientific methods during the 17th Century, philosophers and scientists alike especially within the European nations became more optimistic that more scientific achievement should be recorded during the Medieval and Greek periods. This prevailing zeal may have led to the postulation of some philosophical theories about science.

Activity 9.3

Can you list one of these philosophical theories?

Philosophical theories such as rationalism and empiricism can all in an attempt to ascertain the veracity or validity of the scientific method which has become trusted as a method of study and obtaining true knowledge about the natural world. Rationalism as a philosophy holds that reason is a very superior avenue for obtaining knowledge. As expounded by Descartes (influenced by Plato) the whole process of knowledge could be deduced mathematically. To him, deductive reasoning and proof that are characteristics of mathematics could be used to explain the logical structure of nature. In one of his works "Principa Philosophiae" he lucidly illustrated that mathematical assumptions based on Euclidian principles could be used to explain natural phenomena especially in the physical sciences through deductive reasoning. This line of argument influenced sciencing a great deal and it is worth noting that the hypothetico-deductive method is still relevant in the study of science today.

Unlike rationalism solely based on reason, empiricism is the theory that experience is the ultimate source of knowledge. In Greek and Mendieval philosophy, Aristotle, Epiricus and St. Thomas Aquinas were empiricists by their line of thinking. Between 17th and 19th Centuries, British empiricists like John Locke, Francis Bacon and John Stuart Mill emerged and created remarkable impact. Bacon believed in inductive reasoning as a source of knowledge. Locke believed that knowledge was not got by observation alone but both by observation and prior knowledge. Mill believed in the use of inductive inference as a tool for generalizations from experience. Mathematical inferences, basically, are supposed to be deductive but in Mill's opinion such generalizations are founded on induction.

So far, it could be seen that right from ancient periods, philosophers of science have struggled to explain the vagaries in the operation of nature itself. This intellectual struggle moved on through times to the 2oth Century. Thus, rationalism and empiricism, as originated by Plato and Aristotle and crystallized into firm existence and recognition by subsequent philosophers like Descartes and Bacon, could be seen as the best philosophies man has arrived at in justifying the scientific method. While Descartes wanted science based on pure reason (rationalism), Bacon wanted it based on experience.

9.5 CONCLUSION

In this unit, you learnt about philosophy and science, great philosophers' contributions to science and some philosophical theories about science. This should have brought you closer to the concept of philosophy.

9.6 SUMMARY

In this unit, you learnt that:

- Philosophy of science is that aspect of philosophy which seeks to explain how science on its own works.
- Philosophers had made attempt to offer rational explanation to the nature of science.
- Contemporary philosophies of science could be traced to the original postulation of Plato and Aristotle.
- There is a difference between philosophy and science.

9.7 Tutor-Marked Assignment

Identify a great philosopher and write on his contribution to science education.

9.8 References

Balogun, T. (1995). The experience of Inter science teaching in Nigeria UNESCO Dakar.

Umeoduagu, S.N. (2000). Evaluating science, technology and mathematics education: Some Historical Consideration. 40th Annual Conference Proceedings STAN 2000.

UNIT 10

PSYCHOLOGICAL FOUNDATIONS OF SCIENCE CURRICULUM

10.0 Introduction

This unit, which is the last in the module on foundations, considers the psychological foundation of the science curriculum. Various learning theories and how they can be applied to the teaching and learning of individuals at various levels of development will be considered.

10.1 Objectives

After studying this unit, you should be able to:

- List some psychological issue that needs to be considered in the classroom.
- Summarize some of the learning principles
- State the implication of each of the learning theories to science teaching.
- List some of the psychological factors affecting the progress in science.

3.0 Science and Psychology

Activity 10.1

List four ways you have been applying psychology in the classroom.

Educational psychology has been concerned with the growth and development of an individual. The teaching of science on the other hand has been consistent with the child's level of intellectual and emotional development. For as described (Yunusa 2000) – Could the teaching of a person in Russian to a group of pupils who had knowledge of that language be teaching them the appreciation of the poem? Or would a lecture on the differential calculus designed for undergraduate be considered teaching if presented to a class of average ten-year olds. So the need for the child's development to be considered in the teaching learning situation.

The relationship of psychology to science education can be viewed mainly from the field of cognitive psychology. The learning theories concerned and their relevance to science education will be discussed in the next section.

Learning theories

Activity 10.2

Take a look at the following names:

- David P. Ausubel
- Jerome S. Bruner
- Robert Gagne and Jean Piaget

Select and two of them and write a sentence each on what you have read about them.

13.3.1 David P. Ausubel (Subsumption)

He emphasizes meaningful learning as contrasted to rote learning. Ausubel considered that rote learning usually associates with new learning. He maintains that meaningful learning can only occur when what is to be learnt is related to what is already known. That what is already known is already present in the mind. Meanings depend on some equivalent representation in the mind. In other words, for a stimulus or concept to have meaning, there must be something in the learners' conscience. This Ausubel labeled as cognitive structure which can provide for the interaction necessary for meaningful learning are called subsumers.. Subsumers are mere generalized ideas. Conceptual schemes or knowledge first acquired by learners that can be associated with various components of new knowledge. When new knowledge is replaced mentally into an existing category of similar knowledge of subsumers in the mind of the learner, then meaningful learning must have taken place.

If a learner does not have a previous subsumer for a new knowledge, Ausubel proposed that advanced organizers may be used. Advanced organizers are prior information or complex sets of ideas or concepts that is given to the learners before the material to be learned is presented. An organizer is meant to provide stable cognitive structure to enhance meaningful learning. An organizer also increases recall.

13.3.2 Jerome Bruner's Model Of Learning By Discovery

J.S. Bruner is amongst the recent psychologists who put forward solution to problems in Education. This theory promotes the acquisition of knowledge through discovery by oneself through the use of mental processes. It takes place in two ways.

- The learner encounters a new situation that is similar to one on the element in his existing structure of knowledge and assimilates it with ease. This is similar to Ausubel's theory.

- When the learner encounters a new situation which is incompatible with its existing knowledge, he then restructures the existing knowledge in order to create a place in his mind for the new knowledge. Bruner believes that it is only through the exercise of problem solving and the effort of discovery that one learns the heuristics of discovery. Students assume more responsibility for their own learning.

  Bruner described four major benefits derived by children when they learn how to investigate and discover for themselves:

  - An increase in intellectual potency.

  - A shift from self-reliance on extrinsic reward to a reliance on intrusive reinforcement, this is because the act of discovery is itself highly pleasant (interesting).

  - Learning the heuristics of discovery.

  - He maintains that discovery facilitates transfer and memory and that frequent use of the discovery methods leads the learner to acquire skill in problem solving.

13.3.3 Robert Gagne Hierarchy

Gagne in his theory made two distinctions regarding the arrangement of learning situations involves the following:

- Management of learning

- Conditions of learning

He implies that learning materials should be structured. He maintains that meaningful learning can only take place in gradual step from the specific to the unknown.

According to Gagne, it should be possible to break down into some steps, one step slightly higher or lower than the preceding step. This he described as hierarchy of learning. The task of the teacher is to break down any information to its hierarchy and the process of breaking down the general knowledge into specific knowledge is called task analysis.

10.3.4 Jean Piaget

Jean Piaget, French-Swiss psychologist was the best student of cognitive development. His work made a significant change in science. He proposed a number of stages through which the process of logical thinking develops as the child grow from birth to 12 years.

Sensory –motor stage (Birth-2 years).

A child at this stage collects information from their environment through their senses and reacts by reflex responses, e.g. moving his arm, kicking its leg and sucking its thumb. During this stage, the child is unaware that objects have no permanency once they disappear from immediate sight. That is objects create to exist if they cannot be seen.

Pre-operational state (2-7 years)

The child in this stage has not acquired the logical operation characteristic of later stages. This period is divided into two stages:

- **Pre-conceptual stage** (2-4 years): The child at this stage represents his environment with symbols. They are inconsistent in their thinking. The child develops immature concepts for example, a child at pre-conceptual stage may have a general idea that birds have wings and that they can fly but he cannot be able to distinguish between the kinds of birds.

- **Intuitive stage** (4-7 years): The children in this stage are egocentric that is self centered from other people's point of view. Example is for a child at this age to call men generally daddy.

The thinking of children during this period is also characterized by irreversibility. They are unable to go back and rethink of a process or concept. Due to this, they tend to say e.g. that liquid poured from one container into another of different size or shape has increased or decreased in volume. This failure to conserve in children is related to their inability to think back and imagine how the liquid looked earlier and to recall that nothing was done to the liquid to change its volume.

Concrete operational stage (7 – 11 years)

The child at this stage can course. The child now knows that transforming liquids or solids in shape does not change there volume of mass, reserving thinking appears. The child is now able to learn the operation of adding,

subtracting, multiplying and dividing. He can classify objects and also
represent external world by memories, images, language and symbols.

Formal operations (11 – Adulthood)

At this stage, the child develops abstract and reflective thinking. A child in the formal operational stage can solve complex problems, formulate hypothesis and make deductions as a scientist.

10.3.5 IMPLICATION OF THE LEARNING THEORIES TO SCIENCE TEACHING

You have gone through some of the learning theories. It will be necessary to consider some implications of these in you as a science teacher.

Implication of Ausubel's Theory

- ϕ It emphasizes expository methods. Materials for learning should be sequentially structured by the teacher.
- ϕ Science teachers should select the organizers which may be scientific principles or generalizations that must contain ideas with which the students will be familiar e.g. Dalton's atomic theory, the law of Definite proportion.

Implication of Bruner's Theory

- ϕ Learners should be provided with tasks to keep their minds at alert all the time so that their mind could be occupied. Discovery enhances problem solving and the child participates actively in finding answers to his problems. The child them remembers and understands what he has learnt than when somebody presents him with the knowledge.
- ϕ Discovery activities provide students with experiences that are helpful in their generalization after undergoing some mental processes such as observation, classifying and this enhances creativity in students because the child is involved.
- ϕ Bruner believes that any knowledge can be taught to any child in some honest form at any level. By that, Bruner means that the statement should be reinterpreted and re-examined in terms of the possibilities of teaching the aspect of any subject at any age, level by using simple language , clear and simple diagram.
- ϕ Bruner advocated the spiral current in which develops and redevelops topics at different rates or different levels for the acquisition of

knowledge – going from simple to complex. Learners should be exposed to simple instances of concepts as they discover relationship among these; they are exposed to the higher level of more generalized concepts which includes their earlier learning. Teachers should be guide in educational process and students should be exposed to discovery approach.

Implication of Gagne's Theory

- ϕ For learning to be effective, a learning programme for each child must take carefully into account what he knows already and what he doesn't know.
- ϕ Learning stimulates a child to make use of capabilities that are already at his disposal.
- ϕ Step by step learning
- ϕ Individuality of learners

Implication of Jean Piaget learning Theory

The developmental stages should be recognized and the child should be taught only what the child is ready to learn at a particular stage.

- ϕ The curriculum should be planned with the level of cognitive operations and structures that children have successfully attained.
- ϕ Children in primary schools should be given objects to manipulate with widely different properties of texture, colour and shape.
- ϕ Emphasis should be placed on doing than telling.

10.4 Conclusion

In this unit, science education viewed from the psychological perspective and various learning theories and their implications to the classroom teaching were also considered.

The need to consider the development stages of the child in planning the curriculum was also stressed.

10.5 Summary

In this unit, you learnt that:

- There are some psychological issues that need to be considered in the classroom.
- The learning theories of Ausubel, Bruner, Gagne and Piaget have various implications for the science teachers.
- There are some psychological factors that can affect the progress of science education.
- There is a need to consider the development stages of the child in planning the curriculum.

10.6 Tutor-Marked Assignment

Choose any one of the learning theories and discuss its implication to your science teaching.

10.7 References

Yunusa, B. (2000). Issues on Curriculum. ABU Press, Zaria.

UNIT 11

CURRICULUM INTEGRATION

11.0 Introduction

As a science teacher, you may have had to teach integrated science at one time or he other. Have you ever wondered what is integrated and why the integration. This unit and unit 13 help to answer this question.

11.1 Objectives

After studying this unit, you should be able to:

- Explain what it means to integrate
- List some integrated curriculum
- List the subsections of the product oriented programmes
- List the groupings of the processes oriented programmes.
- Draw the relationship between the processes and products of science.

11.2 Integration and Some Integrated Curriculum

Activity 11.1

What does it mean to integrate?

So many words have been used in an attempt to explain integration – fusion, unity or putting together. Integration could be seen as an attempt at synthesizing or putting together subject matter from different disciplines or subject matter.

Activity 11.2

Name some integrated curriculum you know.

This includes the following:

- Integrated science
- Social Studies
- Introductory Technology

- Business Studies
- Home Economics etc.

11.3 Content Variable

Activity 11.3

Take for instance, integrated science as your integrated curriculum.

What can you say about the content of the curriculum as regards the breath and depth?

A major issue as stated by Balogun 1995, on the content of integrated curriculum relates to the scope and intensity of integration (To find out whether or not depth move virtuous than breadth). The question of scope is about how many disciplines or sub-disciplines and indeed of knowledge in great, should be included in, for instance, an integrated science programme.

Intensity on the other hand is concerning the desirable degree of fusion between the various content elements of such a programme. (So the question is to find breadth).

Taking a look at the various dimensions of content of science programmes which of them for instance can lead to the greatest intensity of integration? To do this, are the following dimensions of science:

- Process
- Product
- Effective content and its interaction with society.

Detailed consideration of only the products and processes of science have been suggested by Balogun 1995 as the possible sources of integration in science education.

11.4 Product Oriented Programmes

The product oriented science programmes have various subsections with subject area as there starting point. The subsections are as follows (Balogun 1995).

1. Subject Areas (sub-disciplines of science): Astronomy, Biology, Chemistry, etc.

2. Subsections of subjects: Organic chemistry, heat, light, etc.

3. Topics – Air, sand, colour, etc.

4. Concepts- Charge, space, time, adaptation, etc.

5 Themes – The molecular theory of matter, the kinetic theory of heat, etc.

11.5 Process- Oriented Programmes

These programmes have the processes of science as there starting points and those were grouped by Balogun (1995) as follows:

- Perception: Observation (sensations – sense data + interpretation).
- Intellectual processes: Clarification, raising questions, formulating hypothesis, formulating models, interpreting data, inferring, predicting, defining operationally.
- Concrete processes: Manipulating objects, measuring, counting and determining number relationships, experimenting, controlling and determining number relationships, experimenting, controlling and manipulating variables communication.
- These groupings according to him are not options since processes – oriented programmes generally use virtually all the processes – so the grouping should make the nature of the processes more explicit.

But the next question is – the fact that a programme is product – oriented does it exclude the processes of science and vice versa?

The answer is No. Infact, the use of the processes of science most in all probably led to the discovery or acquisition of scientific product (information/knowledge). However, the relationship is not necessarily a reversible one. That is, you should be able to teach scientific information without the processes of science.

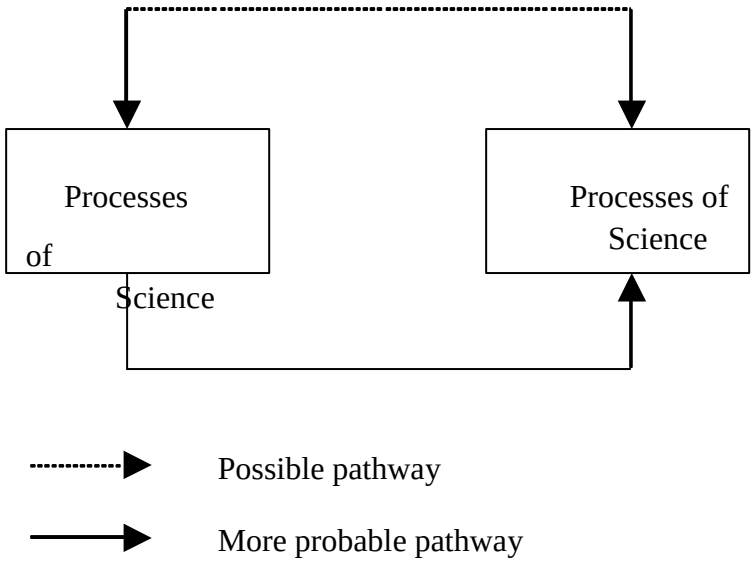

Fig. 1: Relationship between Processes and Product of science.

This relationship has very important implication for science curriculum development especially at the primary and secondary levels. Although it is increasingly becoming common to refer to science programme at the primary level as integrated science, initially virtually none of these programmes, both at home and abroad, actually use these label for themselves. For example, the former Bendel state Primary science programme: "Science is Discovery", the Primary Science for the Northern states (PSNS), science education Programme for Africa (Africa Primary Science Programme: APSP) are just science programmes without any of the adjectives: integrated, combined, or general, etc.

The same is true for Conceptually Oriented Programmes in Elementary Science (COPES), Elementary Science Studies (ESS – with which, incidentally, APSP has affinity), Science Curriculum Improvement Study (SCIS), Science: A process Approach (SAPA): all in the United States; and the Nuffield Junior Science (U.K.).

But it can be seen under product 3 to 5 and processes 1 – 3 allows us to do without the qualifying adjectives. If we can do without the qualifying, then why integrate? We shall be considering this in Unit 13.

11.6 Conclusion

In this unit, you learnt about the concept of integration, some of the integrated curriculum. Also the products and processes oriented programmes were considered and this led to the big question of why integrate?

11.7 Summary

In this unit, you learnt that:

- Integration is an attempt at synthesizing subject matter from different disciplines.
- Integrated curriculum includes social studies, integrated science, business studies etc.
- Processes and products of science are possible sources of integration in science education.
- The product oriented programmes has subsections starting with the subject areas.
- The process oriented programmes could be grouped.
- There is a relationship between the process and product oriented curriculum.

11.8 Tutor-Marked Assignment

Take the JSS III Integrated science textbook by the Science Teachers Association of Nigeria.

- List the topics and group according to the various subject areas.
- Which subject area dominates?
- Are there overlaps?

11.9 References

Balogun, T.A. (1995). Integrated science teaching concept, problems and progress in Integrated Science Teaching in Africa schools.

UNIT 12

LEVELS OF CURRICULUM INTEGRATION

12.0 Introduction

In the last unit, we focused on integrated curriculum in schools. In this unit, you will be introduced to the various levels of integration for your science curriculum.

12.1 Objectives

After studying this unit, you should be able to:

- Give 2 examples of inter-disciplinary integration
- Distinguish between intra and inter-disciplinary integration.
- Give 2 examples of intra-disciplinary integration.
- List some processes and products of science.
- Integrate some of the products and processes of science.

12.2 Inter-Disciplinary Integration

Activity 12.1

Name 1 discipline that is inter-disciplinarily integrated.

This includes:

- Social sciences
- Mathematics
- Natural Sciences
- Technology etc.

For instance, integration between:

- The natural sciences (biology, chemistry, earth sciences and physical). For example, The Nigerian Integrated Science Project (NISP) by the Science Teachers Association of Nigeria (STAN) was an attempt made to develop science curriculum by inter-disciplinary integration.

- The National Sciences and Mathematics, for example – The National Primary Science and Mathematics Project (NPSMP). This was an attempt made by the Nigerian Educational Development Research Council (NERDC) to correct deficiencies that were still apparent in the design of the curriculum and general approach to science teaching at the primary school levels.

- The Natural Sciences and Technology – With the coming in and emphasis on technology, so many projects are now coming up. Integrating science and technology and some cases even with mathematics. For instance, the Science, Technology and Mathematics Project (STM) or the STM clinic for girls which is geared at encouraging more girls into science, mathematics and technology.

- The natural aspects of the social sciences or languages, geography, sociology, anthropology, Yoruba, etc. For instance, the yoruba medium project: Western State Primary Science Project (W.S.P.S.P.) by the Faculty of Education, University of Ile-Ife (now Obafemi Awolowo University) which was an attempt to integrate Yoruba language with science.

Activity 12.2

List two journals as examples of inter-disciplinary integration.

This may include:

- Journal of Science, technology and Mathematics Education (JOSTMED) published by Department of Science Education, Federal University of Technology, Minna, Nigeria.

- School Science and Mathematics – An official journal of the School science and Mathematics Association, USA.

12.3 Intra-Disciplinary Integration

With the same discipline, certain aspects can be integrated. This is the intra-disciplinary integration, For example – There are various aspects of chemistry which include: organic, inorganic and physical chemistry. Any attempt to merge any of these brings about intra-disciplinary integration. The same applies in biology with anatomy and ecology merged.

Activity 12.3

Which aspects of physics could be integrated under the intra-disciplinary integration?

This might include light, heat, electricity or mechanics.

12.4 Integration Of Product And Process

In Unit 11, you learnt that a curriculum or programme is product oriented and processes of science, For instance, products such as concepts, topics and themes can be integrated with the processes of science.

Activity 12.4

List 4 processes of science mentioned under Unit 11

This includes:- classification, observation, formulating models, interpreting, inferring, manipulating etc.

12.5 Conclusion

In this unit, you learnt about some of the levels of curriculum integration. In the next unit (Unit 13), you will be able to determine if there is really any justification in integrating curriculum.

12.6 Summary

In this unit, you learnt that:

- Inter-disciplinary integration refers to integration between disciplines.
- There are various examples of inter-disciplinary integrated curriculum.
- Intra-disciplinary integration refers to integration within the same discipline.
- Products and processes of science can be integrated.

12.7 Tutor-Marked Assignment

As a member of the Science Teachers Association of Nigeria, List some of the single discipline associations' curriculum materials and those that integrates.

12.8 REFERENCES

Balogun, T.A. (1995). Integrated science teaching concept, problem and progress. In Integrated Science Teaching in Africa Schools. UNESCO Dakar.

UNIT 13

JUSTIFICATION FOR CURRICULUM INTEGRATION

13.0 Introduuction

There had been so many questions on why we need to integrate science. Might be you or your students are asking the same question. If so, this unit will help you as you focus on some of the rationale (Philosophical, psychological, pedagogical and practical) for integrating (Balogun 1995).

13.1 Objectives

After studying this unit, you should be able to:

- State some philosophical reasons for integrating science.
- Advance some psychological reasons why science should be integrated.
- List some advantages of integrated science from pedagogical point of view.
- Advance argument for and against curriculum integration.

13.2 Psychological Consideration

Activity 13.2

As regards enrolment into sciences and other disciplines in your school, what has been your experience?

Recent research efforts have been geared towards encouraging more students into science and technology. Making science interesting and fun has been the emphasis to combat its abstract nature.

We have mentioned earlier under psychological foundations how it is important that the intellectual and emotional development of the child be taken into consideration in learning. So integrated science which tends to unify the sciences and starts with the basics might motivate the generality of the children than the separate sciences. The child is able to see the same concept and principles applied on many situations (biological, chemical, physical) and enables the child to better achieve internal integration and meaningful concept formation.

13.3 Philosophical Consideration

The argument here surrounds the supposed unity of knowledge and specifically that of scientific knowledge. Previously you have learnt about the origins of science – its nature (epistemology) and methods (methodology).

If science is methodologically analytic because we can only learn "bits" of the world at a time, then the ultimate aim of doing science should be to discover and provide a unifying view (synthesis) of the world (Balogun 1995). That is, science is ultimately concerned with discovering the unity that underlines all processes and phenomena in nature.

So, integrating the sciences should reflect the true nature of science.

13.4 Pedagogical Consideration

List one topic that as a student or teacher you learnt under different subjects (or disciplines).

There are so many topics that cut across disciplines. For example, a Gas law in chemistry is also a topic in physics.

From the pedagogical point of view, integrating the sciences satisfies the principles of unity, coherence, economy and efficiency. It takes care of the overlaps in the various disciplines and the students are able to see the unity in science. For an essential goal of science education should be simplified and search for unity rather than the fragment knowledge. So, many educationists consider integrating the science as a desirable objective in interest of well rounded education.

13.5 PRACTICAL CONSIDERATION

Activity 13.3

Do you have integrated science teachers and laboratory in your school?

In most schools, there are no laboratories specifically for integrated science and the same applies to integrated science teachers. The latter have had to be teachers from other science disciplines so integrating the sciences makes for effective use of available teachers and teaching facilities. It also eases the pressure on time-table. A subject (integrated science) is now slotted in for the lower classes (for instance in Junior Secondary Schools) rather than three subjects (chemistry, physics and biology).

It is also a vehicle for developing and promoting scientific literacy.

13.6 Conclusion

In this unit, you learnt about the justification for integration of science.

The implications of this however will be discussed in the next unit.

13.7 Summary

In this unit, you learnt that:

- There are some psychological considerations in integrating.
- The learner might be more motivated than separate sciences.
- The fact that the science is ultimately concerned with discovering the unit that underlines processes or phenomena in nature should provide the philosophical consideration for motivation.
- There had been overlap across disciplines and from pedagogical point of view, integrating takes care of the overlap.
- Integrating the science for instance, helps on the effective use of available teachers, teaching facilities and eases the pressure on the time.
- It is a vehicle for developing and promoting scientific literacy.

13.8 Tutor Marked Assignment

As a science teacher, advance some argument for and against curriculum integration.

13.9 References

Balogun, T.A (1995). Integrated science teaching: Concept, problem and progress in integrated science teaching in Africa schools, UNESCO, Dakar.

UNIT 14

SOME PROBLEMS OF CURRRICULUM INTEGRATION

14.0 Introduction

In the last three units (units 11 - 13),. you had considered curriculum integration, the various levels and the justification provided for curriculum integration. In this unit, you will learn about problems that could nullify the justification for integration.

14.1 Objectives

After studying this unit, you should be able to:

- State reasons why lack of qualified teachers should hinder integration.
- List some factors that can militate against integrating the curriculum.
- State the advantages of using the teachers' guide.
- Justify why sufficient time should be provided for integrated curriculum.
- Justify why some teachers and students would prefer single disciplines than the integrated curriculum.

14.2 Qualified Teachers

Activity 14.1

Do you have integrated science department in your school? If yes, how many, teachers are teaching this course -that really specialized in integrated science.

Research report in Nigeria indicated that several science teachers teach out of their areas of specialized. (Ogunsola-Bandele). This has even been more evident with integrated. For it has been found that most of the teachers teaching integrated science in schools are actually qualified in other disciplines (chemistry, physics, biology, zoology, botany etc) due to lack of qualified teachers in integrated science. This is so, because formerly our higher education programmes tend to be highly specialised until recently when the integrated science is introduced to especially the colleges of education who train teachers for the lower levels. To address the short-fall in qualified teachers, Balogun (1995) had stressed the importance of using the teachers guide to help teach integrated science. According to him, professionally trained and other science teachers can do a good job of teaching integrated science if they have access to the teachers guide and are willing to make the efforts. So, publishers should be encourage to produce teachers guide which for sometime has been off the shelves.

13.4 Content Variable

In the last unit 13, we emphasised on the unity of science and the need for integration. But the fact that teachers with various specialised areas are still found in the integrated science classroom tends to dis-integrate what is supposed to be integrated.

If you are a physics teacher and due to lack of integrated science teacher you are asked to teacher the subject, how will you approach it?

In most cases, the physics or other subject discipline teacher will choose the familiar topics, - topics that he/she is more comfortable with and teaches these topics very well to the disadvantage of other topics. Infact it was found that single discipline teachers tend to only select the topics in their disicplines (Ogunsola – Bandele, 1999).

So all attempt to teach integrated science in schools had failed by dis-integrating it and nullifying the objective of unifying science. Another issue related here is that of breath and not depth. Some students have been heard to complain that the integrated science curriculum is too wide because there is so much to cover within a short time. So teachers have to rush the syllabus and students would rather go in for the single discipline subjects.

14.4 Equipment And Facilities

In most schools, integrated science students have had to share facilities and laboratory with other science departments. When it is time for biology related practical - the students are moved to the biology laboratory, to the chemistry laboratory when it is chemistry related practical and so on. This allows the students again to see the various components of the integrated science and defeating achieving the objective of unifying science.

Some schools without a laboratory of its own for Integrated Science, move the students from one laboratory to another may not be ideal as regards time and adequacy of facilities.

Also as regards improvisation, it has been argued that it is easier to provide for three.

14.5 Conclusion

In this unit, you learnt that despite the justification for integrating the curriculum, there could be some problems. Problems discussed here was centered on integrated science which is more applicable for the science teacher.

14.6 Summary

Some of the factors inhibiting integration include:

- Nature of the subject (breadth and not depth)
- Lack of laboratory
- Lack of equipment
- Lack of materials
- Lack of interest
- Lack of qualified teachers
- Lack of teachers guide
- And lack of enough time allocation.

14.7 Tutor-Marked Assignment

Discuss some of the problems you have in your school militating against the integrated curriculum.

14.8 References

Balogun T.A. (1995), Integrated Science Teaching: Concept, problems and progress in Integrated Science = teaching in african schools. Unesco, Dakar.

Ogunsola - Bandele M.I.(1999).Teaching science courses in and out . of 'Area of certification in single-sec/co educational schools. A paper presented at the NARST Conference. Boston USA.

CURRICULUM EVALUATION

15.0 Introduction

In Unit 6, you learnt that evaluation is one of the stages of curriculum development and should be a continuous process to ensure the success of the curriculum. In this unit, you will be introduced to the concept of curriculum evaluation, the types and problems involved with evaluation.

15.1 Objectives

After studying this unit, you should be able to:

- Define curriculum evaluation.
- List some problems involved in evaluation.
- List the two types of evaluation.
- Differentiate between summative and formative evaluation.

15.2 The Concept Of Evaluation

From Unit 6, you learnt that the importance of evaluating every curriculum programme to be in line with the stated aims and objectives.

Activity 15.1

But what do you understand by evaluation?

Evaluation from an instructional point of view can be seen as a systematic process of determining the extent to which instructional objectives are achieved. And as regards the curriculum, every programme initiated can either be discarded or continued because of some forms of evaluation undertaken.

Activity 15.2

But why is it necessary to evaluate?

- To determine the relative effectiveness of the programme in terms of students behavioural output;
- To make reliable decisions about educational planning;

- To ascertain the worth of time, energy and resources of the programme;
- To identify students growth or lack of growth in acquiring certain knowledge, skills, attitudes and social values;
- To help teachers determine the effectiveness of their teaching techniques and learning materials;
- To help motivate students to want to learn more as they discover their progress or lack of progress in given tasks;
- To encourage students to develop a sense of discipline and systematic study habits;
- To provide educational administrators with adequate information about teachers effectiveness and school need;
- To acquaint parents or guardians with their children's performances.
- To identify problems that might hinder or prevent the achievement of set goals;
- To predict the general trend in the development of the teaching learning process;
- To ensure an economical and efficient management of scare resources;
- To provide an objective basis for determining promotion of students from one class to another as well as the award of certificates;
- To provide a just basis for determining at what level of education the possessor of a certificate should enter a career;

You can see from the above that evaluation is not only for students but also for teacher, parents, administrator, educational planners or curriculum planners and so on.

15.3 Formative Evaluation

This is usually undertaken during the process of development of any
programme aimed at ensuring the acquisition and development of knowledge

and skills by students. It can be used to find out whether students could do what they could not do initially before a learning experience.

Activity 15.3

Give an objective that could come under the formative evaluation

Tyler in Ben - Yenusa 2000?gave a short term objective of formative evaluation as students able to pass the end of year promotional examination and the long-term, would be able to pass the school certificate examination.

These, objectives wouldn't have been achieved without your students going through certain learning experiences. Infact the main aim of formative evaluation is therefore to help the student to perform well at the end of whatever programme he or she finds herself.

Activity 15.4

Give one advantage of formative evaluation:

Well among others, it reassures the programme users of the chances of success. It also provides feedback to the teacher, learner and curriculum planners on the achieved success.

3.2 Summative Evaluation

Summative evaluation is primarily concerned with the progress, purposes and out comes of the teaching learning process. In the classroom situation for instance, your students performances, the quality of the teacher and the processes and strategies used by the teacher are evaluated and summed up as the usefulness of the programme.

Summative evaluation are based on the following assumptions:

- That the programme's objectives are achievable.
- That the teacher-student materials interactions have been conducive to learning.
- That the teaching techniques, learning materials and audio-visual aids are adequate and have been judiciously dispersed.
- That there is uniformity in classroom conditions for all learners (Ben - Yenusa 2000).

Activity15.5

List one advantage summative evaluation may have over formative evaluation?

From the assumptions above, you can see that summative evaluation is more comprehensive and objective than formative evaluation. From the summative, one could easily determine the success of a new program in comparison to the old one. This might inform some statistical analysis to be accurate. It also helps the curriculum planner make modifications on any programme found to be defeated before the final stage of going to the public. This helps to save cost.

15.5 Problems Of Evaluation

Activity 15.6

List two of the problems militating against successful evaluation of programmes.

Despite the emphasis on the need to evaluate every programme before use, the following are some of the factors hindering this:

- The programme might be under-funded and not able to go through all the stages of development.
- The programme may have been initiated too late.
- The programme is not in line with the stated objectives.
- There was not adequate preparations devoted to the writing team.
- Lack of expertise and experience.
- Government policies and actions may sometimes impedes evaluations.
- Effective evaluation should be .continuous but might not be possible due to funds number of students and other factors.

15.6 Conclusion

In this unit, you learnt about the concept of curriculum evaluation itself and the two types of evaluation - summative and formative evaluation. The problems involved in the evaluation process are also discussed.

15.7 Summary

In this unit, .you learnt that

- Evaluation is a process of determining the extent to which the objectives can be achieved.
- Evaluation should be a continuous process.
- Formative evaluation concerns itself with the process of development of any programme.
- Summative evaluation is primarily concern with the progress, purposes and outcome of the teaching learning process.
- That the summative evaluation is more comprehensive and objective than the formative evaluation.
- There are many problems that can impede the process of evaluation.

15.8 Tutor-Marked Assignment

The evaluation stage is very important to any curriculum development. Discuss.

7.0 References

Ben-Yenusa, M. (2000), Issues on cumculum. A.B.U. Press. Zaria.

UNIT 16

CURRICULUM RESEARCH

16.0 Introduction

This is your last unit in this course on curriculum development in science education. So, in this unit you will learn about science education research - the content, style and replication. This unit will also help you to know the present trend in science education research.

2.0 Objective

After studying this unit, you should be able to

- List some of the research work that are familiar.
- Support the fact that Science Education research rose after the 70's.
- List some of the categories into which journal articles can be grouped.
- State the present research style in science education.
- Advance reasons why some researches in science education are replicated.
- Report on the research style on present articles published in some Nigerian Science Education Journals.

16.2 Science Education Research Trends

Activity 16.1

Take a science education journal and look through the content of the articles - what did you notice?

A cursory look of the titles of journal articles could give the impression that science education divides into diverse categories. They are usually studies related to:

- Curricula

- Teaching styles Behaviour in the laboratories
- Motivation
- Students belief
- Classroom and laboratory management and other topics.

The single purpose responsible for the diversity according to Gunstone and White (2000) is to bring students to understand concepts and natural phenomena in the terms that scientists use. Most of these study share the goal of improving learning and science education.

Another unifying characteristic is that science education concerns the understanding of specific content, which is a vital variable. For content is a factor that has given science education an identity distinct from education in general.

16.3 Progress In Science Education Research

Activity 16.2

Take any 2 of the Science Teacher's Association of Nigeria Journal. One in the 80's and the second one in the 90's. Can you observe any difference in the direction of research?

According to Gunstone & White (2000), there was no much progress in science education research in the 1960's but, certainly in the 1970's the quantity of research increased tremendously. This could be seen in the comparison of the review of science education research by Watson (1963) in the first edition of the Handbook of Research on Teaching with those in the second edition by Shulman and Tami (1973) and the third by White and Tisher (1986) and with other numerous chapters in the Handbook of Research on Science Teaching and Learning (Gabel 1994) reveals a surge in the amount, richness, and diversity of research. But to really on whether there has been progress in science education research or not, Gunstone and White (2000) advised that we look at the research style.

16.4 Research Style

The research style as said earlier has a role to play in determining the progress of research. And the questions are:

- Has the research style changed in ways that appear more likely to create principles which are useful guides to practice?

- Have such principles appeared?
- What evidence is there that the research has influenced classroom practice?

White (1997) made an analysis of the shifts between 1965 and 1995 in research style and concluded that the change in style amounted to a revolution. There has been a marked shift from interventionist studies in which the researcher imposed on experimental form of teaching to descriptive ones where the researcher made observations over lengthy periods of time of events in working classrooms. This shift also was evident in the statistics employed. It involved greater reliance on qualitative data and verbatim reporting of teachers and students words rather than means of scores of tests. That is moving away from reporting sophisticated inferential statistics to simple descriptive statistics or no statistics at all.

16.5 Research Content

The number of studies on content also rose tremendously between 1965 and 1995 although it is unlikely that any single scholar or publication was sole responsible. For example Ros Driver's doctoral study (1973) and her subsequent articles and books (Driver and Easley 1978, Driver 1981, 1983, Driver & Erickson 1983; Driver et al 1985; Driver and Bell 1986) certainly had significant effect.
Also where Gagne and White (1978) had conceived of memories for events as wholly beneficial to understanding Driver perceived that beliefs formed from experience could impede understanding. This perception constitutes a very important principle (Gunstone and White 2000).

After Driver's initial work studies on students' conception revealing differences between their beliefs and scientist explanations, proliferated. This soon dominated science education research. The bibliography compelled by Pfundt and Duit (1985, 1988, 1991 and 1994) grew edition by edition until the fourth listed around 3,500 studies. And embedded in the early studies of alternate conception was another significant principle - sciences concepts/topics to be learned are a significant variable in feeding the concepts/topics.

Research on alternative conception includes Zarour (1995), Encleson (1979), Viennot 1979); Champagne et al (1980) and Osborne (as reviewed in Osborner and Freyberg 1985).
They investigated beliefs of topics usually from physics but also from chemistry (Wheeler and Kess 1978) biology (Brumby 1979, 1981) astronomy (Nussbarm and Novak 1976) and earth science (Happs 1985).

16.6 Replication Of Research

From all the researchers mentioned so far, have you ever reference or read about any of them or their work.

Usually replicating a research work may be possible under different socially cultural set up or rather with variations across cultures. However these variations are usually consistent with the social/cultural differences associated with the concept and so it served to reinforce the initial research work rather than oppose the principle.

Many of the research work mentioned above have been replicated in Nigeria and thus benefiting from the developed world as they research into science education.

16.7 Conclusion

In this unit, which is the last- the science education research trends, the styles and research replications in science education was discussed.

16.8 Summary

In this unit, you learnt that:

- There are diverse categories of research reports
- The diversity brings students to understand concepts and natural phenomena in terms of the scientist use. - There has been much progress in science education research as from the 70's.
- The research style has shifted between 1965 to 1995 from descriptive/ research to observational research.
- There had been shift in statistics employed from quantitative to qualitative data.
- Replication of research could be possible under different social and cultural set up.

16.9 Tutor Marked Assignment

Take any two science education journals in the 70's and 90's. Check through the articles and report on the research style.

16.10 References

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