

**COURSE
GUIDE**

SED 314

AFRICAN COSMOLOGY AND INTEGRATED SCIENCE

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INTRODUCTION

This Course brings to focus the concept of African Cosmology as it relates to integrated Science. The course will discuss the meaning of cosmology African mythology and science. African tradition and some natural phenomena will be presented and discussed. In This course will also discuss the concepts of African and Integrated Science

WHAT YOU WILL LEARN FROM THIS COURSE

You will learn the concepts of African cosmology and mythology in relation to scientific practices in general, African science and integrated science in particular.

COURSE AIMS

The aim of this course is to enable you have clear understanding of the concepts and issues of African cosmology and mythology in relation to scientific practices in general, African science and integrated science in particular.

COURSE OBJECTIVES

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

- (i) define cosmology, mythology, science and integrated science;
- (ii) discuss the myths surrounding the teaching of integrated science;
- (iii) provide mythological and scientific explanations for some natural phenomena;
- (iv) explain the concept of African tradition as it relates to science;
- (v) discuss African concern for the universe and the concept of reality;
- (vi) discuss the African belief system, ways of knowing and use of numbers in relation to science;
- (vii) Discuss the similarities between African science and integrated science.

WORKING THROUGH THE COURSE

To complete this course, you are expected to read the study units, and other relevant books and materials provided by the National Open University of Nigeria at the end of each unit of work.

Each unit contains self-assessment exercises and at certain points in the course, you are required to submit assignments for assessment purpose. At the end of the course, there is a final examination. This course is

expected to last for a period of one semester. Below, you will find listed, all the components of the course, what you have to do, and how you should allocate your time to each unit in order that you may complete the course successfully and on time.

ASSIGNMENTS

There are fourteen (14) assignments in this course, covering all the units studied.

You are expected to complete and submit these assignments to your facilitators in course of the study whether in synchronous or asynchronous sessions. The marks you obtain for these assignments will count towards the final mark you obtain for this course. Further information on assignments will be found in this Course Guide in the section on assessment. You are equally required to use in-text references to enrich your studies.

THE COURSE MATERIALS

National Open University of Nigeria will provide you with the following:

The Course Guide: This consists of four Modules, each having up to five units of work as listed hereunder.

Also at the end of each unit are lists of books – References and For Further Reading in addition to some online resources. While you may not procure or read all of them; they are essential supplements to the course materials.

Remember also that you must submit answers to the TMAs as and at when due.

STUDY UNITS

The course will be presented in four modules, namely:

- Module 1 Cosmology, African mythology and science
- Module 2 Explanation of some natural phenomena
- Module 3 African Tradition
- Module 4 Concepts of African science and Integrated science

In Module 1, the meaning of cosmology and the branches were treated. The module focused on African Mythology and how it relates to science. African concern for the universe and the concept of reality were highlighted.

In Module 2 you will be exposed to the concept of natural phenomena. The natural phenomena that were treated in this module are rainbow, Twin, Lightning and Thunder, Echo and Mirage.

Module 3 focused on the use of numbers and ways of knowing in African belief system. It also compared African belief system with science

Module 4, centred on the concept of African science and Integrated science focusing on meaning and history of African sciences, meaning and history of integrated sciences, concept of African sciences as different from integrated science and identified the elements of integration in African traditional science. The module also discussed possible ways of curbing superstitious belief through integrated science. The module ended up with African contributions to science, technology and development.

ASSESSMENTS

There are three aspects of the assessments. First are Self-Assessment Exercises(SAEs), second is the Tutor – Marked Assignments (TMAs) and the third is the Final Examination.

SELF ASSESSMENT EXERCISES

You are advised to be sincere in attending to the exercise. You are expected to apply knowledge, information and skills that you have acquired during the course. The assignment must be submitted to your tutor for formal assessments in accordance with the deadline stated in your schedule of presentation/ academic calendar.

ASSIGNMENT

Assignments may be a Fill-in the Blank spaces Question (FBQ) or Multiple Choice Question (MCQ) format and each of them carries 10 marks making a total of 30 marks for the three TMAs.

Aside from your course material provided, you are advised to read and research widely using other references which will give you a broader viewpoint and may provide a deeper understanding of the subject.

Ensure all completed assignments are submitted on schedule before set deadlines. 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. Except in exceptional circumstances, extensions may not be granted after the due date.

FINAL EXAMINATION

The final examination for this course will be of three hours duration and have a value of 70% of the total course grade. All areas of the course will be assessed and the examination will consist of questions which reflect the type of self-testing, practice exercise and tutor assignments you have previously encountered. Utilise the time between the conclusion of the last study unit and sitting the examination to revise the entire course. You may find it useful to review your self-assessment exercises, tutor marked assignments comments on them before the examination.

COURSE MARKING SCHEME

The work you submit will count for 30% of your total course mark. At the end of the course however, you will be required to sit for a final examination, which will also count for 70% of your total marks. The grand total for the course would remain 100%.

HOW TO GET THE MOST FROM THIS COURSE

In distance learning, the study materials are specially developed and designed to replace the lecturer. Hence, you can work through these materials at your pace, and at a time and place that suits you best. The course materials are interactive enough and allow you to fill the gap created by the absence of the teacher in a face-to-face encounter. However, the online synchronous facilitation and instructional video supplements are also meant to bridge this gap.

Visualize it as reading the lecture instead of listening to a lecturer.

Each of the study unit 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/outcomes. These objectives let you know what you should be able to do by the time you have completed the unit. Use these objectives to guide your study.

On finishing a unit, go back and check whether you have achieved the objectives. If made a habit, this will further enhance your chances of completing the course successfully.

The following is a practical strategy for working through the course:

- Read this course guide thoroughly.
- Organize a study schedule, which you must adhere to religiously. The major reason students fail is that they get behind in their course work. If you encounter difficulties with your schedule, please let your tutor/ facilitator know promptly.
- Turn to each unit and read the introduction and the objectives for the unit.
- Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow.
- Review the objectives of each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult with 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.
- After submitting an assignment to your facilitator for grading, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your facilitator's comments.
- After completing the last unit, review the course and prepare yourself for final examination. Check that you have achieved the units objectives (listed at the beginning of each unit) and the course objectives listed in this course guide.

FACILITATORS/TUTOR AND TUTORIALS

There will be specific time made available for tutorial sessions, in support of this course. You will be notified of the dates, time 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. 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 your discussion group (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 unit 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

This course is designed to with you the concepts of cosmology, African mythology and belief system and how they are related to science in general and Integrated science in particular. This will to equip you with the appropriate knowledge, skills attitude in the teaching of integrated science

We, therefore, sincerely wish you the best and that you enjoy the course.

**MAIN
COURSE**

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MODULE 1 COSMOLOGY, AFRICAN MYTHOLOGY AND SCIENCE

- Unit 1 Meaning of Cosmology, mythology, Science and integrated science
- Unit 2 African Mythology and Science
- Unit 3 African Concerns for the Universe
- Unit 4 Conceptions of Reality

UNIT 1 MEANING OF COSMOLOGY, MYTHOLOGY, SCIENCE AND INTEGRATED SCIENCE

Unit Structure

- 1.1 Introduction
- 1.2 Intended Learning Outcomes
- 1.3 Meaning of Cosmology, Mythology, Science and Integrated Science
 - 1.3.1 Meaning of Cosmology
 - 1.3.2 Meaning of Mythology
 - 1.3.3 Meaning of Science
 - 1.3.4 Meaning of Integrated Science
- 1.4 Summary
- 1.5 References/Further Readings/Web Resources
- 1.6 Possible Answers to Self-Assessment Exercise(s)

1.1 Introduction

Welcome to this unit, as an integrated science student, it is pertinent that you have a clear understanding of the meanings of cosmology, mythology, science and integrated science especially as they relate to African. Your understanding of these concepts will be useful for you to be able to appreciate their relevance to your course and you as a teacher on training. This unit will also help you to get acquainted with how the society developed and used these concepts over time.

In this module, you will be exposed to the meaning and definitions of cosmology, mythology, science and integrated science. You will learn the history of cosmology, mythology science and integrated science. African concern for the universe will be highlighted. This module will also expose you to the concept of reality in the African belief system and science.

1.2 Intended Learning Outcomes

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

- explain the meaning of cosmology
- define mythology in relation to Africa
- define science
- explain the meaning of Integrated Science.

1.3 Meaning of Cosmology, Mythology, Science and Integrated Science

1.3.1 Meaning of Cosmology

As you are growing up, you must have had many stories about the universe, why and how things happen in nature. Some of these stories, we might offer concrete explanations for them as they are based on ‘hear say’. The major aim of scientists is to study, understand and explain nature which includes our physical world and the universe for the benefit of mankind. You may ask, what is this nature? Nature is the phenomena of the physical world collectively, including plants, animals, the landscape, and other features and products of the earth, as opposed to humans or human creations. On the other hand, the universe is all of space and time and their contents, including planets, stars, galaxies, and all other forms of matter and energy. (<https://en.wikipedia.org/wiki/Universe>). The study of the universe is a branch of science called astrology. In astrology, studies which are focused specifically on the origin and evolution of the universe is called cosmology. Cosmology was derived from two Greek words ‘kosmos’ which means world and ‘logia’ which means study. Literarily, cosmology is the study of the world. It is a branch of astronomy concerned with the study of the chronology of the universe. Cosmology involves the origin and evolution of the universe, from the Big Bang to today and into the future. It involves the study of the large-scale properties of the universe as a whole. In cosmology the scientific method is used to understand and explain the origin, evolution and ultimate fate of the entire Universe. While other aspects of astronomy deal with individual objects and phenomena or collections of objects, cosmology spans the entire universe from birth to death, with a wealth of mysteries at every stage. Like any field of science, cosmologists are engaged in careful observations, hypothesizing and experimentation based on which theories and laws are propounded about the universe that can be used to make specific predictions about phenomena.

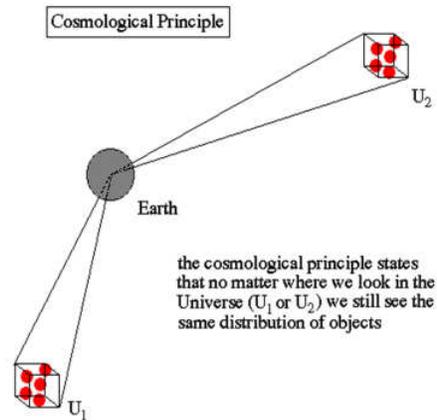
Nala (2017) remarks that humanity's understanding of the universe has evolved significantly over time. In the early times and history of astronomy, Earth was regarded as the center of all things, with planets and stars orbiting it. In the 16th century, Polish scientist Nicolaus Copernicus suggested that Earth and the other planets in the solar system in fact orbited the sun, creating a profound shift in the understanding of the cosmos. In the late 17th century, Isaac Newton calculated how the forces between planets especially in terms of gravitational forces interacted.

The dawn of the 20th century brought further insights into comprehending the vast universe. Albert Einstein proposed the unification of space and time in his General Theory of Relativity. In the early 1900s, scientists were debating whether the Milky Way contained the whole universe within its span, or whether it was simply one of many collections of stars. Edwin Hubble calculated the distance to a fuzzy nebulous object in the sky and determined that it lay outside of the Milky Way, proving our galaxy to be a small drop in the enormous universe. Using General Relativity to lay the framework, Hubble measured other galaxies and determined that they were rushing away from the us, leading him to conclude that the universe was not static but expanding.

In understanding cosmology, two major categorizations based on either scientific method or religious and cultural traditions and beliefs have been adopted. The first categorization is based on systematic scientific study that depends on evidence from observation and experimentation to understand the universe. Cosmology, provides a description of the largest-scale structures and dynamics of the universe and allows study of fundamental questions about its origin, structure, evolution, and ultimate fate. (https://en.wikipedia.org/wiki/Physical_cosmology). This is referred to as physical cosmology. On the other hand, when the understanding of the universe is based on cultural and religious traditions, beliefs and myths, it is referred to as religious cosmology or mythology.

Studies in physical cosmology are based on some assumptions which are referred to as the principle of cosmology. In a nutshell, the cosmological principle states that the universe looks essentially the same at any location in the universe. In modern physical cosmology, the cosmological principle is the notion that the spatial distribution of matter in the universe is homogeneous and isotropic when viewed on a large enough scale, since the forces are expected to act uniformly throughout the universe, and should, therefore, produce no observable irregularities in the large-scale structuring over the course of evolution

of the matter field that was initially laid down by the Big Bang. (https://en.wikipedia.org/wiki/Cosmological_principle).



Source: <http://abyss.uoregon.edu/~js/cosmo/lectures/lec05.html>

This principle remains a largely untested assumption because we cannot travel to every location in the universe to perform experiments to test the assumption. There are four assumptions in the cosmology principle. These assumptions are:

1. Physical laws are universal. Any science experiment, if performed under identical conditions, will have the same result anywhere in the universe because physical laws are the same everywhere in the universe.
2. On a sufficiently large scale the universe is homogeneous. We know there is large scale structure in the universe, such as clusters of galaxies; so, we assume that the universe is homogenous only on scales large enough for even the largest structures to average out.
3. The universe is *isotropic*, meaning that there is no preferred direction in the universe.
4. Over sufficiently long times the universe looks essentially the same at all times.

These assumptions are the bases for observation and experimentation on physical natural phenomena.

The scope of religious cosmology is more inclusive than a strictly scientific cosmology (physical cosmology) in that religious cosmology is not limited to experiential observation, testing of hypotheses, and proposals of theories. Every culture and religion have its own mythology. China, India, Greeks, Africa, Hindu, Islam, Christianity etc. have mythology peculiar to them.

The term *cosmology* was first used in English in 1656 in Thomas lount's *Glossographia*, and in 1731 taken up in Latin by German philosopher Christian Wolff, in *Cosmologia Generalis*.

Self-Assessment Exercise 1

1. Explain the term cosmology?
2. Discuss the two branches of cosmology.
3. List the basic assumptions of cosmology

1.3.2 Meaning of Mythology

As we discussed earlier in the introduction, mythology is a branch of cosmology in relation with cultural and religious values and beliefs. Mythology was derived from the Greek word 'mythos' for story-of-the-people, and logos for study. From this, we can literally define cosmology as the study of the story of a people. Mythology is therefore the study and interpretation of often sacred tales or fables of a culture known as myths or the collection of such stories which deal with various aspects of the human condition: good and evil. Myths express the beliefs and values about these subjects held by a certain culture. Myths tell the stories of ancestors and the origin of humans and the world, the gods, supernatural beings and heroes with super-human, usually God-given, powers. Myths also describe origins or nuances of long-held customs or explain natural events such as the sunrise and sunset, the cycle of the moon and the seasons, or thunder and lightning storms.

There are four basic theories of myth. Those theories are:

1. rational myth theory which states that myths were created to explain natural events and forces.
2. functional myth theory are myths that were created as a type of social control,
3. structural myth theory are myths that were patterned after human mind and human nature and
4. the psychological myth theory which states that myths are based on human emotion.

Plagiarist, (1996) has noted that the rational myth theory states that myths were made to better understand natural events and forces that occurred in the everyday lives of people. This theory also explains that the gods and goddesses controlled all of these happenings of nature. Examples of this type of myth are creation myths from different cultures. Creation myths explain how man was created and explain what the gods and goddesses used and what actions they took to create

humans. These myths also tell what substances were used (if any) in order for man to exist. The existence of man is a natural event but creation myths give other explanations

The functional myth theory talks about how myths were used to teach morality and social behavior. It states that myths told about what types of things should and shouldn't be done, and the consequences for those wrong doings. The functional myth theory also states that myths were created for social control and served the function of insuring stability in a society.

Structural myths are said to be myths based on human emotion. These types of myths show the two sides of the human mind; the good side and the bad side. They show the divided self and the duality of human nature.

The psychological myth theory states how myths are based on human emotion and that they come from the human subconscious mind. Cultures all around the world had similar fears, questions, and wishes which, to them, were unexplainable.

Mythology has played an integral part in every civilization throughout the world. Pre-historic cave paintings, etchings in stone, tombs, and monuments all suggest that, long before human beings set down their myths in words, they had already developed a belief structure.

Another classification of myths distinguishes three types of myths, namely:

- Etiological Myths
- Historical Myths
- Psychological Myths

Etiological myths (from the Greek *aetion* meaning 'reason') explain why a certain thing is the way it is or how it came to be. This type of myth is usually defined as an origin story. Historical myths retell an event from the past but elevate it with greater meaning than the actual event (if it even happened).

Psychological myths present one with a journey from the known to the unknown which represents a psychological need to balance the external world with one's internal consciousness of it. However, that may be, the story of the myth itself.

Self-Assessment Exercise 2

1. What do you understand by the term mythology?
2. List any three types of myths.
3. Discuss how these myths are applied to help man understand nature and existence.

1.3.3 Meaning of Science

Science is derived from the Latin word '*scientia*' which means 'knowledge' (Harper (2014)). Science is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. Science has been defined as knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method and such knowledge or such a system of knowledge is concerned with the physical world and its phenomena.

Carpi and Egger (2009) have enumerated some of the key facts in the processes which scientists engage in. The facts include;

1. Science is a process of investigation into the natural world and the knowledge generated through that process.
2. Scientists use multiple research methods to study the natural world.
3. Data collected through scientific research must be analyzed and interpreted to be used as evidence.
4. Scientific theories are testable explanations supported by multiple lines of evidence.
5. Scientific knowledge evolves with new evidence and perspectives.
6. Science benefits from the creativity, curiosity, diversity, and diligence of individuals.
7. Science is subject to human bias and error.
8. The community of science engages in debate and mitigates human errors.
9. Uncertainty is inherent in nature, but scientists work to minimize and quantify it in data collection and analysis.
10. Scientists value open and honest communication in reporting research.
11. Science both influences and is influenced by the societies and cultures in which it operates.
12. Science is valuable to individuals and to society.

As scientists go through the processes of scientific investigation, it is expected that they acquire skills which we refer to as science process

skills. These skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists. The process skills are grouped into two types-basic and integrated. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills.

The basic process skills include the following:

1. Observing - using the senses to gather information about an object or event.
2. Inferring - making an "educated guess" about an object or event based on previously gathered data or information.
3. Measuring - using both standard and non-standard measures and estimates to describe the dimensions of an object or event.
4. Communicating - using words or graphic symbols to describe an action, object or event.
5. Classifying - grouping or ordering objects or events into categories based on properties or criteria.
6. Predicting - stating the outcome of a future event based on a pattern of evidence.

On the other hand, the integrated process skills include the following:

1. Controlling variables - being able to identify variables that can affect an experimental outcome, keeping most constant while manipulating only the independent variable.
2. Defining operationally - stating how to measure a variable in an experiment.
3. Formulating hypotheses - stating the expected outcome of an experiment.
4. Interpreting data - organizing data and drawing conclusions from it.
5. Experimenting - being able to conduct an experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally defining those variables, designing a "fair" experiment, conducting the experiment, and interpreting the results of the experiment.
6. Formulating models - creating a mental or physical model of a process or event. Examples: The model of how the processes of evaporation and condensation interrelate in the water cycle.

In scientific investigations, there are steps which scientists usually follow. These series of steps which scientists follow during their investigation constitute the scientific method. It is important to note that all scientists do not follow these steps logically the same way. As there

are many scientists, so are the order in which the steps can be followed in scientific investigations.

The scientific method has five basic steps, plus one feedback step:

1. Make an observation.
2. Ask a question.
3. Form a hypothesis, or testable explanation.
4. Make a prediction based on the hypothesis.
5. Test the prediction.
6. Iterate: use the results to make new hypotheses or predictions.

The operational use of the steps is shown in figure below.

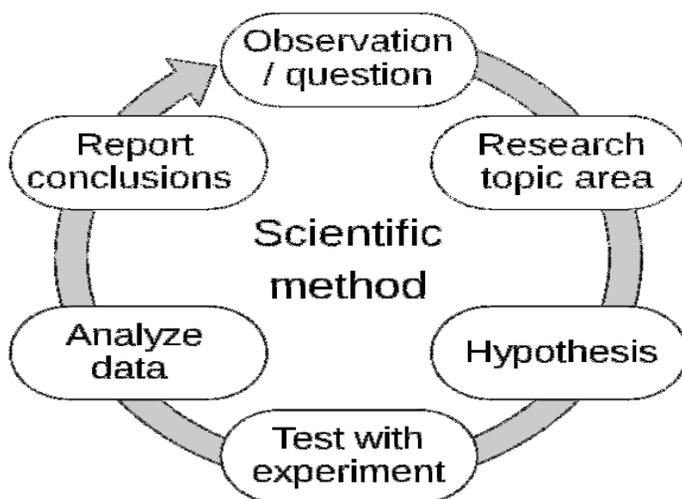


Fig. 1: Steps in the Scientific Method

Science is both a body of knowledge (product) and a method of inquiry (process). Science is therefore a continuous search for new knowledge through continuous inquiry. The knowledge which science generate are in the form of:

1. Generalizations - a proposition asserting something to be true
2. Facts - A scientific fact is the result of a repeatable careful observation or measurement (by experimentation or other means), also called **empirical evidence**.
3. Concepts –These are abstract ideas which are understood to be the fundamental building blocks behind principles, thoughts and beliefs
4. Principles - These are ideas based on scientific rules and laws that are generally accepted by scientists. They are fundamental truths that are the foundation for other studies
5. Theories - theories are systematic explanations of the underlying phenomenon or behaviour

6. Laws - observed patterns of phenomena or behaviours

It is the application of these products in form of knowledge that we refer to technology. As scientists engage in scientific investigations, they are expected to acquire certain pre-dispositions which may act as code of conduct for their operations. This code of conduct is what we refer to as scientific attitude.

Some of these scientific attitudes include;

1. critical-mindedness,
2. suspended judgment (restraint),
3. respect for evidence (reliance on fact),
4. honesty,
5. objectivity,
6. willingness to change opinions,
7. open-mindedness,
8. questioning attitude, and
9. tolerance of uncertainty.

Modern science is typically divided into three major branches that consist of the natural sciences (e.g., biology, chemistry, and physics), which study nature in the broadest sense; the social sciences (e.g., economics, psychology, and sociology), which study individuals and societies and the formal sciences (e.g., logic, mathematics, and theoretical computer science), which deal with symbols governed by rules. The earliest roots of science can be traced to Ancient Egypt and Mesopotamia in around 3000 to 1200 BC.

Self-Assessment Exercise 3

1. What is science?
2. What are science process skills?
3. What is scientific method?
4. What are scientific products?

1.3.4 Meaning of Integrated Science

The term “integrated science” is often used as a synonym for interdisciplinary and unified science, which may be applied generally to any curriculum effort in which two or more previously separated science subjects are combined. The effort may be characterized as a collaboration among, a blending with, or a fusion of a number of “subjects” traditionally taught separately. Thus, the meaning of

integration in various types of integrated science is different. An integrated science course may be characterized by a focus on processes of scientific inquiry, or a wish to cater for the interests of pupils, or it may be a course structured around topics, themes, or problems that require a multidisciplinary approach. Brown (1977) identified four groups of meanings of integration in science: (1) as the unity of all knowledge, (2) as the conceptual unity of the sciences, (3) as a unified process of scientific enquiry, and (4) as interdisciplinary. (Wei, 2015).

Self-Assessment Exercise 4

What is integrated Science

1.4 Summary

In this unit you have learnt that Cosmology is generally described as the study of the origin and evolution of the universe. The origin and evolution of the universe can be understood based on scientific facts that are verifiable (physical cosmology) or on cultural practices, beliefs, values, traditions and myths (religious or mythological cosmology). Science drives the current world because; its understanding is major determinant of growth and development because its knowledge is empirical and experiential. Although science has many branches its application in real life is integrated. This explains the reason for studying integrated science especially at the Basic education level in Nigeria.

1.5 References/Further Reading/Web/Resources

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1.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. Explain the term cosmology?
Literarily, cosmology is the study of the world. It is a branch of astronomy concerned with the study of the chronology of the universe.
2. Discuss the two branches of cosmology.
In understanding cosmology, two major categorizations based on either scientific method or religious and cultural traditions and beliefs have been adopted. The first categorization is based on systematic scientific study that depends on evidence from observation and experimentation to understand the universe. **Cosmology** provides a description of the largest-scale structures and dynamics of the universe and allows study of fundamental questions about its origin, structure, evolution, and ultimate fate). This is referred to as physical cosmology. On the other hand, when the understanding of the universe is based on cultural and religious traditions, beliefs and myths, it is referred to as religious cosmology or mythology.
3. List the basic assumptions of cosmology
 - i. Physical laws are universal.
 - ii. On a sufficiently large scale the universe is homogeneous.
 - iii. The universe is *isotropic*, meaning that there is no preferred direction in the universe.
 - iv. Over sufficiently long times the universe looks essentially the same at all times.

SAE 2

1. What do you understand by the term mythology?
Mythology is therefore the study and interpretation of often sacred tales or fables of a culture known as myths or the collection of such stories which deal with various aspects of the human condition: good and evil.
2. List any three types of myths.
 - i. Etiological Myths
 - ii. Historical Myths
 - iii. Psychological Myths
3. Discuss how these myths are applied to help man understand nature and existence.

Etiological myths (from the Greek *aetion* meaning 'reason') explain why a certain thing is the way it is or how it came to be. This type of myth is usually defined as an origin story.

Historical myths retell an event from the past but elevate it with greater meaning than the actual event (if it even happened).

Psychological myths present one with a journey from the known to the unknown which represents a psychological need to balance the external world with one's internal consciousness of it. However, that may be, the story of the myth itself

SAE 3

1. **What is science?**
Science is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. Science has been defined as knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method and such knowledge or such a system of knowledge is concerned with the physical world and its phenomena.
2. **What are science process skills?**
These skills are defined as a set of broadly transferable abilities appropriate to many science disciplines and reflective of the behaviour of scientists.
3. **What is scientific method?**
In scientific investigations, there are steps which scientists usually follow. These series of steps which scientists follow during their investigation constitute the scientific method.
4. **What are scientific products?**
The scientific products are the knowledge which science generates in the form of generalizations, facts, concept, principles, theories and laws.

SAE 4

1. **What is integrated Science?**
The term “integrated science” is often used as a synonym for interdisciplinary and unified science, which may be applied generally to any curriculum effort in which two or more previously separated science subjects are combined.

UNIT 2 AFRICAN MYTHOLOGY AND SCIENCE

- 2.1 Introduction
- 2.2 Intended Learning Outcomes
- 2.3 African Mythology and Science
 - 2.3.1 Meaning of African Mythology
 - 2.3.2 History of African Mythology
- 2.4 Summary
- 2.5 References/Further Readings/Web Resources
- 2.6 Possible Answers to Self-Assessment Exercise(s)

2.1 Introduction

In the previous unit we discussed the meanings of cosmology, mythology, science and integrated science from our discussion you can see and appreciate the relationship between these concepts. In this unit, we will be discussing mythology as it relates to Africa and how this has evolved and development over time. You will be acquainted with how African mythology is connected to science.

2.2 Intended Learning Outcomes

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

- explain the meaning of African Mythology
- discuss the history of African Mythology
- discuss how African mythology and science are connected.

2.3 African Mythology and Science

2.3.1 Meaning of African Mythology

As we discussed earlier, mythology is the study of a collection of myths belonging to particular religious or cultural traditions. Africa as a continent is place that has people of diverse culture and languages. In Africa, there is no single set of myths and legends that unites their diverse population. However, different cultural groups and societies may share some common mythological elements which may include beliefs and values, preserved relics of ancient times, origin of the world and the fate of the individual after death. The beliefs and values of the African people are reflected in their myths. Up till today, African myths and legends function as a meaningful part of their everyday life unlike in most other parts of the world where mythologies do not play active and significant roles in their daily lives in recent times. In discussing African mythology, we need to have a clear understanding of myths, tales, folktales and fables.

A myth is a widely held idea or belief that cannot be proved. Myths usually come up as traditional stories concerning in the early history of a people used in explaining natural or social phenomena, and typically involving supernatural beings or events. Myths are usually presented in form of tales or represented diagrammatically using paintings. A tale is **usually an imaginative narrative of an event**. We could have clear view when we pursue stories which might illuminate the nature of the beliefs and customs of the culture of a people. African mythology has not been presented in a consistent manner and set of characters because of her diversity even though some tribes tell similar stories which crossover into folktales and fables. Folktales are stories in the oral tradition, or tales that people tell each other out loud, rather than stories in written form. They're closely related to many storytelling traditions. Every human society has its own folktales; these well-known stories, handed down between generations, are an important way of passing along knowledge, information, and history. Fables are short tales to teach a moral lesson, often with animals or inanimate objects as characters for instance the fable of the tortoise and the hare. Fables could be stories about supernatural or extraordinary persons or incidents.

(<https://www.youtube.com/watch?v=buZ7vrLZWwI>)

In African oral cultures and myths embody philosophical reflections, express values, and identify moral standards. Unlike Western mythology, African myths are not recounted as a single narrative story, nor is there any established corpus of myth

(<https://www.britannica.com/topic/African-religions/Mythology>). Instead, myths are embedded and transmitted in ritual practice. African cultural groups did not use written language until modern times. Instead, they possessed rich and complex oral traditions, passing myths, legends, and histories from generation to generation verbally. In some cultures, professional storytellers preserved the oral tradition. Written accounts of African mythology began to appear in the early 1800s with the arrival of European explorers and colonizers, and present-day scholars work to record the continent's myths and legends before they are lost to time and cultural change.

African mythology commonly depicts the cosmos anthropomorphically. The human body is a microcosm that incorporates the same primordial elements and essential forces that make up the universe. The concept of twins is a predominant theme in many West African myth and ritual, because the human body is conceived as the twin of the cosmic body. According to the cosmogony shared by the Dogon, Bambara, and Malinke peoples of Mali, the primordial beings

were twins, and twins therefore represent the ideal. This expresses their link with the universe

The myths of people living along the Nile and on the fringes of the Sahara, as well as the Bantu around the Niger and Congo Rivers, are more generally concerned with the origins of social institutions, such as clans and kingships, than with cosmic themes, such as the creation of the world. In contrast, the non-Bantu groups of the Niger River area, especially the Dogon, Yoruba, and Bambara, have complex and lengthy tales about the origins of things found in the natural world. Fables, folklore, and legends about **tricksters** and animals are found in nearly all African cultures.

African mythology is more focused on myths on the supernatural beings who influence human life. Some of these beings are powerful deities. Others are lesser spirits such as the spirits of ancestors. Most African traditional religions have multiple gods, often grouped together in family relations. Almost every one of them recognizes a supreme god, an all-powerful and known creator who is usually associated with the sky.

Self-Assessment Exercise 1

1. What is your definition of African mythology?
2. What are the differences between African and Western mythologies

2.3.2 History of African Mythology

The history of African mythology is as old as the history of the African continent as well as history of Africans as a people. Myths and legends developed over thousands of years in Africa, South of the Sahara. The developments that took place in the myths and legends then were greatly influenced by the mass migrations that took place from time to time. About 7,000 years ago, the ancestors of the Hottentot and Bushman moved from the Sahara towards Southern Africa. Five thousand years later, the people who spoke Bantu languages spread out from Cameroon, on Africa's west coast they eventually inhabited much of sub-Saharan Africa. Such migrations in great measure brought about mixing of myths and legends. For instance, the Bantu groups developed new homelands. They developed legends to explain their ruling families and the structure of their societies.

The ancient people of Africa did not use written language until modern times. The ancient people of Africa possessed rich and complex oral traditions, passing myths, legends, and history from one generation to

another generation in spoken form. In some cultures, professional storytellers preserved the oral tradition. Written accounts of African mythology began in 1800s, and through the present-day scholars' efforts, records of the continent's myths and legends are preserved.

However, since the spread of Islam and Christianity to sub-Saharan Africa, the indigenous religions, myths, and legends are weakened. But traditional beliefs have not disappeared. They have blended with new religions from other cultures in some places.

In most African religions, the supreme god is a faraway being that is no longer involved in day-to-day human life. The people rarely call on this deity directly. Instead, they approach this deity through lesser deities, many of whom has specific roles. Examples of such deities are given as follows:

Deity	People and Region	Role
Eshu	Yoruba, Nigeria	Trickster and message god
Katonda	Bungada, East Africa	Creator god, father of the gods, king and judge of the universe
Kibuka	Bungada, East Africa	War god
Leza	Bantu, Central and South Africa	Creator and sky god
Mujaji	Lovedu, South Africa	Rain goddess
Nyame	Ashanti and Akan, Ghana	Creator god associated with sun and Moon
Ogun	Yoruba, West Africa	God of war and iron
Olorun	Yoruba, West Africa	Sky god and supreme deity
Ala	Ibo, Nigeria	Mother goddess, ruler of the underworld, goddess of fertility
Amma	Dogon, Mali	Supreme god
Cagn	Bushmen, South Western Africa	Creator god

Source: African Mythology–Myth Encyclopaedia p. 3-4).

The number of gods and goddesses vary from culture to culture. In the Congo River region, the most densely populated wooded part of Africa, the forest itself constitutes a deity – or where other world spirits dwell.

Self-Assignment Exercise 2

1. Trace the history of African mythology
2. Lists any four deities and their believed functions.

2.3.3 African mythology and science

African mythology has served very important function as it has created a very conducive atmosphere for the realisation of very important psychological and moral needs of the individual and community at large. It has helped them in understanding who they are, how they originated, their existence and its essence. These understanding are based on belief which has driven their culture, tradition and religion over the years. Within the African set-up metaphysics remained and still remains relevant yet in a manner that contrasts with the understanding of metaphysics as a tool for science motivated explanation of reality. Here metaphysics takes the form of a set or body of belief and practices in relation to the ultimate reality. This is African mythology. In African mythology the dynamic constitution of nature, whose self-explanatory force is fundamental for scientific growth, is replaced by belief in a dynamic force in the form of a personal god, spirit or other agencies responsible for explanation of the reality of things. This model of metaphysics concentrates primarily in grasping the nature of the being responsible for the existence of the world, it is comfortable with taking stock of the very attribute of this personal being, his relationship with man, nature etc. (Asouzu ,1990). It is the African mythology that is instrumental to tackling fundamental issues of ethics and society and as such has been instrumental to questions of cohesion, social control, law and order within African societies.

According to Asouzu (1990), the fact that African metaphysics has provided answers to the practical question of life is highly laudable but not sufficient enough. Its method has failed in giving satisfactory answers in such areas as prediction and control of diseases, hunger, natural catastrophes, climatic and cosmic changes, etc. As long as the approach to questions posed in these areas is enclosed within a casual framework explicable mostly by recourse to the activities of mythological magical forces, there would hardly be any appreciable progress towards understanding, mastering and giving satisfactory and adequate solutions to them.

Based on the dependence of science on evidence based on systematic and verifiable process of experimentation and observation, its application to human problems and understanding the universe still proves to be more dependable.

Self-Assignment Exercise 3

1. Discuss any two major contributions of African mythology to the African society.
2. Discuss any two limitations of African mythology in the African continent

2.4 Summary

In this unit, you have learnt that African mythology is anchored on belief system driven by “culture” and religion. African mythology to a large extent determines the lifestyle of the people. African mythology is as old as Africa as a continent. Its early form could be traced to myths and legends developed over thousand years ago in Africa, South of the Sahara. At this time, there were no written documents or accounts of African mythology. And because Africa did not use written language until modern times, they passed their myths, legends, cultures, and history from generation to generation in oral form. Modern African mythology depends heavily on documentaries and other written records. African metaphysics has provided answers to the practical question of life which is highly laudable but not sufficient enough. Its method has failed in giving satisfactory answers in such areas as prediction and control of diseases, hunger, natural catastrophes, climatic and cosmic changes, etc. Based on the dependence of science on evidence based on systematic and verifiable process of experimentation and observation, its application to human problems and understanding the universe still proves to be more dependable

2.5 Reference/Further Reading/Web Resources

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2.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. What is your definition of African mythology?
African mythology is the study and interpretation of often sacred tales or fables of a culture known as myths or the collection of such stories which deal with various aspects of the human condition in Africa. Here metaphysics takes the form of a set or body of belief and practices in relation to the ultimate reality. This is African mythology.
2. What are the differences between African and Western mythologies?
Unlike Western mythology, African myths are not recounted as a single narrative story, nor is there any established corpus of myth. Instead, myths are embedded and transmitted in ritual practice. African cultural groups did not use written language until modern times. Instead, they possessed rich and complex oral traditions, passing myths, legends, and histories from generation to generation verbally.

SAE 2

1. Trace the history of African mythology.
The history of African mythology is as old as the history of the African continent as well as history of Africans as a people. Myths and legends developed over thousands of years in Africa, South of the Sahara. The developments that took place in the myths and legends then were greatly influenced by the mass migrations that took place from time to time. About 7,000 years ago, the ancestors of the Hottentot and Bushman moved from the Sahara towards Southern Africa. Five thousand years later, the people who spoke Bantu languages spread out from Cameroon, on Africa's west coast they eventually inhabited much of sub-Saharan Africa. Such migrations in great measure brought about mixing of myths and legends. For instance, the Bantu groups developed new homelands. They developed legends to explain their ruling families and the structure of their societies.

The ancient people of Africa did not use written language until modern times. The ancient people of Africa possessed rich and complex oral traditions, passing myths, legends, and history from one generation to another generation in spoken form. In some cultures, professional storytellers preserved the oral tradition. Written accounts of African mythology began in 1800s, and through the present-day scholars' efforts, records of the continent's myths and legends are preserved.

2. Lists any four deities and their believed functions.

Eshu	Yoruba, Nigeria	Trickster and message god
Katonda	Bungada, East Africa	Creator god, father of the gods, king and judge of the universe
Kibuka	Bungada, East Africa	War god
Leza	Bantu, Central and South Africa	Creator and sky god

SAE 3

1 Discuss any two major contributions of African mythology to the African society.

African mythology has served very important function as it has created a very conducive atmosphere for the realisation of very important psychological and moral needs of the individual and community at large. It has helped them in understanding who they are, how they originated, their existence and its essence

2. Discuss any three limitations of African mythology in the African continent

African mythology has failed in giving satisfactory answers in such areas as prediction and control of diseases, hunger, natural catastrophes, climatic and cosmic changes, etc. As long as the approach to questions posed in these areas is enclosed within a casual framework explicable mostly by recourse to the activities of mythological magical forces, there would hardly be any appreciable progress towards understanding, mastering and giving satisfactory and adequate solutions to them.

Based on the dependence of science on evidence based on systematic and verifiable process of experimentation and observation, its application to human problems and understanding the universe still proves to be more dependable

UNIT 3 AFRICAN CONCERN FOR THE UNIVERSE

- 3.1 Introduction
- 3.2 Intended Learning Outcomes
- 3.3 African Concern for the Universe
 - 3.3.1 African Supreme Beings
 - 3.3.2 Creation and Existence
 - 3.3.3 Attributes of Beings and Expression
- 3.4 Summary
- 3.5 References/Further Readings/Web Resources
- 3.6 Possible Answers to Self-Assessment Exercise(s)

3.1 Introduction

In the previous unit, we discussed the mythology as it relates to African reality and science. For a very long time in history, the culture and tradition of the people of Africa was shaped by their mythology. This mythology was based on oral tradition. There is the belief that humans exist as both spirit and body. African supreme beings are spiritual beings or divinities that are as varied as the peoples of sub-Saharan African, the world's second largest continent after Asia. But belief in Supreme Being tends to be universal among most of the different peoples of Africa. The diversity of cultural forms and linguistic differences of Africans notwithstanding, they hold a certain uniformity and similarity in the nature, attributes, and powers of the supreme beings and the world around them where they live in.

In this unit we will be discussing African the African concern for the universe in their belief system and practices. The unit will focus on the on their belief about creation and existence. Some African ancient names will be identified and explained. This unit will further highlight the concept and attributes of beings and other entities.

3.2 Intended Learning Outcomes

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

- explain creation and existence
- identify and explain ancient names
- describe the relationship that exists between spiritual beings, human beings and other cosmic entities
- explain attributes believed to be expressed by beings in African mythology.

3.3 African Concern for the Universe

3.3.1 African Supreme Beings

Belief in a supreme being is universal among Africans. Africans have rich cultural values and respect for the supreme beings who they believe created the universe and all that is in it. African supreme beings are spiritual beings or divinities that are as varied as the peoples. There are four foundational beliefs in the traditional African society, namely:

- (1) belief in impersonal (mystical) power(s)
- (2) belief in spirit beings
- (3) belief in divinities/gods and
- (4) belief in the Supreme Being.

The centrality of these beliefs is that there is a Supreme Being that controls the affairs of all creatures. They hold the belief that the Supreme Being created the universe and everything in the universe. The diversity of cultural forms and linguistic differences of Africans, notwithstanding the relationships of African supreme beings to the created order (including the human, spiritual, and other entities), reveal to a great extent a certain uniformity and similarity in the nature, attributes, and powers of the supreme beings. Supreme beings carry a distinct and unique quality in African cosmology as creators with all other supreme attributes in the universe. Before the coming of Islam and Christianity into Africa and their influences on the African cultures and values, the nature, characteristics, attributes of the Africans were demonstrated in their Supreme Being. Africans' belief that, air, waters, plants, fruits, soil, rocks, moon, sun, stars and other creations are created to make life conducive. This belief therefore encourages Africans to nurture and preserve their environments.

Self-Assessment Exercise 2

1. List the four fundamental beliefs in the African mythology
2. What are the effects of Islam and Christianity on African culture?

3.3.2 Creation and Existence

Different groups of Africans have developed varying myths around their supreme beings. Despite the Africans' diverse perceptions towards supreme beings, they express relatively common patterns that run through African social organisation and hierarchical structures, including relationships between elders and youths and humans' interconnections with natural phenomena. The sky, the earth, and the underworld (beneath the earth) are believed to be controlled by different

categories of spiritual and physical beings, and all are connected in certain relational ways to the Supreme Being.

African peoples hold their supreme being responsible for the creation of their universe, including the earth and sky, human beings, and spiritual beings. Also, the African peoples affirm that their supreme being delegated to lesser spiritual beings the responsibilities of creating the local universes of Africa; creation and allocation of what each community considers to be essence of human beings (including destiny and pre-destination). Therefore, the entire universe is dependent upon the power and authority of the Supreme Being.

This is the premise for the general notion of an intermediary in African religion, which is also reflected in African social and political setting. In the African setting generally, most of the myths are handed down through many generations. They are often told in traditional language by priests of indigenous religious traditions and by elders.

Supreme beings are divine persons, with names and epithets that convey their attributes and reveal something about their nature. In addition to personality, their characteristics include celectiality, primordality, and omniscience. These are associations with creation and death, remoteness and symbolic means of access and their tendency to be replaced by other concepts. In terms of celectiality (state or condition of being celectial) **for instance**, the names of numerous supreme beings refer to their connections with the sky. They are seen as heavenly beings. In Africa, one of the names for the supreme being of the Galla and other Oromo peoples is Waq ("sky"), as in the phrases *guraci waq* ("dark sky") and *waka kulkullu* ("calm sky"). He is also called Cólók ("the sky"). Among the Ewe people, the universal father is called Dzingbe ("sky"). The largest population of Ewe people is in Ghana (6.0 million), and the second largest population in Togo. They speak the Ewe language (Ewe: Ewegebe) which belongs to the Gbe family of languages.

Some other accounts see the Supreme beings as beings dwelling in the sky, or as expressing themselves through celectial elements such as the sun, stars and the rains. **Primordality** is another name ascribed to the supreme beings in some African cultures. This refer to the antiquity of supreme beings, who often reveal, as part of their own nature, the meaning of what is primordial, most fundamental, a part of the nature of existence from its earliest beginnings. Primordality is thus part of a supreme being's nature.

Supreme beings are also referred to as omniscience and omnivoyance. Many other refer to Supreme beings as the source of all life and power. They ascribe to the Supreme Being as cosmogonic power. More often

than not, the sky is the principal manifestation of Supreme Being. From this preponderance of historical facts has come the term *high god*. This refers to the remoteness of the Supreme Being.

The names of African supreme beings reflect the different African language groups. Different African language groups have different names of African supreme beings. The names used by different African language groups for supreme beings can be broadly classified into two:

- i. The ancient or primary local names; and
- ii. The descriptive or secondary names.

Ancient or primary names are those that are mostly used by older and elderly members of the communities. The ancient names express the inexplicable nature, character, essence, and attributes of a being as an almighty, ever-present creator, and who is supreme in all senses of supremacy, among others. Examples are Chukwu of the Ibos, Allah of the Hausas and Olódùmarè of the Yoruba of Nigeria and Mulungu of the Bantu-speaking peoples of East Africa.

Descriptive names have etymologies that express the perceived knowledge and living experiences of people in their mundane situation. The descriptive names divulge intrinsic and functional meanings and functional spatial locations which identify supreme beings with the nature of such locations. The descriptive names generally reflect the nature of African universe and socio-political structure. These names also describe the people's perception of their environment and the polarity of the Supreme Being. These names describe the activities of the Supreme Being on the people's life.

Self-Assessment Exercise 2

Identify and list any 3 ancient or primary names of supreme beings in Nigeria

3.3.3 Attributes: Being and Expression

African supreme beings are spiritual beings or divinities that are as varied as the peoples of sub-Saharan Africa. African conceptions of supreme beings are closely related to those of most Western and Eastern religions with respect to Godly characteristics, which include Omnipotence, Omniscience, Omnipresence, transcendence, immanence, benevolence, to mention a few. As we have discussed earlier, it is these characteristics that identify the supreme being based on which the supreme being is named. These attributes express a complex relationship between the Supreme Being and other entities; human and non-human,

animate and inanimate, visible and invisible, material, and spiritual. Some supreme beings exhibit negative behaviours. Such supreme beings are those that serve as intermediaries of supreme beings. These attributes are manifested in such things as natural occurrences like thunder, storm, wind, whirlwind, thick cloud, running streams, flood, beaming oceans, among others.

The moral aspect of the relationship of the Supreme Being to the African universe reveals the polarity of the being that is essential good. The polarity is demonstrated in the Supreme Being giving man and other organisms of choice of what to do and what not to do. Thus, the concept of free will and determinism by which the Supreme Being operates in the theocentric universe. This idea is expressly explained in African mythologies that the Supreme Being creates certain spiritual beings and deities to whom he delegates responsibility for creating other universal entities, including human beings.

Self-Assessment Exercise 3

1. What are supreme beings
2. Identify any 3 universally accepted attributes of supreme beings.

3.4 Summary

In this unit, we have learnt about African concern for the universe. We saw that the universe is created by the Supreme Being based on the African belief system. Africans as they differ in languages so also do they differ in the names ascribed to supreme beings. Basically, supreme beings' names are grouped into two:

- i. Ancient or primary names
- ii. Descriptive or secondary names

The moral aspect of the relationship of the Supreme Being to the African universe include the concept of will and determinism.

3.5 References/Further Readings/Web Resources

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3.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. List the four fundamental beliefs in the African mythology.
 - (i) belief in impersonal (mystical) power(s);
 - (ii) belief in spirit beings;
 - (iii) belief in divinities/gods and
 - (iv) belief in the Supreme Being.
2. What are the effects of Islam and Christianity on African culture? Before the coming of Islam and Christianity into Africa and their influences on the African cultures and values, the nature, characteristics, attributes of the Africans were demonstrated in their Supreme Being. Africans believe that air, waters, plants, fruits, soil, rocks, moon, sun, stars and other creations are created to make life conducive. This belief therefore encourages Africans to nurture and preserve their environments. Christianity and Moslem changed this orientation and belief.

SAE 2

1. Identify and list any 3 ancient or primary names of supreme beings in Nigeria.
 - i. Chukwu of the Ibos,
 - ii. Allah of the Hausas and
 - iii. Olódùmarè of the Yorubas

SAE 3

1. What are supreme beings?

These are the supernatural being conceived as the perfect and omnipotent and omniscient originator and ruler of the universe which are the object of worship in monotheistic religions.
2. Identify any 3 universally accepted attributes of supreme beings.
 - i. Omnipotence,
 - ii. Omniscience,
 - iii. Omnipresence

UNIT 4 CONCEPTIONS OF REALITY

Unit Structure

- 4.1 Introduction
- 4.2 Intended Learning Outcomes
- 4.3 Conceptions of Reality
 - 4.3.1 The meaning of reality
 - 4.3.2 Reality and science
- 4.4 Summary
- 4.5 References/Further Readings/Web Resources
- 4.6 Possible Answers to Self-Assessment Exercise(s)

4.1 Introduction

Africans as a people live in environments that influence them and they in turn impact their environment through their activities and interactions to suit their needs which could be physical, emotional and spiritual needs. The processes of meeting these needs might be through adoption or/and adaptation. Therefore, this unit introduces you to the concept and conceptions of reality. It will acquaint you with the relationship between reality and science.

4.2 Intended Learning Outcomes

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

- explain the meaning of reality
- distinguish between reality and science.

4.3 Conceptions of Reality

4.3.1 Meaning of Reality

In our daily lives we are sometimes confronted with questions about the reality of things, stories, occurrences and happenings in our environment. Philosophical questions about the nature of reality or existence or being are considered under the rubric of ontology, which is a major branch of metaphysics in the Western philosophical tradition (<https://en.wikipedia.org/wiki/Reality>). Realities are opposed to idealistic or notional idea of them. The interpretation of reality by any group of people involves tough processes. For instance, in farming, success cannot be recorded without some rational knowledge of the soil, seeds and climate. Similarly, a fisherman is likely to fail if he lacks the rational knowledge of the weather, wind systems and tidal phenomena. A herbalist cannot cure without a relational knowledge of the signs and

symptoms of diseases (Atadoga & Onaolapo, 2008). Therefore, for any race to survive at all, there must be an exhibition of rational thinking – whether white or black. The question is: What exactly is reality?

Literarily speaking, reality is the state of things as they actually exist, as opposed to an idealistic or notional idea of them. Reality is the state of things as they are, rather than as they are imagined to be. Our imaginations are not real until they are practicalised. Faye (2006) has remarked that the metaphysical account of realism as regards the external world has so far provided us with three more precise claims.

The claims are;

- 1) physical things which we experience immediately through our senses exist objectively in some way or another irrespective of our beliefs in them;
- 2) theoretical entities which are not objects of direct sense experience, but which are related to our best scientific theories are real and not merely mental constructions; and
- 3) the best scientific theories tell us how the world is.

We may define Realism as a general metaphysical doctrine consisting of four components. First, there is the ontological component of the view: whatever there is, is what it is regardless of how we think of it. A real entity, or a law of nature, has full, concrete specificity and determinateness, or lacks both, independently of our mental powers.

Secondly, the meaning of statements about the external world must be analyzed by reference to the notion of truth conditions whose specification in principle may reach beyond any possible empirical justification. Thirdly, we have objective knowledge of the world as it is. Knowledge in the objective sense is independent of anybody's beliefs or anybody's claims of knowledge.

The fourth element of realism is that in the right circumstances ordinary people or scientists are able to provide warranted judgement about the truth of all kinds of beliefs regardless of whether they are about observable or unobservable entities or are formulated in terms of singular or universal sentences.

Based on these descriptions, the basic elements which we can use to define reality include the following:

1. Reality is thought process: This means reality is human enterprise.

2. Reality is rational thought: This means reality is systematic and void of biases.
3. Reality is aimed at overall development of any society.

From these elements, one can define reality as the totality of all things, structures (actual and conceptual), events (past and present) and phenomena, whether observable or not. It is what a world view (whether it be based on individual or shared human experience) ultimately attempts to describe or map. **Reality** is the sum or aggregate of all that is real or existent within a system, as opposed to that which is only imaginary.

Jaja (2014) remarks that, myths tell us about the reality of the universe and its components. African myths explain in the context of African cultures, great human concerns and realities such as death, creation, the evolution of living things, man's relationship with other living creatures etc. However, the purpose of a myth is far more than being explanatory. It has many values in the African societal setting. It acts as a socializing agent. It is used to nourish and to buttress the traditions of the ancestors. Myths are also educative in that they teach people especially the younger ones the meaning of the universe and man's place in it. They place the world before us as an object of indifferent investigation, a world to be known not just as an abstracted object but as a wholistic real entity. A universal knowledge arises from man's effective engagement with the world and myths help to explain the great human concepts of his time. According to Wessel (2012), it is important to note that there is a difference between scientific reality and religious reality. However, causality is closely linked with rationality. Rational thought processes which are important in the interpretation of reality form a meaningful basis for the study of science in Africa.

Self-Assessment Exercise 1

What is your definition of reality?

4.3.2 Science and Reality

Sometimes, we are challenged with the real definition or explanation of what science is. Science has been defined in several different ways.

For instance, the *Random House Webster's Unabridged Dictionary*, 1 ed., has defined science as follows:

1. a branch of knowledge or study dealing with a body of facts or

- truths systematically arranged and showing the operation of general laws: *the mathematical sciences*.
2. systematic knowledge of the physical or material world gained through observation and experimentation.
 3. systematized knowledge in general.

In general terms therefore, science is a way of knowing the world we live in, in rational terms as put forward by Dienye and Gbamanja, (1990). But any way of knowing that is not based on scientific criteria may not be acceptable to science. Otuka and Uzoechi (2009), remark that science tries to uncover the hidden reality. Science is experiential and based on concrete evidence.

There are many ways and approaches of knowing in scientific. Some of the scientific ways of knowing include observation, experimentation, explanation and predicting of events and phenomena in the world. There exists close relationship between what is known and the ways of knowing in science. Methods employed in knowing determines to a large extent the quality of what is known.

Science involves the formulation of statements of proposed facts (observable truths) about the physical world, along with statements about relationships between the facts, in the form of physical laws. In science, these statements of laws and proposed facts are subject to criticism and testing by observation and experiment.

On the concept of reality, the *Random House Webster's Unabridged Dictionary*, 1 ed., has also defined it as follows:

1. the state or quality of being real.
2. *Philos.*
 - a. something that exists independently of ideas concerning it.
 - b. something that exists independently of all other things and from which all other things derive.

It based on this premise that it is explained that. the product of interplay between what man perceives or senses and his capacity to organise such inputs into explainable sensations is reality. Reality is constructional, irrespective of the seemingly concrete or abstract object, event or phenomenon may be.

We should be wary of the idea that the nature of reality is relative to what someone believes. Suppose I believe that the Earth is flat and you believe it is round. Therefore, the line goes, we have two different realities. This cannot be right, for we are talking about (referring to) the same thing. We just differ in our beliefs about it. But whatever the

nature of reality is, it cannot be hostage to anyone's view of it. It must be independent of any individual's mind.

To ascertain what reality is, scientists interact with nature and make observations. Man's observations may be limited to the extent of his capable of seeing or perceiving. What he is able to perceive may generally be limited by some lack of special techniques or innovations and also the available worldview. Take a fighter pilot as an example. If she looks out the window at 700mph, all she may see is a mist of darkness-obscured blur whizzing past her window. If she looks down at her instruments however, she is provided with a much more useful reality simulation. A radar screen tells her where she is in the world and what is coming up far beyond her 'real' vision. A topographical display and night-vision goggles help her see the ground she is flying over.

We should also note that, a scientific explanation becomes tentative and could be revised or discarded for one that is more useful in making predictions that are verifiable. Also, the one that is more generalised than its predecessor like the shift from geocentric to heliocentric universe in which the latter has proved more useful in verifying predictions.

Self-Assessment Exercise 2

What is scientific reality?

4.4 Summary

In this unit, you have learnt about reality and science. Reality consists of an endless flow of perceptual interpretations which we, the individuals who share a specific membership have learned to make in common. Scientists in the context of this unit work within a given paradigm. We have also discussed the critical elements of reality differentiating scientific reality from religious and cultural reality. Causality is linked with rationality, rational thought processes which are important in interpretation of reality form a meaningful basis for the study of science in Africa.

4.5 References/Further Readings/Web Resources

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4.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. What is your definition of reality?
Reality is the state of things as they are, rather than as they are imagined to be.

SAE 2

1. What is scientific reality?
Science involves the formulation of statements of proposed facts (observable truths) about the physical world, along with statements about relationships between the facts, in the form of physical laws. In science, these statements of laws and proposed facts are subject to criticism and testing by observation and experiment. The outcomes of these observation and experimentations which are verifiable are known as scientific reality.

MODULE 2 EXPLANATION OF SOME NATURAL PHENOMENA

Unit 1	Cosmic Serpent
Unit 2	Rainbow
Unit 3	Twins
Unit 4	Lightning and Thunder
Unit 5	Echo and Mirage

UNIT 1 COSMIC SERPENT

Unit Structure

- 1.1 Introduction
- 1.2 Intended Learning Outcomes
- 1.3 Cosmic Serpent
 - 1.3.1 The Serpent
 - 1.3.2 The Cosmic Serpent
 - 1.3.3 Significance of Cosmic Serpent
 - 1.3.4 The Rainbow Serpent
- 1.4 Summary
- 1.5 References/Further Readings/Web Resources
- 1.6 Possible Answers to Self-Assessment Exercise(s)

1.1 Introductions

This unit introduces you to the concept of natural phenomenon in our universe in the scientific context and based on the African belief system. The unit discusses the mythological representation of the serpent and the use of the serpent symbol, African conception of the serpent, cosmic and rainbow serpents and their significance as natural phenomena based on belief system.

A phenomenon, in a scientific context, is something that is observed to occur or to exist while a natural phenomenon is a thing **that occurs or manifests without human input**. In this module we will be discussing the mythology of the cosmic serpent and some of the natural phenomena in our universe. The natural phenomena will be discussing in this module are the rainbow, twins, lightning, thunder, echo and mirage.

1.2 Intended Learning Outcomes

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

- explain the mythology of the serpent
- explain the cosmic serpent.
- discuss significance of cosmic serpent.
- explain the rainbow serpent.

1.3 Cosmic Serpent

1.3.1 The Serpent

Our environments are made up of living and non-living organisms, plants and animals, some of these living organisms inhabit land, seas and rivers (waters). **Serpent** (from Latin: *serpens*, *serpentis*) is a word used in mythological or religious contexts to denote a being that looks like a snake but has a heightened sense of intelligence. Mythologically, Serpents are part of the living organisms that we find in the world around us. The serpents are of different colours, sizes and names. One of the important questions that come to mind is: How do Africans regard and treat them? Some of the serpents that some Africans hold on high esteem are pre-determined by their cultural beliefs and myths about them. However, reptilian serpent has been an archetype for many tribes, societies and civilisations. Snakes have been associated with some of the oldest rituals known to mankind and represent dual expression of good and evil.

The serpent is one of the oldest and most widespread mythological figures found in various cultures. It was recognized in early times that a snake's venom, like certain chemicals of plants and fungi, had the power to either heal, poison or provide expanded consciousness. The snake was often considered one of the wisest animals because of its herbal knowledge and entheogenic association. Its habitat in the earth between the roots of plants made it an animal with chthonic properties connected to the afterlife and immortality. Additionally, the way a snake sheds its skin and comes forth from the lifeless husk glistening and fresh, made it a universal symbol of renewal, rebirth and the regeneration that potentially led to immortality.

In some cultures, snakes were fertility symbols. For example, the Hopi people of North America performed an annual snake dance to celebrate the union of Snake Youth (a Sky spirit) and Snake Girl (an Underworld spirit) and to renew the fertility of Nature. During the dance, live snakes were handled, and at the end of the dance the snakes

were released into the fields to guarantee good crops. "The snake dance is a prayer to the spirits of the clouds, the thunder and the lightning, that the rain may fall on the growing crops.

On the one hand, serpents are commonly connected with regeneration, renewal, and health (which is still implied by the modern medical symbol); yet, on the other hand, they are frequently seen in Judeo-Christian and Islamic cultures as symbols of evil and wickedness. Such ambivalent viewpoints reflect the fascination that humanity has placed in these creatures over the ages. For instance, In African Yoruba mythology, Oshunmare was a mythic regenerating serpent.

Self-Assessment Exercise 1

1. What is a serpent?
2. Discuss symbolical representation and understanding of the serpent in some cultures

1.3.2 The Cosmic Serpent

The **serpent** or snake, is one of the oldest and most widespread mythological symbols. The word serpent is derived from the Latin word *serpens*, a crawling animal or snake. Snakes have been associated with some of the oldest rituals known to mankind and represent dual expression of good and evil. Serpents have been associated with mythology in various cultures around the world.

The Cosmic Serpent is a trans-cultural icon. It is a global symbol that highlights the interconnected nature of fundamental concepts in earth, space, life and environmental sciences. Around the world, for thousands of years, in one form or another, the reptilian serpent (snake, dragon, Naga - of Hindu tradition, the Native Hawaiian mo'o) has been an archetype for countless tribes, societies and civilizations. In almost every instance, the serpent stands for immense and powerful cosmic movements. This is true of archetypal serpents deep under the earth, deep under the oceans, on the earth surface and in the sky. In fact, it is the very ability of serpents to move between various worlds and different dimensions which give them a significance, providing purpose and direction to ways of knowing and being, world-wide.

Indigenous cultures around the world use cultural lore in the form of story to teach important lessons applicable to life. Many of these stories, often termed "myth" have foundational representations of the natural world, including the human connection and human participation in the place in which they live. Sometimes the cosmic serpent is viewed as

representative of negative energy, sometimes as positive and sometimes as providing balance and/or ambivalence.

Cosmic Serpent archetype as it pervades many different cultures seems to speak to the idea that our diverse cultures have many things in common. The archetype has a specific meaning within each culture, yet as a global symbol it helps to convey the message that all cultures are interconnected by virtue of their humanity and, more specifically, it conveys what the project hopes to accomplish, which is to build bridges between Western and Native world views.

In most African traditions, the serpent is a symbol for immense and powerful cosmic movements. The serpent, when forming a ring with its tail in its mouth, is a clear and widespread symbol of the "All-in-All", the totality of existence, infinity and the cyclic nature of the cosmos. The cosmic serpent is identified as a reptile, an earthly serpent, a flying dragon, a water serpent, with many supernatural characteristics. These symbolic characteristics are based on biological observation. Sometimes the cosmic serpent is viewed as a representative of negative energy and in other instances viewed as positive energy. Sometime it is believed to provides balance and/or ambivalence. For instance, the story of Adam and Eve in the garden of Eden portrays serpent as deceitful being.

The demigod Aidophedo of the West African Ashanti people is also a serpent biting its own tail. In Dahomey mythology of Benin in West Africa, the serpent that supports everything on its many coils was named Dan.

Self-Assessment Exercise 2

1. Explain what you understand by cosmic serpent.
2. Discuss the characteristics of the cosmic serpent as a mythological phenomenon

3.2 Significance of Cosmic Serpent

Cosmic serpent is symbolic and unique as unifying bridge between the African science and western science worldviews. Museum practitioners patronise cosmic serpent. The cosmic serpent has introduced many people to the knowledge of the serpent through multiple academic disciplines. Globally, cosmic serpent helps to convey the message that all culture is interconnected by virtue of their humanity. In many cultures, serpents are linked to protection and guardianship and so considered as friends, and should not be hurt or killed.

Self-Assessment Exercise 3

What message does the understanding of the cosmic serpent convey globally?

3.3 The Rainbow serpent

The Rainbow Serpent (also known as the Rainbow Snake) is a major mythological being for Aboriginal people across Australia, although the creation myths associated with it are best known from northern Australia. The **Rainbow Serpent** or **Rainbow Snake** is a common deity often seen as a creator god, known by numerous names in different Australian Aboriginal languages by the many different Aboriginal peoples. It is a common motif in the art and religion of many Aboriginal Australian peoples. Rainbow serpent was introduced to the wider world through the work of anthropologists. In fact, the name *Rainbow Serpent* or *Rainbow Snake* appears to have been coined in English by Alfred Radcliffe-Brown, an anthropologist who noticed the same concept going under different names among various Aboriginal Australian cultures, and called it "the rainbow-serpent myth of Australia. The rainbow serpent is in the first instance, is the rainbow itself. It is said to inhabit particular waterholes, springs etc., owing to the fact that such bodies of water can exhibit spectral colours by diffracting light, according to one explanation. The Rainbow Serpent came from beneath the ground and created huge ridges, mountains, and gorges as it pushed upward. The Rainbow Serpent is understood to be of immense proportions and inhabits deep permanent waterholes. and is in control of life's most precious resource, water. In some cultures, the Rainbow Serpent is considered to be the ultimate creator of everything in the universe.

In some cultures, the Rainbow Serpent is male; in others, female; in yet others, the gender is ambiguous or the Rainbow Serpent

The serpent is viewed as a giver of life through its association with water, but can be a destructive force if angry. When the rainbow is seen in the sky, it is said to be the Rainbow Serpent moving from one waterhole to another and the divine concept explained why some waterholes never dried up when drought struck.

The sometimes unpredictable Rainbow Serpent (in contrast to the unyielding sun) replenishes the stores of water, forming gullies and deep channels as the Rainbow Serpent slithers across the landscape. In this belief system, without the Serpent, no rain would fall and the Earth would dry up. In other cultures, the Serpent is said to come to stop the

rain. In addition to the identification with the rainbow, the Serpent is also identified with a prismatic halo around the moon that can be regarded as a sign of rain. The Rainbow Serpent is sometimes associated with human blood, especially circulation and the menstrual cycle, and considered a healer. Thunder and lightning are said to stem from when the Rainbow Serpent is angry, and the Serpent can even cause powerful rainstorms and cyclones.

Stories about the Rainbow Serpent have been passed down from generation to generation. The Serpent story may vary, however, according to environmental differences. Tribes of the monsoonal areas depict an epic interaction of the sun, Serpent, and wind in their Dreamtime stories, whereas tribes of the central desert experience less drastic seasonal shifts and their stories reflect this. It is known both as a benevolent protector of its people (the groups from the country around) and as a malevolent punisher of lawbreakers. The Rainbow Serpent's mythology is closely linked to land, water, life, social relationships, and fertility.

Some commentators have suggested that the Rainbow Serpent is a phallic symbol, which fits its connection with fertility myths and rituals

Self-Assessment Exercise 4

What is rainbow serpent?

1.4 Summary

In this unit, we learnt that cosmic serpent is a trans-cultural icon, a symbol that highlights the interconnected nature of fundamental concepts in earth, space, life and environmental sciences. In the unit, we also learnt that formation of rainbow can be traced to the serpent named the “Rainbow Serpent”. Biblically, rainbow was identified as sign of covenant between God and man in the generation of Noah when the world was destroyed by flood because of sin.

1.5 References/Further Readings/Web Resources

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1.6 Possible Answers to Self-Assessment Exercise(s)

SAE1

1. **Serpent** (from Latin: *serpens*, *serpentis*) is a word used in mythological or religious contexts to denote a being that looks like a snake but has a heightened sense of intelligence. Mythologically, Serpents are part of the living organisms that we find in the world around us.
2. The serpent is one of the oldest and most widespread mythological figures found in various cultures. It was recognized in early times that a snake's venom, like certain chemicals of plants and fungi, had the power to either heal, poison or provide expanded consciousness. The snake was often considered one of the wisest animals because of its herbal knowledge and entheogenic association. Its habitat in the earth between the roots of plants made it an animal with chthonic properties connected to the afterlife and immortality. Additionally, the way a snake sheds its skin and comes forth from the lifeless husk glistening and fresh, made it a universal symbol of renewal, rebirth and the regeneration that potentially led to immortality.

In some cultures, snakes were fertility symbols.

SAE2

1. The Cosmic Serpent is a trans-cultural icon. It is a global symbol that highlights the interconnected nature of fundamental concepts in earth, space, life and environmental sciences.
2. The serpent is a symbol for immense and powerful cosmic movements. The serpent, when forming a ring with its tail in its mouth, is a clear and widespread symbol of the "All-in-All", the totality of existence, infinity and the cyclic nature of the cosmos. The cosmic serpent is identified as a reptile, an earthly serpent, a flying dragon, a water serpent, with many supernatural characteristics. These symbolic characteristics are based on biological observation. Sometimes the cosmic serpent is viewed as a representative of negative energy and in other instances viewed as positive energy. Sometime it is believed to provides balance and/or ambivalence. For instance, the story of Adam and Eve in the garden of Eden portrays serpent as deceitful being.

SAE 3

1. Globally, cosmic serpent helps to convey the message that all culture are interconnected by virtue of their humanity. In many cultures, serpents are linked to protection and guardianship and so considered as friends, and should not be hurt or killed

SAE 4

1. The Rainbow Serpent (also known as the Rainbow Snake) is a major mythological being for Aboriginal people across Australia, although the creation myths associated with it are best known from northern Australia. The **Rainbow Serpent** or **Rainbow Snake** is a common deity often seen as a creator god, known by numerous names in different Australian Aboriginal languages by the many different Aboriginal peoples.

UNIT 2 RAINBOW

Unit Structure

- 2.1 Introduction
- 2.2 Intended Learning Outcomes
- 2.3 Rainbow
 - 2.3.1 Mythology of the Rainbow Serpent
 - 2.3.2 Features of the Rainbow
 - 2.3.3 Formation of the Rainbow
- 2.4 Summary
- 2.5 References/Further Readings/Web Resources
- 2.6 Possible Answers to Self-Assessment Exercise(s)

2.1 Introduction

We are all familiar with the rainbow. In our early days in school we sang many songs using the rainbow and its beautiful colours. We also have heard stories in our localities about the rainbow, the myths and cultural beliefs. Different cultures have different stories and beliefs about the rainbow. Sometimes some of these stories cut across cultures. Most cultures believe that all natural phenomena around us can be traced to some original source(s). Based on an Australian belief the origin of rainbow is traced to a serpent called rainbow serpent. In this unit we will be discussing the myth surrounding the origin of the rainbow as a natural phenomenon. The scientific explanation of the formation of the rainbow as a natural phenomenon will be discussed.

2.2 Intended Learning Outcomes

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

- discuss the mythology of the rainbow serpent.
- discuss the features of the rainbow
- explain scientifically how the rainbow is formed.

2.3 Rainbow

2.3.1 Mythology of the Rainbow Serpent

According to a British anthropologist named Alfred Radcliff-Brown in his stories in 1926, certain serpent was said to be closely associated with the rainbow, rain, rivers and deep waterholes. The serpent was given different names by different tribes across Australia. Radcliffe-Brown was the one who gave the name Rainbow Serpent that is called till

today, worldwide to represent the Pan-Australian myth and as a symbol of Aboriginal mythology in general.

The Rainbow Serpent is generally recognised by those who tell the Rainbow Serpent myths, as snake of some enormous size often living within the deepest waterholes of Australia's waterways; it is known both as a benevolent protector of its people and as malevolent punisher of law breakers. The rainbow serpent's mythology is closely linked to land, water, life, social relationships and fertility. It reveals itself to people in this world as rainbow as it moves through water and the rain, shaping landscapes naming and singing of places, dreaming them into being. According to biblical injunction, rainbow is a symbol of seal of covenant between God and man; that He (God) will not destroy the world with water again after the generation of Noah.

Self-Assessment Exercise 1

What is rainbow serpent?

2.3.2 Features of the rainbow

The **rainbow** is a meteorological phenomenon that is caused by reflection, refraction and dispersion of light in water droplets resulting in a spectrum of light appearing in the sky. It takes the form of a multicoloured circular arc. Rainbows caused by sunlight always appear in the section of sky directly opposite the Sun. It is therefore an arch of colours visible in the sky, caused by the refraction and dispersion of the sun's light by water especially rain or other water droplets in the atmosphere. The colours of the rainbow are generally said to be red, orange, yellow, green, blue, indigo, and violet.

Rainbows can also be full circles not arc. However, the observer normally sees only an arc formed by illuminated droplets above the ground, and centered on a line from the Sun to the observer's eye.

We can have a primary rainbow in which the arc shows red on the outer part and violet on the inner side. This rainbow is caused by light being refracted when entering a droplet of water, then reflected inside on the back of the droplet and refracted again when leaving it. On the other hand, we can also see a double rainbow in which a second arc is seen outside the primary arc, and has the order of its colours reversed, with red on the inner side of the arc. This is caused by the light being reflected twice on the inside of the droplet before leaving it.



Fig. 1: Image of The End of A Rainbow



Fig. 2: Rainbows Formed in the Spray of a Waterfall (called spray bows)



Fig. 3: Rainbow

Self-Assessment Exercise 2

What are the common features of the rainbow?

2.3.3 Formation of the Rainbow

A rainbow is **caused by sunlight and atmospheric conditions**. Light enters a water droplet, slowing down and bending as it goes from air to denser water. The light reflects off the inside of the droplet, separating into its component wavelengths--or colours. When light exits the droplet, it makes a rainbow.

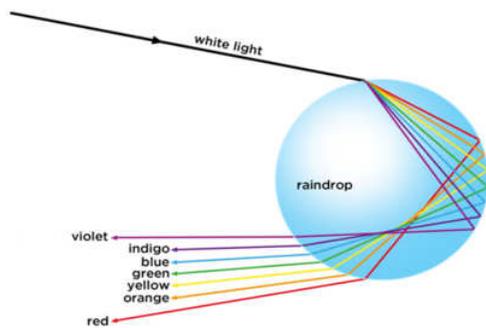


Fig. 4: Formation of Rainbow

Sunlight is made of many different wavelengths, or colours, that travel at different speeds when passing through a medium. This causes the white light to split into different colours. Longer wavelengths appear as red and shorter wavelengths appear as blue or violet. We see the colour spectrum of the rainbow as the light passes through the raindrop at different angles of approximately two degrees, from red to violet. This is not a true spectrum as the colours mix and blur throughout the spectacle. The angle of scatter from raindrops is different for everyone which means that every rainbow is unique to the observer.

However, for the observer to see a rainbow, they must be in a specific position relative to the sun and water droplets:

- The observer must be positioned so the sun is behind them.
- The lower the sun in the sky, the more of an arc of a rainbow the observer will see – it must be less than 42° in the sky.
- Water droplets such as rain or fog must be in front of the observer.

You should note that the light must strike the drops of water at a particular angle that corresponds to that colour. The angle is measured

with respect to the line of sight of the observer. The colour red is peeled away when the sunlight strikes a drop at an angle of 42 degrees, whereas violet is peeled away when the angle formed is 40 degrees. The rest of the colours are peeled away when the angle lies somewhere between 42 and 40 degrees.

The bent, contiguous stripes of colours travel to the opposite side of the drop, where some light refracts and therefore rises as it exits the drop, but most of the light is *reflected* by the drop's surface. The angle of reflection is equal to the angle of incidence, so the violet ray is reflected more inward than the red ray. This causes the order of the stripes to invert. The inverted stripes now refract again, rising (they appear to bend, as they are inverted) as they exit through the surface from which they entered. As millions of prisms refract the Sun's light, the stripes of colours collectively form what we perceive as a stunning rainbow.

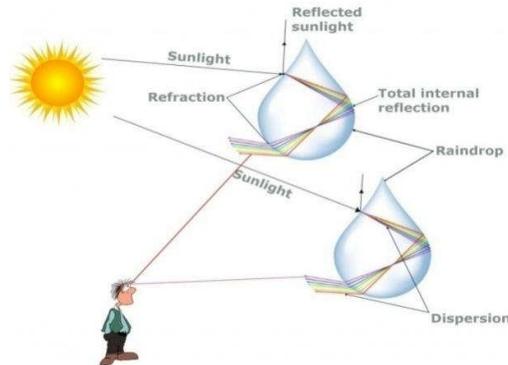


Fig. 5: Viewing the Rainbow

Self-Assessment Exercise 3

Describe how rainbow is formed

2.4 Summary

In this unit we have discussed the myths and traditional beliefs about the rainbow. The belief in the rainbow serpent as a natural phenomenon was highlighted. This unit further presented the scientific explanation of the nature and features of the rainbow. It also explained how the rainbow is formed as a result of reflection, refraction and dispersion of white light rays from the sun by water droplets or vapour.

2.5 References/Further Readings/Web Resources

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2.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

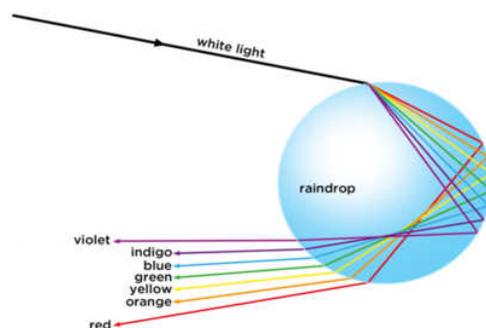
1. According to a British anthropologist named Alfred Radcliffe-Brown in his stories in 1926, certain serpent was said to be closely associated with the rainbow, rain, rivers and deep waterholes. The serpent was given different names by different tribes across Australia. Radcliffe-Brown was the one who gave the name Rainbow Serpent that is called till today – worldwide to represent the Pan-Australian myth and as a symbol of Aboriginal mythology in general.

SAE 2

2. The **rainbow** is a meteorological phenomenon that is caused by reflection, refraction and dispersion of light in water droplets resulting in a spectrum of light appearing in the sky. It takes the form of a multicoloured circular arc. Rainbows caused by sunlight always appear in the section of sky directly opposite the Sun. It is therefore an arch of colours visible in the sky, caused by the refraction and dispersion of the sun's light by water especially rain or other water droplets in the atmosphere. The colours of the rainbow are generally said to be red, orange, yellow, green, blue, indigo, and violet.

SAE 3

3. Light enters a water droplet, slowing down and bending as it goes from air to denser water. The light reflects off the inside of the droplet, separating into its component wavelengths--or colours. When light exits the droplet, it makes a rainbow.



UNIT 3 TWINS

Unit Structure

- 3.1 Introduction
- 3.2 Intended Learning Outcomes
- 3.3 Twins
 - 3.3.1 Mythology of twins
 - 3.3.2 Formation of twins
- 3.4 Summary
- 3.5 References/Further Readings/Web Resources
- 3.6 Possible Answers to Self-Assessment Exercise(s)

3.1 Introduction

In the last Unit we discussed the myth and realities surrounding the formation of rainbow. The link between the formation of rainbow and the cosmic serpent was also discussed. In this unit we will be discussing twins as natural phenomenon. Natural phenomena in all communities influence the cultures of the people. In this unit we will focus on the myth and cultural beliefs surrounding the formation and existence of twins. Scientific explanation of the formation and production of twins in African communities will also be discussed

3.2 Intended Learning Outcomes

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

- discuss the mythology of twins
- give scientific explanation of how twins are formed.

3.3 Twins

3.3.1 Mythology of twins

As two children born on the same day to the same mother, twins have a unique sense of identity. They have more in common with one another than any two ordinary people, especially if they are identical twins. Yet twins are also separate beings who may be very different in character. Myths about twins—as partners, rivals, opposites, or halves of a whole—are rooted in this basic mystery of sameness and difference.

The history of twin mythology exact date is not known till date. Twin is one of the natural phenomena in the African culture. **Twins** appear in the mythologies of many cultures around the world. They are however especially important in African and Native American mythology. In

some cultures they are seen as ominous, and in others they are seen as auspicious. Twins in mythology are often cast as two halves of the same whole, sharing a bond deeper than that of ordinary siblings, or seen as fierce rivals. They can represent another aspect of the self or a shadow. However, twins can also reflect a complete opposition of the other or in the commonly known instance of good and evil twin identities. Twins can also be shown as having special powers and deep bonds. Another example of this strong bond shared between twins would be the Ibeji (twins) among the Yorubas of Nigeria, within African mythology. Among the Yoruba people of Nigeria, twins are called ibejis after Ibeji, the patron deity of twins. People believe that, depending on how they are treated, twins can bring either fortune or misfortune to their families and communities. For this reason, twins receive special attention.

Ibeji (twins) are viewed as one soul shared between two bodies. If one of the twins die, the parents then create a doll that portrays the body of the deceased child, so the soul of the deceased can remain intact for the living twin. Without the creation of the doll, the living twin is almost destined for death because it is believed to be missing half of its soul.

In Nigeria, we have different descriptions of twins based on some cultural myths. Some of these descriptions include:

- Mawu- Lisa - Twins representing moon and sun, respectively.
- Yemaja - Mother of all life on earth.
- Aganju - Twin and husband of Yemaja
- Ibeji -Twins of joy and happiness. Children of Shango and Oshun



Figure 2: *Ibejis* (named after the deity of twins, Ibeji)

The mythology of ancient Egypt includes examples of twinship operating in different ways. According to one version of the Egyptian creation myth, the earth god Geb and the sky goddess Nut were twins and also lovers, locked together in a tight embrace. The great god Ra*

separated them with air, leaving Nut arched across the heavens above Geb. Nut and Geb are complementary symbols—meaning that the two complete each other, forming a whole.

To the Dogon of Mali, twinship represents completeness and perfection. The symbol of this wholeness is the deity Nummo, who is really a set of twins, male and female. The act of creating the other gods and the world required the sacrifice of one part of Nummo. From that time on, all beings were either male or female, lacking Nummo's divine completeness.

The supreme creator deity of the Fon people of Benin is Mawu-Lisa, a being both male and female who is sometimes described as a pair of twins. Mawu is the moon and the female element of the deity, while Lisa is the sun and the male part. They gave birth to all of the other gods, who also were born as pairs of twins.

Greek mythology believed that twins were produced after a mother copulated with a god like; such as Heracles and his twin brother Iphicles and Romulus and Remus – half god, half human. In several native American cultures, they believed that if women ate twin like fruits, such as double almond or apples, it would increase the chances of having twins. While in other cultures, twins were attributed to the virility of the father.

One of the most common dichotomies is the belief that there is a “good” and “bad” twin. Mothers of twins usually reported that each twins have had the good and bad moments. Expression about the opposition of twins given by Greeks was based on Apollo and Artemis. Apollo became the sun god and Artemis became moon goddess. In Brazil, the Xingu mythology has Kuat as the sun and Lae as the moon who were twin brothers.

Self-Assessment Exercise 1

Explain any three myth surrounding twins in Africa
--

3.3.2 Formation of twins

As we have discussed earlier, in many cultures, there are many myths and legends surrounding the birth of twins or having multiple birth in one pregnancy. Twins and multiples are the subjects of much interest and attention. Although they have become more common in recent generations, they are still a relatively rare phenomenon. For every one

hundred people you encounter, only three will be a twin, and much fewer can claim to be a triplet or higher-order multiple.

Because of their scarcity, there are many misunderstandings about them. One of the most common misunderstandings is the cause of twins and multiples.

Scientifically, **twins** are two offspring produced by the same pregnancy. Not all twinning can be attributed to the same cause. In order to understand the causes of twins, it's important to understand that there are two types of twins, classified by zygosity. Twins can be either *monozygotic* ('identical') or *dizygotic* ('non-identical' or 'fraternal'). In rare cases twins can have the same mother and different fathers (heteropaternal superfecundation).

Monozygotic multiples form from a single zygote (fertilized egg) that splits after fertilization. Monozygotic twins are more commonly known as identical twins because they originate from a single egg/sperm combination and share the same genetic background, so they often look alike and share many of the same characteristics. Monozygotic twins are always the same gender (with very few, very rare, exceptions).

Dizygotic or multizygotic multiples form from two or more zygotes, which are separate eggs fertilized by separate sperm that share the same period of gestation. Dizygotic twins are more commonly known as fraternal twins. With their own unique combination of genes, they have the same genetic connection as any other siblings but share a womb during gestation. Dizygotic twins can be boys, girls, or a combination.

In the reproduction process, during a normal cycle of ovulation, a single egg (or oocyte) is released from a woman's ovaries. If the egg is fertilized by sperm from a man during sexual intercourse, the resulting zygote travels to the woman's uterus, dividing and duplicating through the process of mitosis, where it will implant and grow into an embryo and eventually a foetus. This foetus develops into a baby that is born boy or girl.

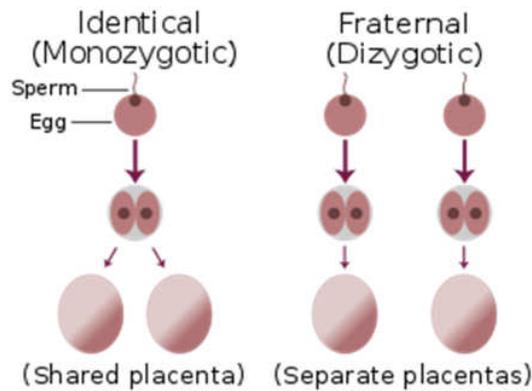
Monozygotic twins form when a single fertilized egg splits into two and each develops separately. From there, two embryos form and will eventually develop into two babies. Monozygotic ("mono" means one and "zygote" means fertilized egg) is the term used to describe this process.

The term "monozygotic" is a more accurate way to describe twins that form from a single egg than the term "identical." Even though the twins

look alike, have similar personalities, and may even share many of the same interests, they are not clones.

The two embryos came from the same source, which means they have the same genetic components. When the babies are born, they are often strikingly similar in appearance—which is why they're commonly called "identical" twins.

Sometimes, more than one egg is released during ovulation. If two eggs are fertilized during sexual intercourse and both successfully implant in the uterus, the result is a multiple pregnancy. If more than two eggs are released, fertilized, and implant, the result is multizygotic multiples, higher-order multiples such as triplets (3), quadruplets (4), quintuplets (5), sextuplets (6), septuplets (7), octuplets (8), or even more, although no multiples beyond octuplets have ever been known to survive.



Self-Assessment Exercise 2

Explain the formation of twins as a scientific process

3.4 Summary

In this unit we have discussed the mythology and cultural legends about twins in various cultures. The scientific explanations of the process of reproduction that give rise to twins, both identical and non-identical were also discussed.

3.5 References/Further Readings/Web Resources

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3.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

Twins appear in the mythologies of many cultures around the world. In some cultures they are seen as ominous, and in others they are seen as auspicious. Twins in mythology are often cast as two halves of the same whole, sharing a bond deeper than that of ordinary siblings, or seen as fierce rivals. They can represent another aspect of the self or a shadow.

SAE 2

In the reproduction process, during a normal cycle of ovulation, a single egg (or oocyte) is released from a woman's ovaries. If the egg is fertilized by sperm from a man during sexual intercourse, the resulting zygote travels to the woman's uterus, dividing and duplicating through the process of mitosis, where it will implant and grow into an embryo and eventually a foetus. This foetus develops into a baby that is born boy or girl. **In the cause of cell division if one fertilized cell splits into two independent cells that develop into two embryos or foetus, identical twins will be formed. One the other hand, if two eggs are fertilized during sexual intercourse and both successfully implant in the uterus, the result is a multiple pregnancy that will produce non-identical twins.**

UNIT 4 LIGHTNING AND THUNDER

Unit Structure

- 4.1 Introduction
- 4.2 Intended Learning Outcomes
- 4.3 Lightning and Thunder
 - 4.3.1 Mythology of Lightning and Thunder
 - 4.3.2 Occurrence of lightning and Thunder
- 4.4 Summary
- 4.5 References/Further Readings/Web Resources
- 4.6 Possible Answers to Self-Assessment Exercise(s)

4.1 Introduction

We have all observed the occurrence of lightning and thunder in our environment especially during the rainy season. There are many myths and legends including cultural stories that have been told about lightning and thunder, Many culture refer to them as ‘gods’ However, science has provided answers and explanations to many questions about lightning. In this unit we will be discussing the concepts of lightning and thunder. We will explore some of the cultural myths and legends about them. Lightning and thunder and their processes of occurrence will be explained scientifically.

4.2 Intended Learning Outcomes

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

- explain the mythology of lightning and thunder
- give scientific explanation of how lightning and thunder occur.

4.3 Lightning and Thunder

4.3.1 Mythology of Lightning and Thunder

The prehistoric humans believed that lightning was the magic fire from the sky which man captured and used to keep warm at night. It kept the savage animals away. As primitive man sought answers about the natural world, lightning became a part of his superstitions, his myths and his early religions.

Lightning is still one of the most extraordinary phenomena in Nature. In the past it was understood as a type of fire and it can be found represented as a symbol in most ancient cultures. There even exist mythological representations of its destructive power.

Despite the scientific progress that has taken place during the last centuries, the myths and beliefs about this phenomenon are still present in great part of the global population.

Early Greeks believed that lightning was a weapon of Zeus. Thunderbolts were invented by Athena, the goddess of wisdom. Since lightning was a manifestation of the gods, any spot struck by lightning was regarded as sacred. Greek and Roman temples often were erected at these sites, where the gods were worshipped in an attempt to appease them. There is a link in African mythology between rainbow serpent and lightning and thunder. It is believed that in the physical world, the Rainbow Serpent represents the element of water and may appear as a rainbow, lightning or thunder. As a lightning is sending of warning to people that do evil; and also a thunder to punish the people who do not heed to warning but continue in sins/evil ways.

Scandinavian mythology alludes to Thor, the thunderer, who was the foe of all demons. Thor tossed lightning bolts at his enemies. Thor also gave us Thurs-day.

In the pantheistic Hindu religion, Indra was the god of heaven, lightning, rain, storms and thunder. The Maruts used the thunderbolts as weapons. The Umpundulo is the lightning bird-god of the Bantu tribesmen in Africa. Even today their medicine men go out in storms and bid the lightning to strike far away. In India, the Navajo hold that lightning has great power in their healing rituals. Sand paintings show the lightning bolt as a wink in the Thunderbird's eye. Lightning is associated with wind, rain and crop growth.

Among the Igbos of southern Nigeria, amadioha is the god of thunder and lightning. He is amongst the most popular of Igbo deities, Sango is the solar and thunder divinity, the lightning god.

It is important to note that, early superstitions were observed as Cause and Effect, which now has been fancified as science. Socrates said, "that's not Zeus up there, it's a vortex of air." Ghengis Kahn forbade his subjects from washing garments or bathing in running water during a storm.

Self-Assessment Exercise 1

Give an example of any African belief system in lightning and thunder.
--

4.3.2 Occurrence of lightning and Thunder

Lightning is a naturally occurring electrostatic discharge during which two electrically charged regions, both in the atmosphere or with one on the ground, temporarily neutralize themselves, causing the instantaneous release of an average of one gigajoule of energy. This discharge may produce a wide range of electromagnetic radiation, from heat created by the rapid movement of electrons, to brilliant flashes of visible light in the form of black-body radiation.

Lightning is the most spectacular element of a thunderstorm. In fact it is how thunderstorms got their name. There is a linkage between thunder and lightning. Well, lightning *causes* thunder.

Lightning is a discharge of electricity. A single stroke of lightning can heat the air around it to 30,000°C (54,000°F)! This extreme heating causes the air to expand explosively fast. The expansion creates a shock wave that turns into a booming sound wave, known as **thunder**.

Lightning causes thunder, a sound from the shock wave which develops as gases in the vicinity of the discharge experience a sudden increase in pressure. Lightning occurs commonly during thunderstorms as well as other types of energetic weather systems, but volcanic lightning can also occur during volcanic eruptions.



Fig. 1: Lightning

As ice crystals high within a thunderstorm flow up and down in the turbulent air, they crash into each other. Small negatively charged particles called electrons are knocked off some ice crystals and added to other ice crystals as they crash past each other. This separates the positive (+) and negative (-) charges of the cloud. The top of the cloud becomes positively charged with particles called protons, while the base of the cloud becomes negatively charged.

As opposite charges attract each other, the negative charge at the bottom of the storm cloud wants to link up with the ground's positive charge. Once the negative charge at the bottom of the cloud gets large enough, a flow of negative charge called a stepped leader rushes toward the Earth. The positive charges at the ground are attracted to the stepped leader, so positive charge flows upward from the ground. When the stepped leader and the positive charge meet, a strong electric current carries positive charge up into the cloud. This electric current is known as the return stroke. We see it as the bright flash of a lightning bolt.

Thunder and lightning occur at roughly the same time although you see the flash of lightning before you hear the thunder. This is because light travels much faster than sound.



Fig. 2: Negative Charges (Electrons) in the Bottom of the Cloud are Attracted to the Positive Charges (Protons) in the Ground



Fig. 3: The accumulation of electric charges must be great enough to overcome the insulating properties of the air. When this happens, a stream of negative charges pours down toward a high point where positive charges have clustered due to the pull of the thunderhead.

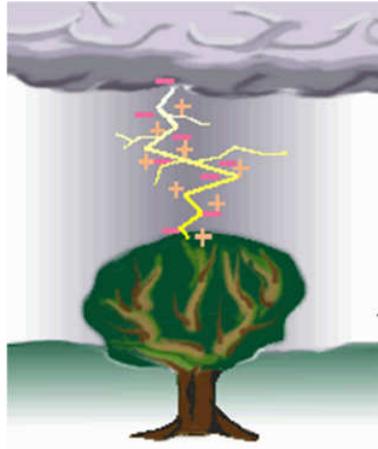


Fig. 4: *The connection is made and the protons rush up to meet the electrons. It is at this point that we see lightning and hear thunder. A bolt of lightning heats the air along its path causing it to expand rapidly. Thunder is the sound caused by the rapidly expanding air.*

Self-Assessment Exercise 2

What is lightning?

4.4 Summary

In this unit we have discussed the myth and cultural beliefs about lightning and thunder. Lightning is still one of the most extraordinary phenomena in Nature. In the past it was understood as a type of fire and it can be found represented as a symbol in most ancient cultures. Science has explained how lightning and thunder occur. In this unit therefore we also discussed how lightning and thunder occur.

4.5 References/Further Readings/Web Resources

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4.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. Among the Igbos of southern Nigeria, amadioha is the god of thunder and lightning. He is amongst the most popular of Igbo deities, Sango is the solar and thunder divinity, the lightning god.

SAE 2

2. **Lightning** is a naturally occurring electrostatic discharge during which two electrically charged regions, both in the atmosphere or with one on the ground, temporarily neutralize themselves, causing the instantaneous release of an average of one gigajoule of energy. This discharge may produce a wide range of electromagnetic radiation, from heat created by the rapid movement of electrons, to brilliant flashes of visible light in the form of black-body radiation.

UNIT 5 ECHO AND MIRAGE

Unit Structure

- 4.1 Introduction
- 4.2 Intended Learning Outcomes
- 4.3 Lightning and Thunder
 - 4.3.1 Mythology of Echo and Mirage
 - 4.3.2 Occurrence of Echo
 - 4.3.3 Occurrence of Mirage
- 4.4 Summary
- 4.5 References/Further Readings/Web Resources
- 4.6 Possible Answers to Self-Assessment Exercise(s)

4.1 Introduction

We are familiar with the reflection of sound, which makes us to hear a repeat of our voice when we talk in a large empty hall. This is also experienced in a deep well, when we talk around the well. There are many cultural beliefs and myths about sound reflection around the world especially in Africa. There are scientific explanations of how echo occur.

We may also have experienced occurrences that look like pool of water along the road when travelling on sunny days. In this unit we will discuss how echo and mirage are explained by different cultural myths and beliefs. We will also be exposed to scientific explanations of these occurrences.

4.2 Intended Learning Outcomes

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

- explain the mythology of echo and mirage
- give scientific explanation of how echo occurs
- give scientific explanation of how mirage occurs.

4.3 Echo and Mirage

4.3.1 Mythology of Echo and Mirage

In audio signal processing and acoustics, an **echo** is a reflection of sound that arrives at the listener with a delay after the direct sound. The delay is directly proportional to the distance of the reflecting surface from the source and the listener. Typical examples are the echo produced by the

bottom of a well, by a building, or by the walls of an enclosed room and an empty room. A true echo is a single reflection of the sound source

In the traditional cultural setting of most societies, there are many myths that surround the explanation and understanding of the concept and occurrence of echo. In Greek mythology for instance, echo was believed to be an Oread who resided on mount Kithaiwn. Zeus loved consorting with beautiful nymphs and visited them on Earth often. Eventually, Zeus wife Hera became suspicious and came from mount Olympus in an attempt to catch Zeus with Nymphs. Echo in the Greek folk story is a mountain nymph whose ability to speak was cursed, leaving her able only to repeat the last words spoken to her.

Zeus the king of the Olympians, was known for his many love affairs. Sometimes, the young and beautiful nymph echo would distinct and amuse his wife, Hera with long and entertaining stories while Zeus took advantage of the moment to vanish to the other mountain nymphs. When Hera discovered the trickery, she punished the talkative echo by taking away her voice except in foolish repetition of another shouted words. Thus, all echo would do was repeat the voice of another.

Mirage

Mirage is associated with the Rainbow Serpent mythology. The rainbow Serpent has control of waters, seas, trees, plants, animals and planets, though it (mirage) is a result of total internal reflection of light on a sunny day. By the Rainbow Serpent myth, it represents one of the elements of the rainbow serpent. It is called devil “sea”.

In Māori mythology, **Ārohirohi** is the goddess of mirages and shimmering heat, and is the wife of Tama-nui-te-rā (the Sun). She created Mārikoriko (Twilight), the first woman, from a mirage and then asked Paoro (Echo) to give her a voice.

Self-Assessment Exercise 1

1. What is the Greek mythology of echo?
2. What is the Greek mythology of mirage?

4.3.2 Occurrence of Echo

Scientifically, echo is a sound or sounds caused by the reflection of sound waves from a surface back to the listener. Sound waves can bounce off smooth and hard objects in the same way as a rubber ball bounces off the ground. Although the direction of the sound waves change, the echo sounds the same as the original sound. But sounds are

not always reflected when they fall on soft surfaces as in studios, the waves are absorbed. On the other hand, if sound waves fall on hard surfaces they are reflected like in walls, wells and large halls or where there are lots of hard surfaces all around. This is why echoes can be heard in mountain ranges, caves and canyon.

Self-Assessment Exercise 2

How is an echo produced?

4.3.2 Occurrence of Mirage

As ray of light passes from dense medium (i.e. the sky) to a less dense medium (i.e. the surface of the earth) it suffers total internal reflection and an observer sees the shadow of the sky as pool of water known as mirage. It is an atmospheric optical illusion in which an observer sees in the distance a non-existent body of water or an image, sometimes distorted, of some object or of a complete scene. Some examples of mirages include; pools of water seen over hot desert sand or over hot pavement; at sea, an inverted image of a ship seen in the heavens or, also at sea, some object that is actually over the horizon but seems to loom up a relatively short distance away.

Mirage as a phenomenon occurs as a result of the following:

1. light rays undergo refraction, i.e., are bent, in passing from a medium of one density into another of different density and
2. the boundary between two of such media acts as a mirror for rays of light coming in at certain angles.

It is observed that the density of the atmosphere gradually decreases with altitude. Variations in temperature disturb the normal state (the density of warm air is less than that of cold air), producing unusual variations in the density of the atmosphere.

In the desert the lake mirage is essentially a reflection of the sky. This occurs as a result of light rays coming at a grazing angle from the sky just above the horizon which are thrown upward by the surface of the area of extremely hot air just above the sand, and the effect to an observer is a shimmering reflecting expanse resembling the surface of a body of water.

In the sea, the inverted image of a ship seen in the heavens is caused by a layer of dense, cool air over the water. This layer of dense cool air bends the rays of light from the ship (below the horizon) in a curved path that arches over the horizon and back to earth. The image formed

appears to be that produced by an object somewhere distant in a straight line from the observer and, therefore, at a position in the sky. This image is sometimes inverted because in the bending process the light rays coming from the object are changed in relative position.

4.4 Summary

This unit discussed echo and mirage. Some cultural beliefs and myths about echo and mirage were presented and discussed. The unit also discussed the scientific explanations of the occurrence of echo and mirage.

4.5 References/Further Readings/Web Resources

Ndupu, B. L. N & Okeke, P. N. (2000). *Round-up Physics*. Lagos: Longman.

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4.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. Echo in the Greek folk story is a mountain nymph whose ability to speak was cursed, leaving her able only to repeat the last words spoken to her.
2. Mirage is associated with the Rainbow Serpent mythology. The rainbow Serpent has control of waters, seas, trees, plants, animals and planets.

SAE 2

1. Scientifically, echo is a sound or sounds caused by the reflection of sound waves from a surface back to the listener.

MODULE 3 AFRICAN TRADITION

- Unit 1 Use of numbers in African tradition
- Unit 2 Ways of knowing in African belief system
- Unit 3 African belief system science

UNIT 1 USE OF NUMBERS IN AFRICAN TRADITION**Unit Structure**

- 1.1 Introduction
- 1.2 Intended Learning Outcomes
- 1.3 Use of numbers in African tradition
 - 1.3.1 Meaning of number
 - 1.3.2 History of number
 - 1.3.3 Uses of number
- 1.4 Summary
- 1.5 References/Further Readings/Web Resources
- 1.6 Possible Answers to Self-Assessment Exercise(s)

1.1 Introduction

The use of numbers is as old as mankind. Use of numbers has been a major source of information, keeping records and documentation. It is the bases of calculation. A number is an arithmetical value, expressed by a word, symbol, or figure, representing a particular quantity and used in counting and making calculations. They are often called numerals. Without numbers, we cannot do counting of things, date, time, money, etc. Sometimes these numbers are used for measurement and sometimes they are used for labelling. The properties of numbers make them capable of performing arithmetic operations on them. Humanity has had a love-hate relationship with numbers from the earliest times. Bones dating from perhaps 30,000 years ago show scratch marks that possibly represent the phases of the Moon. The ancient Babylonians observed the movements of the planets, recorded them as numbers, and used them to predict eclipses and other astronomical phenomena. The priesthood of ancient Egypt used numbers to predict the flooding of the Nile.

Traditional practices in African which were practiced even before western education was brought into the continent. Before the advent of western education, African had their way of knowing and finding out things and occurrences in their environment. Africans had their ways of keeping records, writing, counting and use of numbers. In this module we will be discussing the use of numbers in African tradition, ways of knowing in African belief system. We will also compare African belief

system with science. This unit will expose you to African tradition meaning and history of number. You will also learn the uses of numbers in African tradition.

1.2 Intended Learning Outcomes

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

- define number
- explain the meaning of number in African tradition
- narrate the uses of number in African tradition.

1.3 Use of numbers in African tradition

1.3.1 Meaning of number in African Tradition

As we have mentioned during the introduction of this unit, a number is an arithmetical value, expressed by a word, symbol, or figure, representing a particular quantity and used in counting and making calculations. Numbers should be distinguished from **numerals**, the symbols used to represent numbers. Natural numbers are symbols or units that are part of a calculating and counting system. A number also stands for a position or amount in a series. Number is different from numerals. A numeral is a representation of a number. A numeral system was invented by the Egyptians, which was improved by the Greeks. The Romans created the Roman numerals, using the Roman alphabet. In the late 14th century, the Hindu–Arabic numeral system became the most common system used around the world to represent the numbers.

The meaning of numbers can be different across cultures. There is no culture without language and there is no culture without number. Therefore, it suffices to conclude that for every culture to sustain its very existence and continuity, it has to have its own unique way of counting and attaching meaning to numbers. (Chirume, 2018) For several cultures, the meaning of numbers follows age-old traditions and cultural beliefs. There are deeply spiritual meanings behind certain numbers that tie back to one's life path. Aside from spiritual meaning, many numbers also a deeper symbolic meaning, and it's essential to gain a deeper understanding of these meanings to understand how they affect the physical world within different cultures. They attach different meanings to many objects, colours, images and numbers.

In Igbo land for instances they use numbers to express religious facts and beliefs. It is also known as numerology. In Igbo land, there are numbers that are very significant and are associated to the Igbo people daily life and observances. Such numbers include: three, four, five and

seven. Each of these numbers is a symbol of one thing or the other. For instance, three signifies “Ikenga” that is “Strength”. A kola nut that has three lobes is said to be “Qj[Ikenga”. Also four represents the four Igbo market days and each day is a symbol of the spirit it represents. The number five is a symbol of affirmation during prayers or rituals and the number seven is a symbol of how many times a man will reincarnate in life before he stops. These numbers are not ordinary numbers and as such should not be joked with or neglected.

Self-Assessment Exercise 1

What are numbers?

1.3.2 History of Number

The idea of number and the process of counting goes back far beyond history began to be recorded. There is some archaeological evidence that suggests that humans were counting as far back as **50,000 years ago**. Numeral systems have progressed from the use of tally marks through to the use of sets of glyphs to efficiently represent any conceivable number. The first method of counting has been argued to be counting on fingers. This evolved into sign language for the hand-to-eye-to-elbow communication of numbers which, while not writing, gave way to written numbers.

Tallies made by carving notches in wood, bone, and stone were used for at least forty thousand years. These tally marks may have been used for counting elapsed time, such as numbers of days, lunar cycles or keeping records of quantities, such as of animals.

Africa is believed to be a cradle of humanity; it is not surprising that the most ancient presently known mathematical artifact was found there. It is the so called Lemombo bone discovered in the 1970s in the Lemombo Mountains between the South Africa and Swaziland and dated to approximately 35,000 BC. Another object to mention here is the Ishango bone from an area near Lake Edward (Nile headwaters, border between Uganda and Congo).

The system of ancient **Egyptian numerals** was used in Ancient Egypt from around 3000 BCE until the early first millennium CE. (Merzbach & Carl, 2011). It was a system of numeration based on multiples of ten, often rounded off to the higher power, written in hieroglyphs. The Egyptians had no concept of a place-valued system such as the decimal system. The hieratic form of numerals

stressed an exact finite series notation, ciphered one-to-one onto the Egyptian alphabet.

The following hieroglyphs were used to denote powers of ten:

Value	1	10	100	1,000	10,000	100,000	1 million, or many
Hieroglyph							
<u>Gardiner's sign list ID</u>	Z1	V20	V1	M12	D50	I8	C11
Description	Single stroke	Cattle <u>hobbles</u>	Coil of <u>rope</u>	<u>Water lily</u> (also called lotus)	Bent finger	<u>Tadpole</u>	<u>Heh</u> [3]

Source: Wikipedia: Egyptian Numerals

There was a complex trade system that developed in the context of trans-Saharan trade and trade with Asia in terms of commodities such as gold and gold dust, kola nuts, leather items such as bags and various types of textiles. The extensive trade that developed Great Zimbabwe and the Swahili city-states necessitated systematic calculation and systems of measurement which involves numbering. Similarly, in Muslim regions, the calculation of inheritance and the distribution of Zakat demanded numbering and mathematical accuracy. Some indigenous systems of calculation had 10 as a base whilst others were vigesimal (have the base 20) such as the Yoruba system. Distinctions were made between prime numbers and multiple. Various symbols were evolved to represent various quantities. African systems of logic were represented in games and activities such as mancala and ayo as well as games of alignment and puzzles.

Self-Assessment Exercise 2

Discuss the place of Egyptians in the evolution of numbers and numerals

3.3 Uses of Numbers in African Tradition

Numbers have religious meaning in many traditional cosmovision. As documented by Mbiti (1969) counting people and livestock is forbidden in many African societies, partly for fear that misfortune could befall those who are numbered. Another reason is that people are not

individuals but corporate members of a society that cannot be defined numerically.

All numbers are significant in African tradition. They have spiritual meanings attached to them. One, primarily deals with strong will, positively, pure energy. It reflects new beginnings and purity.

Two: Two is kindness, balance, tact, equation and duality. It reflects a quiet ower of judgement, and the need for planning. Three: Three deals with magic, intuition, fecundity and advantage. It invokes expression, versatility and pure joy of creativity. Number four represents stability and, invokes the grounded nature of all things. Number five deals with travel, adventure and motion. Five also carry instability and unpredictability and radical changes. The spiritual meaning of five draws our attention to the wonder of life, and beckons us to appreciate the perception of chaos all around us. Six is legend. Six represents harmony, balance, sincerity, love and truth. Six naturally reveals solutions for us in a calm, unfolding manner. The number “six” is sacred to the Shona and Jie, who sacrifice six animals. The Akamba and Vugusu have taboos attached to number “seven”. Seven like threes, deal with magic forces, activation of imagination and manifesting results in our lives through the use of conscious thought and awareness. Eight deals largely with business, success and wealth. Also, matters of business and wealth largely depend on cycles to fulfil their manifestation. The spiritual meaning of nine brings us to the height of vibrational frequencies in this number sequence. Also, nine represent attainment, satisfaction, accomplishment. The number “nine” is sacred for the Baganda and all their gifts, sacrifices and sacred vessels must number nine or its multiples.

Self-Assessment Exercise 3

Discuss the meaning of any 2 (two) numbers in African tradition

1.4 Summary

In this unit, you have learnt what numbers are in African tradition. The business use of numbers in the African tradition started on wider scope at the beginning of trans-Saharan trade, and in Islam religion, the calculation of inheritance and the distribution of Zakat. All numbers in African tradition have spiritual meanings attached to them.

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1.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

A number is an arithmetical value, expressed by a word, symbol, or figure, representing a particular quantity and used in counting and making calculation

SAE 2

The system of ancient **Egyptian numerals** was used in Ancient Egypt from around 3000 BCE until the early first millennium CE. (Merzbach & Carl, 2011). It was a system of numeration based on multiples of ten, often rounded off to the higher power, written in hieroglyphs. The Egyptians had no concept of a place-valued system such as the decimal system. The hieratic form of numerals stressed an exact finite series notation, ciphered one-to-one onto the Egyptian alphabet

SAE 3

The number One, primarily deals with strong will, positively, pure energy. It reflects new beginnings and purity.

Two is kindness, balance, tact, equation and duality. It reflects a quiet ower of judgement, and the need for planning.

UNIT 2 WAYS OF KNOWING IN AFRICAN BELIEF SYSTEM

Unit Structure

- 2.1 Introduction
- 2.2 Intended Learning Outcomes
- 2.3 Main Content
 - 2.3.1 Meaning of African belief system
 - 2.3.2 African ways of knowing
- 2.4 Summary
- 2.5 References/Further Readings/Web Resources
- 2.6 Possible Answers to Self-Assessment Exercise(s)

2.1 Introduction

Africa is the second largest and second most populated continent in the world, covering around 6% of the earth's surface with 54 independent countries and around 1.3 billion people. There are over 3000 different ethnic groups or cultures across Africa, each with shared histories, languages and beliefs. With such a diversity, it is impossible to talk of a single 'African belief system'. Indeed, Africa is home to a wide variety of religious, cultural and traditional beliefs and practices. (Fargion, 2021).

Indigenous African belief systems are strong and well embedded within cultures across the vast continent. These frequently co-exist alongside the major world religions of Islam, Judaism and Christianity, which themselves have long histories on the continent. More than a millennium ago Islam moved southwards from the Middle East, into North Africa and across the Sahara Desert into West African countries such as Nigeria and Mali as well as countries in the 'horn of Africa' (such as Somalia and parts of Sudan) and the Swahili Coast in Kenya and Tanzania. Judaism was also present in North Africa and Ethiopia by 400 CE.

It was around this same time that Christianity became rooted in Africa. The Kingdom of Aksum (or Axum) in present-day Ethiopia and neighbouring Eritrea were amongst the first to adopt the religion officially in the 4th Century. (Fargion, 2021).

In this unit you will be introduced to the African traditional belief system. Attention will be paid to a clear understanding of the concept of belief system. The African traditional ways of knowing will be discussed.

1.2 Intended Learning Outcomes

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

- explain the meaning of belief system
- explain the meaning of African belief system.
- discuss African ways of knowing.

2.3 Ways of Knowing in African Belief System

2.3.1 Meaning of African Belief System

A belief is an attitude that something is the case, or that some proposition about the world is true (Primmer, (2018). Belief is therefore the attitudes about the world which can be either true or false (*Stanford Encyclopedia of Philosophy 2019*). To believe something is to take it to be true A belief system is an ideology or set of principles that helps us to interpret our everyday reality. This could be in the form of religion, political affiliation, philosophy, or spirituality, among many other things. These beliefs are shaped and influenced by a number of different factors. These beliefs are shaped and influenced by a number of different factors. Our knowledge on a certain topic, the way we were raised, and even peer pressure from others can help to create and even change our belief systems.

African belief systems have the oldest roots of any of the continent's religions. Just as there is great cultural diversity so there is diversity in belief systems. These encompass the worship of gods, ancestors and spirits, and are based on an understanding that the spiritual infuses every aspect of daily life. The concept of a supreme being is not always present and the gods, ancestors and spirits – the conceptualisation of which often overlaps – are not necessarily thought to be omnipresent.

The role of ancestors is often significant, indicating a strong association between forebears and their living descendants. Diviners, priests or community members communicate with them or call on (invoke) them, and beliefs are enacted and reinforced through prayers, rituals, festivals and ceremonies that involve texts, whether danced, enacted, sung or spoken.

Based on the diverse socio-cultural and economic background of the continent, traditional African ways of thinking and reasoning differ significantly in many respects from the dominant international approach. Despite the independence from the colonisation, the decisions about agriculture, health and nature management are still heavily based on the concepts of African traditions. In the community we live in this day

displaces uncountable products of African belief systems. These include tribal marks, shrines, prayer houses, symbols, naming of beings, artistic expressions, traditional leadership and title. Other products of African belief systems include reasoning and thinking.

Myth and ritual are extremely important in African traditional belief systems. Rites of passage, seasonal ceremonies, and religious celebrations are all a big part of community life, whether people are nominally Christians, Muslims, or traditionalists. Even sophisticated urbanites maintain the beliefs of their ancestors in many ways.

Indigenous African belief systems are **strong and well embedded within cultures across the vast continent**. These frequently co-exist alongside the major world religions of Islam, Judaism and Christianity, which themselves have long histories on the continent.

Self-Assessment Exercise1

What is your definition of African Belief System?

3.2 African ways of knowing

Despite Africa's immensity and diversities, which include about a thousand indigenous languages, African indigenes show distinct, consistent and enduring commonalities transcending geographic boundaries and ethnicity. Hence, in the African context, we can talk about unity in diversity. The most enduring commonalities of African hood include ways of knowing that are grounded in indigenous African cultural traditions, history and ecology.

In the world we live in today, thinking among Africans ranges from traditional to modern, but in most cases both systems of thinking can be observed parallel to each other. Traditional worldviews and traditional institutions play an important role. The African worldviews and belief systems are influenced by the various religious practices they are involved in. Mbiti (1969) identified five categories that the various

African religious practices brought to his belief system. These are:

- a. God as the ultimate explanation of the genesis and sustenance of man and all beings.
- b. Spirits, made up of superhuman beings and spirits of ancestors.
- c. Man, including human beings alive and those not yet born.
- d. Animals and plants or the remainders of biological life.
- e. Phenomena and objects without biological life.

Religious and philosophical concepts have roles within the African ways of knowing and belief systems. Very often, a hierarch between divine beings, spiritual beings, especially the ancestors, men and women, and natural forces, such as climate, disease, flood, soil, vegetation, animals, is indicated. This is known as Cosmovision. These cosmovisions mentioned give rise to several rituals in which the elders, the priests, soothsayers and spiritual leaders play a significant role. Cosmovision are consulted to know which of the way land, water, plants and animals are to be used; how decision are taken; problems are solved and experimentation takes place and how rural people organise themselves (Haverkort & Hiemstra, 1999). Millah (1999) presents the cosmovision of the people of Northern Ghana in Figure 1.

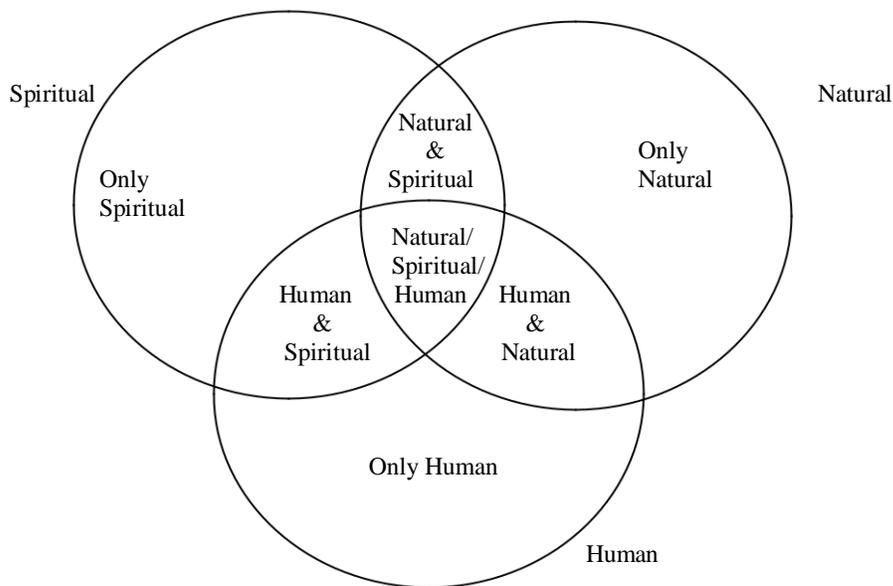


Figure 1: Constellations of Cosmovision Related to Knowledge

Source: COMPAS (2006) Series 3:21

From the figure 1, it can be deduced that the interaction of the human, natural and spiritual worlds will generate the following possible constellations of knowledges:

- i. Knowledge resulting from social interactions only.
- ii. Combination of knowledge of the social and natural worlds.
- iii. Combination of knowledge between the social and spiritual worlds.
- iv. Knowledge resulting from natural interactions only.
- v. Combination of knowledge of the natural and spiritual worlds.
- vi. Knowledge resulting from spiritual only.
- vii. Combination of social, spiritual and natural.

The natural world provides habitat for the spirits and sends message from the spiritual world to the human world. The spiritual world provides guidance, punishment and blessing to the human world. Therefore, people have to relate to both the natural and spiritual worlds. Rain is regarded by African people as one of the greatest blessings of God, who is often referred to as the rain-giver. Many of them make sacrifices, offerings and prayers to God in connection to rain. Rainmakers are reported in all parts of the continent. Their duties are to solicit God's help in providing rain or in halting it if too much falls.

African worldviews and belief system hold beyond a production factor with economic significance, land, water, animals and plants. They have their place within the sanctity of nature. In some countries within the continent, certain places have a special spiritual significance and are used as locations for rituals and sacrifices 'shrines, mountains and rivers. Fig trees and baobabs are treated as sacred trees. The sun, moon and stars feature in myths and beliefs of many people. Certain beings such as animal species have a spiritual significance too. Cattle, sheep, goats, chicken, pigeon are often used for sacrifices and other religious purposes. Snakes, lizards, chameleons and certain birds like owls are considered messengers of the spiritual world.

African ways of thinking and reasoning are mystical, illogical and incapable of scientific pursuit. This is linked up with the state of technology in Africa. Also, Africa is seen to depend heavily on oral, magical, prelogical past for his thinking and reasoning.

African ways of knowing and belief system are demonstrated in artistic expressions. Proverbs as African ways of knowing and belief system represent values related to religions, immorality, survival, goodwill; communal and individual values, morality, responsibility, marriage and family life, work ethic, chieftaincy, aesthetic values, knowledge and wisdom, human rights and ancestors.

African art and artefacts such as masks, clothes, body painting, architecture and sculptures, like African music, have been emerged in the function of religion, rites and rituals, and are undoubtedly expressions of African emotions and identity. Internationally reputed artists like Picasso, Moore and Giacometti have found great inspiration in African sculptures and paintings. Music such as jazz, blues and reggae have equally found their roots in Africa.

In most cases, traditional communities have a variety of traditional leaders, specialists and spiritual mediums, who play an important role in village life. The specialists include medicine man/woman – healers (or

sometimes called witch doctors, rainmakers. Others are kings, queens, and rulers, priests, soothsayers and religious founders. They all have their specified roles to play with the community.

There is a well-recognised and organised structure of passing knowing. In the African sense, a child is a child of every adult in the community. Teaching the child in traditional Africa was therefore not the monopoly of the biological parents. Every responsible adult could teach any child about the community's ways (etiquette, survival, welfare, etc). There was a division of labour and specialization whereby youths were apprenticed to skilled masters of healing arts, blacksmithing, hunting, midwifery, craftwork, etc. Any adult who happened to be free could enjoy teaching children traditional games including counting, puzzles, riddles and reciting children's poems (to the new moon, to the rain, to the sun, etc). Grandparents were not relegated into seclusion by virtue of old age but they remained with the family, imparting their acquired wisdom and philosophical ideas of the community. Children would congregate at the home of a well-known story teller whose services they reciprocated by bringing firewood. Certain information was taught through taboos, initiation rites and apprenticeships. Taboos originated from people's tacit knowledge. Tacit knowledge involves intuitions and hunches acquired by people through their informal experiences. Information was also transmitted through song and poems. Topical issues were sung about.

Self-Assessment Exercise 2

Briefly describe the African ways of knowing.

2.4 Summary

In this unit we have discussed that a belief is an attitude that something is the case, or that some proposition about the world is true. We have also discussed that belief system is an ideology or set of principles that helps us to interpret our everyday reality. Ways of knowing in African belief system are rooted principally on combinations of social, spiritual and natural worlds. Indigenous African belief systems are strong and well embedded within cultures across the vast continent.

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2.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

1. What is your definition of African Belief System?

African belief systems have the oldest roots of any of the continent's religions. Just as there is great cultural diversity so there is diversity in belief systems. These encompass the worship of gods, ancestors and spirits, and are based on an understanding that the spiritual infuses every aspect of daily life. The concept of a supreme being is not always present and the gods, ancestors and spirits – the conceptualisation of which often overlaps – are not necessarily thought to be omnipresent.

SAE 2

1. Briefly describe the African ways of knowing.

The natural world provides habitat for the spirits and sends message from the spiritual world to the human world. The spiritual world provides guidance, punishment and blessing to the human world. Therefore, people have to relate to both the natural and spiritual worlds.

UNIT 3 AFRICAN BELIEF SYSTEM AND SCIENCE

Unit Structure

- 3.1 Introduction
- 3.2 Intended Learning Outcomes
- 3.3 African Belief System and Science
 - 3.3.1 African and Science Reality
- 3.4. Summary
- 3.5 References/Further Readings/Web Resources
- 3.6 Possible Answers to Self-Assessment Exercise(s)

1.1 Introduction

In the previous unit we discussed the meaning of belief and belief system. We discussed the relationship between culture, religion and belief system in Africa. Africans have their ways of life. African belief system originates from indigenous environment. Characterised African knowledge is mostly rooted in spiritual-centred wisdom as it is the view of some people. African peoples live in diverse culture with different cultural beliefs and practices. African belief system and traditional Knowledge, is as old as the existence of the African peoples themselves. This belief system and knowledge base has provided sustenance for Africans in a diverse, complex, and risk-prone environment. Spirituality is the bedrock of this belief and knowledge system that makes it remarkably different from other knowledges/sciences. Bio-cultural diversity is another feature that characterises African traditional belief and knowledge system. To a very large extent there is a clear difference between this system of belief and knowledge and science which has systematic process and based on evidence.

This unit will therefore focus on the meanings of African belief system and science. Also, the unit compares African belief system to science with emphasis on African and science reality.

3.2 Intended Learning Outcomes

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

- explain the African belief system in relation to science.
- discuss similarities and differences between African belief system and science reality.

3.3 African Belief System and Science

3.3.1 African Belief System and Science

A number of Africans and African writers have made their observations on African belief system. Africans themselves have perceptions about themselves. Africans have their ways of life. African belief system originated from their indigenous environment. Characterised African knowledge is mostly rooted in spiritual-centred wisdom as it is the view of some people. African peoples live in diverse culture with different cultural beliefs and practices. An important yet basic view about nature held by the traditional African is that life forces permeate the whole universe and that matter and spirits are inseparable realities. Goduka (2000) characterises African knowledge as spiritually-centred wisdoms. In traditional African view, the universe is a spiritual and a material whole in which all beings are organically interrelated and interdependent.

Africans believe that existence is a religious phenomenon; “man” is a deeply religious being living in a religious universe. Five categories of things have been identified to exist in the universe. These are recognised consistently by the various African religious practices. These are: God as the ultimate explanation of the genesis and sustenance of man and all things; spirits, made up of superhuman beings and spirits of ancestors; man, including human beings alive and those not yet born; animals and plants or the remainders of biological life; and phenomena and objects without biological life. In addition to these five categories, a vital force, power or energy permeates the whole universe. For the Africans, every plant, animal and natural phenomenon is a carrier of the divine. God is the source and the ultimate controller of these vital forces and the spirits have access to some of them. Selected human beings, such as medicine men, witches, priests and rainmakers, have the knowledge and ability to tap, manipulate and use these forces; some use it for the good and others for the ill of their communities.

Often a hierarchy between divine beings, spiritual beings, especially the ancestors, men and women, and natural forces, such as climate, disease, floods, soil, vegetation, animals, is indicated.

Therefore, African belief systems mean many things to many people. African belief system involves ways of reasoning and thinking.

Some of the generally accepted features of African belief system include:

1. African belief system is a way of life. This definition associates African belief with the culture of a people.
2. African belief system is a way knowledge is generated. Therefore, this definition sees it as a way of doing things.
3. African belief system is orderly body knowledge. This definition focuses on how knowledge is acquired.

Science means many things to many people. Therefore, science has more than one definition. Definition of science is as many as the number of scientists. To some, science is what scientists do. However, in defining what science is all about, some of the features that are taken into consideration include that:

1. Science is a way of knowing the world in rational terms. This implies that the product of science and its knowledge depends on how the knowledge is required.
2. Science is also defined as a process by which knowledge is required. By this definition, science is about doing things.
3. Science to some is a way of life. This definition links science with the culture of the people.

African belief system and way of knowing have a lot in common with science, although there are marked differences between them. Both the African belief system and way of knowing and science engage in observing the natural environments. They ask questions such as “How?”, “What?” and “Why?”. They attempt to find answers to their questions.

Self-Assessment Exercise 1

What are the common features of African belief system and science?
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3.2 African and Science Reality

Science is as old as human because since humans came into existence, they have been searching for explanations for the “world” and the “happenings” around them. Indigenous African culturally believe that apart from him, there must be other beings and powers that make things to happen. African belief system holds that hidden beings and forces reside in different locations like in animals, trees, seas, mountains, valleys, winds, rivers which can be channelled to and for man’s purpose. African belief system through the eyes of rain maker for example, sees

the relationship between rain, growth of crops and the very survival of man as being determined by certain “powers” that must be appeased with invocation, incantations, prepared portions and sacrifices for cooperation. But science has been provoked to find explanations, which has resulted in topics like water cycle, nutrition, ecology, agriculture, among others (Dienye & Gbamanja, 1990).

Every culture works hard to interpret reality in its own setting because how reality is perceived might count towards the overall development of any society. Africa as a continent is made up of peoples with diverse culture. Reality is a product of interplay between what man perceives or senses and his ability to organise such inputs into explainable sensations. Therefore, reality is liable to change should man discovers another basis for interpreting his observation. To ascertain what reality is, a scientist will have to interact with the nature he observes and his observations may be limited to that he is capable of seeing or perceiving in the absence of using special techniques. An African belief views hold that a herbalist cannot cure without a rational knowledge of the signs and symptoms of the diseases. Scientifically, treatment cannot start without running tests in addition to knowledge of signs and symptoms of the diseases. Therefore, both African belief system and science admit rational thinking.

African belief system hold the view that unseen forces could be seen in action by everyone, like in thunder and lightning, earthquake or flood, disease and pestilence, which were accepted as evidence of acts by evil spirits. Natural phenomena in African belief system are correlated with those of the evil world (Atadoga & Onaolapo, 2008). The subtle insight of the African belief system into the general relationships of nature and African manipulative acts led to certain empirical knowledge of various substances. African belief system is based on causality as it is linked with rationality. Rational thought processes which are important in interpretation of reality forms a meaningful basis for the study of science in Africa. Scientists work within a given paradigm and members in a different community could drastically after the nature of the perceptual plane data, and the nature of circuit of its verification.

Self-Assessment Exercise 2

What are the common features of African belief system and science reality?

3.4 Summary

In this unit, you have learnt about African belief system and science. African belief system and science ask common questions such as “How?”, “What?”, “Why?”. African belief system and science attempt to give explanations and find solutions to natural phenomena and to problems in the “world” (environments) people live in. Basically, their approaches are based on observation and rational thinking approaches.

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3.6 Possible Answers to Self-Assessment Exercise(s) within the content

SAE 1

1. What are the common features of African belief system and science? Both the African belief system and way of knowing and science engage in observing the natural environments. They ask questions such as “How?”, “What?” and “Why?”. They attempt to find answers to their questions.

SAE 2

2. What are the common features of African belief system and science reality?

Reality is a product of interplay between what man perceives or senses and his ability to organise such inputs into explainable sensations. Therefore, reality is liable to change should man discovers another basis for interpreting his observation. To ascertain what reality is, a scientist will have to interact with the nature he observes and his observations may be limited to that he is capable of seeing or perceiving in the absence of using special techniques. An African belief views hold that a herbalist cannot cure without a rational knowledge of the signs and symptoms of the diseases. Scientifically, treatment cannot start without running tests in addition to knowledge of signs and symptoms of the diseases. Therefore, both African belief system and science admit rational thinking. African belief system hold the view that unseen forces could be seen in action by everyone, like in thunder and lightning, earthquake or flood, disease and pestilence, which were accepted as evidence of acts by evil spirits. Science also believes in evidence and it is experiential but every natural phenomenon has to be investigated and proved.

MODULE 4 AFRICAN SCIENCE AND INTEGRATED SCIENCE

- Unit 1 Meaning and history of African Science
- Unit 2 Meaning and history of Integrated Science
- Unit 3 African Sciences and Integrated Science
- Unit 4 Possible ways of curbing superstitious belief Through Integrated Science
- Unit 5 African contributions to science, technology and development.

UNIT 1 MEANING AND HISTORY OF AFRICAN SCIENCE

Unit Structure

- 1.1 Introduction
- 1.2 Intended Learning Outcomes
- 1.3 African Ways of Knowing about the Natural World
 - 1.3.1 Africa's Past and Present
 - 1.3.2 African Technical Knowledge and Practices
- 1.4 Summary
- 1.5 References/Further Readings/Web Resources
- 1.6 Possible Answers to Self-Assessment Exercise(s)

1.1 Introduction

Africans as a people have existed in their environment and have made efforts on sustainable development and fashioned out ways of solving problems that confront them. These efforts could be referred to as traditional or cultural but indigenous to them. The essence of science is to solve problems that confront a people which Africans have applied in their own indigenous way to solve their problems and find out things hidden in nature. One can therefore state that Africans have the science that has worked for them since prehistoric times, which could be referred to as African science. Every culture has its own science which is a part of its total symbolic expression and so is inseparable from its architecture, art, sculpture, and even religion. African science' is being condemned to the level of the mystic religious or supernaturalist worldview. Critics remark that African science is purely esoteric, personal, and devoid of elements of objectivity and rigorous theorization which is the basis of western science.

The general feature of science and the methodology it employs are in specific terms referred to as observation and experimentation. These two methodologies reflect how science differs from other systematic modes of inquiries. This description characterises, strictly, 'Western science' and it is contrasted with the indigenous mode of enquiry that has come under the name, 'African science'. In contemporary scholarship, 'African science' is being condemned to the level of the mystic religious or supernaturalist worldview. 'African science' is said to be purely esoteric, personal, and devoid of elements of objectivity and rigorous theorization. Bajah (1980, p. 25) asks ...is there such a thing as African science? In response, Murfin (1992) remarked that, there is a science in Africa; activities and nature which call for understanding and explanations occur in Africa just as in other parts of the world...we also have traditional thinkers in Africa who also through their years of training attempt to unfold the truth in nature.

Bajah (1980, p. 6) defines African science as a "systematic, complex and exclusive traditional process (commonly noticed in a number of African cultures), in which an attempt is made to describe, understand, predict and control nature.

According to Ezeabasili, every culture has its own science which is a part of its total symbolic expression and so is inseparable from its architecture, art, sculpture, and even religion. The questions which concern scientists of a particular culture, the choice of them, the framing of the questions and the methods of thought are determined by the particular preoccupation of the people and the way in which the universe presents itself to their understanding. Western science selects as its subject matter those that are regular and then finds it can predict their behaviour. But this is no basis for concluding that irregular and irrational phenomena are not important or trivial. He believes that both Western and African science have demonstrated their validity through their utility in various situations. Ezeabasili remarks that, Western peoples have simply absorbed only those aspects of Egyptian, Roman and Arab science which appeal to a people with a mechanistic frame of mind.

This unit introduces you to African ways of knowing, African past and present, and technical knowledges and practices.

In this Module we will be discussing the concepts of African science and integrated science. Their history will be traced and how African science and western science are related will be highlighted. In this unit we will also discuss how integrated science can be used to curb superstitious beliefs and African contributions to science, technology

and development will be highlighted. The units will be presented as follows;

1.2 Intended Learning Outcomes

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

- explain African ways of knowing science
- enumerate African ways of knowing science.
- discuss African past and present ways of knowing
- explain African technical knowledges and practices.

1.3 Meaning and History of African Science

1.3.1 African Ways of Knowing About the Natural World

Knowledge is given different expressions by different people from different cultural background. Hence, we talk about African sciences. However, there are many common elements in African ways of knowing; the worldviews, ecological spirituality and the existing cultural/religious practices do have similarities. In the real traditional African context, there is no clear cut between “arts” and “science”. In the African culture, what the younger generations know are not knowledge generated by their explorations of the environments but they were told or handed over to them by their ancestors.

African culture does not assume that reality can be perceived through reason alone. Other modes of knowing by the African include:

- i. Imagination
- ii. Intuition
- iii. Personal feelings
- iv. Inspiration

For this reason, the deepest expression of the African cultural reality has been through art, myths and music. The ways are mechanical and not through logical analysis as the case with the western mode. The traditional African view about nature is that matter and spirits are inseparable. The African hardly proffers definitions of the life forces but often demonstrates understanding and offers descriptions of the forces in terms of their functions and operations (Miller & Haverkort, 2006). Emegiawali (2003) opined that the African way of knowing seems to be relatively less transferable than conventional science, considering its holistic socio-cultural and spiritual dimensions. The African way of knowing appears to be largely communication in terms of discovery and experimentation which is collective rather than individualistic. The

community is a source of strength for the African way of knowing in terms of the discovery process and knowledge production. Goduka (2000) characterised African knowledge as spiritually-centred wisdoms. In traditional African view, the universe is a spiritual and a material whole in which all beings are organically interrelated and interdependent.

Self-Assessment Exercise 1

Enumerate some of the African ways of knowing.

1.3.2 Africa's Past and Present

Sub-Saharan Africa is made up of diverse cultures. Some of the factors that brought about a diversity of lifestyles, professional practices, values, regions and knowledge systems include historic developments, demographic and ecological differences, as well as economic opportunities, colonial impact and religious missionary activities. Nomadic people often compete for land and water resources – with sedentary people. Traditional religions have common elements, but there is also a great variation in rituals, traditional institutions and leadership structures. The population of Africa has rural background, and agriculture remains the main occupation. Due to degraded African soils, combined with a harsh climate, African agriculture becomes complex, diverse, and risk prone. Africa has bad roads and poor communication system. The first African people hunted a wide range of animals, and learnt to use fire to control vegetation. During the last glacial period, Africa was not covered with ice, but, as much of the earth's water resources reserve was frozen, endured drought. Millar and Haverkort (2006) observed that about 9000 years ago, sorghum, millet, rice, yam, oil palm, as well as cattle were domesticated, while barley was introduced from Western Asia. The introduction of iron tools made way for the development of sophisticated settlements in Africa and the construction of monumental centres and phenomenal civilisations such as Great Zimbabwe. From the 8th century onwards, Arab trading penetrated sub-Saharan Africa, bring oil, lamps, pottery and cowry shells in exchange for ivory, ebony, gold, as well as slaves. As a result of trades, several kingdoms emerged. The Portuguese were the first Europeans who got involved in slave trade, bringing Christianity with it. In the 19th century, the Portuguese lost their monopoly and the British, French, Belgians and Germans colonised and Christianised the continent, except Ethiopia. These colonies lasted until around the second part of the 20th century, when the independent nation states were formed. The colonial past had a great impact on the indigenous cultures and peoples. It aimed to replace traditional knowledge and beliefs with western knowledge and by that, it has limited the African capacity to

solve their own problems and to develop technologies and skills to build their own ways of knowing. However, this aspect of colonisation did not record full success. The continent has a low level of literacy and few people are educated in the western sense. The good news is that the traditional education is still widely practiced and, co-exists with western knowledge system. The systems of governance of most of the present nation states, established less than 50 years ago, often reflect more aspects of the colonial system than indigenous systems. The same situation holds for both the legal and educational systems. The way of farming and social organisation is greatly influenced by the ancestral knowledge. In rural Africa today, most medical practices are based on traditional healers and knowledge, using herbs and rituals. Even among the educated Africans, both traditional health services and western health care are widely used. Africa is changing fast. Some aspects of indigenous knowledge are expressed openly, whilst other aspects are secretive and hidden from outsiders.

Contributions of Ancient African Civilizations to Science in Ivan Van Sertima's (1984) book *Blacks in Science: Ancient and Modern*, countless examples of African science from articles by several different authors are given. A few examples will be listed below for each of the major scientific disciplines.

In Chemistry, 1,500 to 2,000 years ago near Lake Victoria, carbon steel was made in blast furnaces. The temperature achieved in the furnaces, 1,800°C, was much higher than was managed in Europe until modern times. Fire was first used 1,400,000 years ago in Chesowanja, near Lake Baringo in Kenya.

In Physics, Earth Science and Astronomy, the Dogon of Mali had an excellent understanding of the solar system and the universe 700 years ago. The Dogon had detailed knowledge of a white dwarf companion star to Sirius A which was not visible to the naked eye. Western scientists stated that there was no way that the Dogon could have uncovered this knowledge on their own and that it must have been supplied to them by a visiting European or an extra-terrestrial visitor. The Yoruba tribe had an exceedingly complex number system based on twenty. An 8,000 year old bone found in Zaire, the Ishango bone, covered with series of notches is thought to be the world's earliest number system. There was a very accurate calendar system in Eastern Africa by the first millennium B.C. A megalithic site similar to Stonehenge dating to 300 B.C. was found in northwest Kenya. Its nineteen basalt pillars were aligned extremely accurately with the stars and constellations. A model of a glider dated to the 4th or 3rd century B.C. was found in Egypt. The structure of the object was most definitely aerodynamically designed. An iron-ore mine in Swaziland, the oldest

found in the world, was dated as 43,000 years old. The ore specularite was used as a cosmetic and pigment. The concepts of distance, area, weight, volume and time were all used by the Egyptians. Egypt also invented standards, units and methods of measurement.

Africans developed technology to build sea-worthy boats and the ability to navigate over long expanses of ocean. There is ample evidence to suggest that African explorers reached South and Central America long before Columbus made his journeys.

In Biology, Africans were the first humans to raise crops and to domesticate cattle 15,000 years ago between 17,000 and 18,500 years ago while ice still covered much of Europe-African peoples were already raising crops of wheat, barley, lentils, chick-peas, capers and dates.

Self-Assessment Exercise 2

Discuss any two Contributions of Ancient African Civilizations to Science.

1.3.2 African Technical Knowledge and Practices

Africa as a people is blessed with a lot of natural resources which when tapped will provide sources of income for the continent.

Based on Africans' ways of knowing, they are involved in a number of practices. Compare your list with the following African practices:

1. Soil and water management
2. Crops and trees, and animal production
3. Medicine
4. Mathematics
5. Food production
6. Metallurgy system
7. Building system.

One of the common characteristics of the African cultures is the perception that the earth is associated with the concept of the mother, or womb. It is often considered a deity, the property of gods, and the founders of a clan or tribe who were the first settlers in the area. The traditional functionaries, such as the earth priest, exercise spiritual control over the land. Based on the technical knowledge, African's soil and water practices involved use of water pockets in plant holes, soil conservation, traditional erosion control, water harvesting and irrigation.

African traditional farmers know the qualities of trees, what they can be used for, and the possibilities and limitations of combining trees with crops. Some tree species have a spiritual significance, which is reflected in taboos and rituals associated with them. Most African houses deal with fowls. They combine species including guinea fowls, ducks, turkeys and pigeons.

African Traditional Medicine (ATM) include hydrotherapy, heat therapy, spinal manipulation, quarantine, bone-setting and surgery. Incantations and other devices of psychotherapeutic are often applied. Treatment from cancer, obesity, drug addiction, diabetes and other ailments have benefited directly and indirectly from traditional African pharmacologists through plants such as the African willow (South Africa), the ibodia (Namibia), iboga (Gabon and Cameroon) and other botanicals (Emeagwali, 2003).

A complex system of trade developed in the context of the trans-Saharan trade and also trade with Asia in terms of commodities such as gold and gold dust, kola nuts, leather items such as bags and various types of textiles. The extensive trade that developed between Great Zimbabwe and Swahili city states necessitated systematic calculation and systems of measurement (Eglash, 1999). Some indigenous systems of calculation had 10 as a base whilst others were vigesimal (have the base of 20) such as the Yoruba system. African systems of logic have also been manifested in games and activities of strategy such as mancala and ayo as well as games of alignment and puzzles.

Indigenous fermented foods in Africa have derived, usually, from cassava tubers, cereal, legumes, oil seeds, palm tree sap, milk and various old other local products. Products such as sorghum, maize or other cereal fermented and made into alcoholic beverages.

In the North/East Ethiopia and Nubia were the major suppliers of gold, with Egypt being a major importer. In Southern Africa, the kingdom of Monomatapa reign supreme as a major gold producer. The various metal products were used for a wide range of purposes including armour as in the case of some Northern Nigeria city states, silver, iron, copper and brass jewellery, currency including circular and non-circular coin; pots and cooking utensils; cloth dyeing, sculpture and agricultural implements.

Builders integrated the concept of the arch, the dome, and the use of columns and aisles in their construction. The underground vaults and passages and rock-hewn churches of Ancient Ethiopia are matched in Nubia and Egypt with pyramids of various dimensions. Mats were

utilised as part of the decor and also to be saturated repeatedly, to cool the room.

Self-Assessment Exercise 3

List some of the areas of African Technical Practices

1.4 Summary

African knowledge and science are related to the perceptions of the people of the continent. The way they know and organise themselves are determined by their religious and socio-cultural background. African technical knowledge and practices have grown beyond the colonial era. African technical knowledge and practices can be seen in the fields of soil and water management, crops and trees, and animal production, medicine, mathematics, food production, metallurgy system and building system.

In this unit, you have learnt African modes of knowing which include:

- Imagination
- Intuition
- Personal feelings
- Inspiration

Also learnt in the unit are the African past and present in the areas of:

- Soil and water management
- Crops and trees, and animal production
- Medicine
- Mathematics
- Food production
- Metallurgy system
- Building system

1.5 References/Further Readings/Web Resources

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1.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

African culture does not assume that reality can be perceived through reason alone. Other modes of knowing by the African include:

1. Imagination
2. Intuition
3. Personal feelings
4. Inspiration

SAE 2

1. In Chemistry, 1,500 to 2,000 years ago near Lake Victoria, carbon steel was made in blast furnaces. The temperature achieved in the furnaces, 1,800C, was much higher than was managed in Europe until modern times. Fire was first used 1,400,000 years ago in Chesowanja, near Lake Baringo in Kenya.
2. In Biology, Africans were the first humans to raise crops and to domesticate cattle 15,000 years ago between 17,000 and 18,500 years ago while ice still covered much of Europe-African peoples were already raising crops of wheat, barley, lentils, chick-peas, capers and dates.

SAE 3

List some of the areas of African Technical practices

1. Soil and water management
2. Crops and trees, and animal production
3. Medicine
4. Mathematics
5. Food production
6. Metallurgy system
7. Building system.

UNIT 2 MEANING AND HISTORY OF INTEGRATED SCIENCE

Unit Structure

- 2.1 Introduction
- 2.2 Intended Learning Outcomes
- 2.3 Meaning of Integrated Science
 - 2.3.1 History of Integrated Science
 - 2.3.2 Why We Teach Integrated Science
- 2.4 Summary
- 2.5 References/Further Readings/Web Resources
- 2.6 Possible Answers to Self-Assessment Exercise(s)

2.1 Introduction

In the previous unit we discussed the meaning and history of African Science and the African way of knowing. In this unit we will be discussing the meaning and history of Integrated science. We will also highlight why we teach integrated science in our schools. We are very familiar with the major branches of science that we offer in our schools like Biology, Chemistry and Physics. Solving natural problems involve the integration of the knowledge of these branches of science. Scientific knowledge should be holistic to enhance effective application. This informed the introduction of Integrated Science especially at the basic education level in most countries. Integrated science is defined as a cumulative approach of scientific study that synthesizes the perspectives of the individual disciplines.

With the increasing complexity of natural and social issues facing our world, it is important to recognize the benefits of utilizing and employing interdisciplinary and integrated scientific approaches to solving the problems that confront us in our society. In this unit we will be discussing the meaning of Integrated science, trace the history of integrated science and the reason why we teach integrated science.

2.2 Intended Learning Outcomes

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

- explain the meaning of integrated science
- discuss the history of integrated science
- explain why integrated science is offered in our schools

2.3 Meaning and History of Integrated Science

2.3.1 Meaning of Integrated Science

In our world, human existence and survival depends on knowledge they gain through the exploration of their environment. This knowledge is gained through conscious and unconscious scientific activities. Science provides knowledge while technology provides ways of using this knowledge and our value concepts guide what we ought to do with both science and technology. Problems that confront humans in nature may be simple or complex, compartmentalized or integrated. This explains why humans adopt different approaches to solve their problems. Knowledge discoveries and usage in nature are made easier through integration of ideas, thoughts, concepts and approaches. This also explains why, science teaching in the modern world ought to be interdisciplinary, unified, society based and aspire above all to achieve scientific literacy.

The term “integrated science” is often used as a synonym for interdisciplinary and unified science, which may be applied generally to curriculum efforts in which two or more previously separated science subjects are combined. These efforts may be characterized as collaboration among or blending with, or a fusion of a number of “subjects” traditionally taught separately. This is a departure from the former old-fashioned compartmentalised science where emphasis is very strictly on divisions into Biology, Chemistry and Physics. Nature Study and Hygiene. The contents of compartmentalised subject disciplines were not enough to make the products cope effectively with their environmental problems.

An integrated science course may be characterized by a focus on processes of scientific inquiry, or a wish to cater for the interests of pupils, or it may be a course structured around topics, themes, or problems that require a multidisciplinary approach.

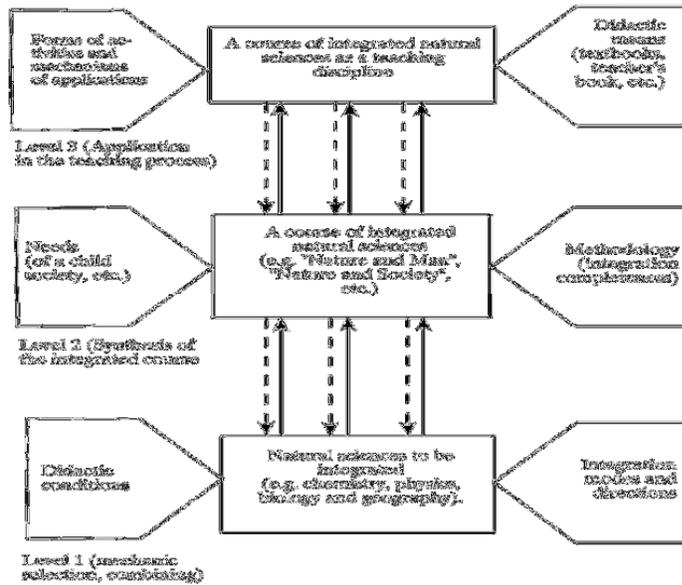


Fig. 1: The model of the process of natural sciences integration (Lamauskas, 2003)

Self-Assessment Exercise 1

1. Using the figure above discuss the process of natural science integration
2. List the issues that matter most in this integration

Table 2 presents an example of the nature of integration in science subject offering

Table 2 A model of integrated learning

Information	Nature of activity	Subjects involved
Facts	Prior knowledge making prediction asking questions Shared experience observation collecting information/data	Learning about social education science environmental education personal development technology studies
Concepts	Processing information listing grouping categorising classifying labelling	Learning through language art drama mathematics movement

	organising ideas	music
Generalisations	Synthesising making statements generalising looking for relationships	Learning about social education science environmental education personal development technology studies
Further information	Refinement and extension of knowledge elaborating justifying reflecting	

Source : (Pigdon, Woolley, 1993)

According to Arokoyu, (2012), UNESCO – UNICEF (1991) defined integrated science as an approach to the teaching/learning of science in which concepts and principles are presented so as to express the fundamental unity of scientific thoughts and avoid premature and undue stress on the distinctions between the various scientific fields. In his contribution to the definition of integrated science, he also remarked that Willard (1995) describes it as a program which offers students experiences which help them to develop an operational understanding of the structure of science that should enrich their lives and make them more responsible citizens in the society. The concept of integration in school science subjects lays emphasis on both concept/theme and teaching methods.

According to D'Arbon (2002), Integration; when applied to science courses, means that the course is devised and presented in such a way that students gain concept of the fundamental unity of science; the commonality of approach to problems of scientific nature; and are helped to gain an understanding of the role and function of science in everyday life and the world in which they live.

In his classification, Brown (2007) describes integrated science under four broad characteristic meanings

- i. The unity of all knowledge: This implies that integrated science has a holistic view of knowledge as essentially one and undivided;
- ii. The conceptual unity of the sciences: Implying that various conceptual units that make up the framework of integrated science are identified;

- iii. A unified process of scientific enquiry; These characteristic places emphasise on the methodological distinctions and similarities among the sciences;
- iv. An interdisciplinary study; Indicates that the discipline is a collaborative venture between subjects and viewing of topic or theme from logically different viewpoints with the learner left to synthesize in any way he chooses.

The integrated science curriculum is concerned with the processes and products by which scientific knowledge is constructed and validated. Science as a process or way of knowing consists of local methods of approach and the right attitudes of mind which guide inquiry into truth about natural phenomena. Scientific process can be approached via observation, data collection, experimentation, formulating hypothesis, stating the problem, making inferences etc; while scientific products are hypotheses, theories, principles and laws. These products subsequently help to discover facts about the universe. Integrated science is characterized by the following processes and products;

- Scientific attitude: searching for truth; science is based on evidence and empirical standards; and it also encourages innovation and skepticism.
- Scientific thinking: scientific knowledge is built on creative thinking; the application of deductive and inductive logic leads to the emergence of new scientific theories, principles, hypothesis and laws which are then tested empirically. Scientific knowledge though durable also has a tentative character.
- Scientific Practice: Precise experiments, design and proper instrumentation; prudent handling of quantitative and qualitative data; honest reporting.
- Scientific Community: community with a collective wisdom, encouraging free exchange and open – minded discussions and debates.

Self-Assessment Exercise 1

What do you understand by the term integrated science.

2.3.2 History of Integrated Science in Nigeria

The first-time science was introduced into the curriculum of schools in Nigeria in the 1890, was in the form of ‘nature study’. During the period 1890 – 1920, many science educators in Europe, America and parts of Africa showed great enthusiasm for the introduction of the study of nature into the school. The main purpose of this movement was to

improve agriculture and to overcome the desire of farmers' children to leave the farm for the city Nature study was targeted at studying natural phenomena in the environment. The main purpose for teaching nature study then was to improve the quality of life, to enhance food production and hygiene among the learners. Nature study was a programme designed to provide knowledge in various fields of science but in reality, the content was majorly biological sciences. Nature Study changed to Hygiene one time, then Rural Science, later Agricultural Science and Domestic Science and then General Science until 1968 when NISP was initiated in Ibadan (Bajah, 1983).

In many countries, several science curriculum were developed, few are the physical science study committee (PSSC), chemical education materials study (CHEM. Study), biological science curriculum (BSC) which are all in United State of America and the Nuffidd science projects in the United Kingdom.

In Nigeria, the historic national curriculum conference held from 8th – 12th September, 1969 encouraged various bodies including the government agencies to develop science curriculum for both primary and secondary levels of education.

This development brought about the new NPE of 1977 revised in 1981 which led to 6-3-3-4 system of education and also with the following; The Nigeria secondary schools project (NSSP) by the defunct comparative education study and adaptation centre (CESAC) now known as part of NERDC.

The Nigeria integrated science project, basic science for Nigeria secondary school (BSNSS) by CESAC and STAN and primary education improvement project: northern states primary school project (NSPSP).

Also, science in Discovering: Mid-western state primary science project (MSPSP, primary education improvement project: western state primary science project (WSPSP).

According to Arokoyu (2012), the introduction of integrated science as a subject into the science curriculum emanated from WAEC 1968 request to STAN for more functional science content. This was as a result of dissatisfaction in the existing curricula by many African countries that just had their independence. About the same time, the African Primary Science Program (A.P.S.P) introduced its unique way of teaching science which involves inquiry/discovery activities whereby learners find out things for themselves while the teacher acts as a supervisor and

not purveyor of knowledge. The APSP was an integrated and environmental based science specifically designed for Africa.

Self-Assessment Exercise 2

Discuss how Integrated Science started in Nigeria

2.3.3 Why we teach Integrated Science

Integrated science was designed based on the observation that the universe is a unified whole therefore there must be a holistic approach to its study (Arokoyu, 2012). Science is not just a body of knowledge or facts, but it is a process of thought and action through which we understand natural phenomena. Gardner (1971) remarked that, to some degree, the concept of integrated science teaching is based on the parallel assumptions that the universe has an inherent unity and that science as an attempt to provide an understanding of the natural world has a unity of purpose, content and process that is far more significant than the differences in language or focus between individual sciences. The integrated science curriculum provides students the broad and sound knowledge base to meet the challenges of living in a technologically advancing society. The curriculum adopts an interdisciplinary systematic approach through inquiry, students will develop scientific knowledge and skills that will help them evaluate the impact of scientific and technological developments. Furthermore, integrated science curriculum empowers students to be inquisitive, reflective and critical thinkers by equipping them with a variety of ways of looking at the world.

According to the Nigerian Integrated Science Project (1970), Integrated principles are intended to produce, among other things a course which:

- (a) is relevant to student-needs and experiences;
- (b) stresses the fundamental unity of science;
- (c) lays adequate foundation of subsequent specialist study; and
- (d) adds a cultural dimension to science education.

Based on the tenets of integrated science discussed earlier, students should be made to master the following skills:

- (i) Observing carefully and thoroughly;
- (ii) Reporting completely and accurately what is observed;
- (iii) Organizing information acquired by the above processes;
- (iv) Generalising on the basis of acquired information;
- (v) Predicting as a result of these generalisations;

- (vi) Designing experiments (including controls where necessary) to check these predictions;
- (vii) Using models to explain phenomena where appropriate;
- (viii) Continuing the process of inquiry when new data do not conform with predictions.

The overall aim of the integrated science curriculum is to provide learning experiences that will enable students to develop scientific literacy. So that students can participate actively in our rapidly changing knowledge – based society, prepare for further studies or careers in fields where the knowledge of science will be useful.

The broad aims of integrated science curriculum are to enable students to:

- Develop interest in and maintain a sense of wonder and curiosity about the natural and technological world;
- Acquire a broad and general understanding of key science ideas and explanatory framework of science and appreciate how the ideas were developed and why they are valued;
- Develop skills for making scientific inquiries;
- Develop the ability to think scientifically, critically and creatively and to solve problems individually or collaboratively in science related contexts;
- Use the language of science to communicate ideas and views on science – related issues;
- Make informed decisions and judgments about science related issues;
- Be aware of the social, ethical, economic, environmental and technological implications of science and develop an attitude of responsible citizenship; and
- Develop conceptual tools for thinking and making sense of the world.

Self-Assessment Exercise 3

Discuss the Broad aims of the Nigerian Integrated Science Curriculum

2.4 Summary

Science provides knowledge while technology provides ways of using this knowledge and our value concepts guide what we ought to do with both science and technology. The essence of science is to solve problems that confront human in nature through the understanding of the environment and applying this knowledge. Integrated science was designed based on the observation that the universe is a unified whole

therefore there must be a holistic approach to its study. Integrated science is an approach to the teaching/learning of science in which concepts and principles are presented so as to express the fundamental unity of scientific thoughts and avoid premature and undue stress on the distinctions between the various scientific fields. The Integrated science curriculum evolved over the years and was given prominence in 1969 after the curriculum conference.

In this unit we have discussed the meaning of integrated science and why Integrated science teaching in Nigeria. The unit highlighted the aims and objectives of integrated science and traced its history and evolution from the time nature study was introduced into the school system to the introduction of the Nigerian Integrated Science Project.

2.5 References/Further Readings/Web Resources

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2.6 Possible Answers to Self-Assessment Exercise(s) within the content

SAE 1

The term “integrated science” is often used as a synonym for interdisciplinary and unified science, which may be applied generally to curriculum efforts in which two or more previously separated science subjects are combined. These efforts may be characterized as collaboration among or blending with, or a fusion of a number of “subjects” traditionally taught separately.

SAE 2

The first time science was introduced into the curriculum of schools in Nigeria in the 1890, was in the form of ‘nature study’. During the period 1890 – 1920, many science educators in Europe, America and parts of Africa showed great enthusiasm for the introduction of the study of nature into the school. The main purpose of this movement was to improve agriculture and to overcome the desire of farmers’ children to leave the farm for the city. Nature study was targeted at studying natural phenomena in the environment. The main purpose for teaching nature study then was to improve the quality of life, to enhance food production and hygiene among the learners. Nature study was a programme designed to provide knowledge in various fields of science but in reality, the content was majorly biological sciences. Nature Study changed to Hygiene one time, then Rural Science, later Agricultural Science and Domestic Science and then General Science until 1968 when NISP was initiated in Ibadan (Bajah, 1983).

SAE 3

The broad aims of integrated science curriculum are to enable students to:

- Develop interest in and maintain a sense of wonder and curiosity about the natural and technological world;
- Acquire a broad and general understanding of key science ideas and explanatory framework of science and appreciate how the ideas were developed and why they are valued;
- Develop skills for making scientific inquiries;
- Develop the ability to think scientifically, critically and creatively and to solve problems individually or collaboratively in science related contexts;
- Use the language of science to communicate ideas and views on science – related issues;
- Make informed decisions and judgments about science related issues;

- Be aware of the social, ethical, economic, environmental and technological implications of science and develop an attitude of responsible citizenship; and
- Develop conceptual tools for thinking and making sense of the world.

UNIT 3 AFRICAN SCIENCES AND INTEGRATED SCIENCE

Unit Structure

- 3.1 Introduction
- 3.2 Intended Learning Outcomes
- 3.3 African Sciences and Integrated Science
 - 3.3.1 Meaning of African Sciences and Integrated Science
 - 3.3.2 African sciences as different from Integrated Science
- 3.4 Summary
- 3.5 References/Further Readings/Web Resources
- 3.6 Possible Answers to Self-Assessment Exercise(s)

3.1 Introduction

Science of what kind, region or people is part of human activities. Africa as a people acknowledge science as a way of life. To this end, this unit exposes you to concept of African science as different from integrated science. In the two previous Units we have been discussing the concepts of African Science and Integrated Science. Africans, over the years have fashioned out ways of understanding their environment and solving problems that confront them in nature. Integrated science evolved as a school subject that applied the interdisciplinary understanding of natural occurrences. In this unit therefore we will be discussing the relationship between African science and integrated science.

3.2 Intended Learning Outcomes

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

- explain African concept of science, western and Integrated science
- define African concept of science
- identify and explain the difference between African concept of science and integrated science.

3.1 African Sciences and Integrated Science

3.3.1 Meaning of African Concept of Science, Western science and Integrated science

In our contemporary world, we find all around us numerous products of African science. This includes woven clothing materials, beads, mats, agricultural implements, beds, Dane guns, talking drums and musical

instruments, among others. Also, other products of African science are herbals. They equally have products such as laws, formulae, principles and concepts. Then, the question that comes to mind is: What exactly is African concept of science? To some it is what African scientists do. This means there exist many definitions of African concept of science. However, any definition is acceptable provided certain conditions are satisfied.

Some of the generally accepted definitions include:

- i. African concept of science is a systematised body of knowledge. This definition places emphasis on the product of African concept of science and processes involved in the acquisition of knowledge.
- ii. Just like modern sciences (American Science), African concept of science is defined as the process by which knowledge is acquired. This view, acknowledges African concept of science as “doing thing”. Therefore, African concept of science is human enterprise.
- iii. Furthermore, another definition of African concept of science is that, it is a way of life. Therefore, this definition associate’s African science with the culture of a people.

In African science, which could be classified into "traditional" and "modernized" African science, some elements of the Western method of science could also be found. However, the traditional African scientists, given their conception of the world, tend to give prominence to the metaphysico-religious method or supernaturalism, in addition to elements of the Western method. Given this background, science is an activity which historical roots could be traced to several ancient cultures. This presupposes that Africa can lay claim to some kind of science no matter how crude it might appear to the modern scientist. Thus, it would be wrong for anyone to say that science is completely alien to Africa, for even before the advent of Western science our forefathers practiced science which could well be labelled “African Science.” This form of science is still prevalent in our contemporary African society. Moreover, such science to some extent has influenced the method of Western science and of course has also in turn been influenced by the method of Western science. However, through observation and the experimental method human beings are capable of discovering the secrets of nature of which they could then use for their own good. This applies to both the western science and African science whose ultimate goal is to understand and interpret nature as it applies to them. Akpan, (2011) remarked that science is fluid. However, for the purpose of this work we shall characterise science as systematized body of knowledge with public, impersonal and objective characteristics aimed at unravelling the

true nature of physical reality through the process of observation, experimentation and explanation – all for the betterment of human life. This definition characterizes all sciences, be it western, African or integrated. As discussed in the previous chapters, integrated science applies interdisciplinary approaches to seeking scientific knowledge. In integration the following principles are employed;

- (a) relevance to student-needs and experiences;
- (b) stresses the fundamental unity of science;
- (c) lays adequate foundation of subsequent specialist study; and
- (d) adds a cultural dimension to science education.

The basic aim of African concept of science is to find answers to questions of: “What?”, “How?” and “why?”, find solution(s) to problem(s).

Self-Assessment Exercise 1

How do the traditional African people perceive science?

3.2 Concept of African Sciences as Different from Integrated Science

Concept of African sciences differ from Integrated Science in a number of ways though both tend to be a fundamental science which cuts across subject boundaries that provide meaningful work for the learners that give ‘birth’ to chemical and physical science, technology and other related disciplines. The teaching of Integrated Science is basically activity based and exploration of the learner environment. This approach enables the learners to acquire knowledge, understanding, skills, values and positive attitudes in such a way that ideas of relationships are made clear and easier. In the teaching of concept of African science, the activity based and exploration approaches are not vigorously adopted.

Integrated Science provides broad generalisation that services as advance organisers which later graduates into specific knowledge. The concept of African sciences on the other hand do not provide broad generalisation. African science focuses on specific issues and concept. There is no adoption of interdisciplinary approaches as most interpretations have spiritual undertone.

In the concept of African sciences, learners are not involved in open ended field of laboratory exercises or activities which can be used to verify or prove certain scientific laws and theories. But integrated science on the other hand involves in open ended field of laboratory

exercises or activities. This may be used to verify or prove certain scientific laws and theories. The concept of African sciences does not have elaborate laboratory; but Integrated Science has. The teaching strategies and methods for Integrated Science include the inclusion of problem-solving activities. This may be problems(s) identified by the learners through observations or interaction with materials or environment, or given by the teachers or found in the learning materials (e.g., texts, online).

The concept of African sciences does not adopt this type of approach and strategy. Most of the findings in the concept of African sciences are not documented unlike Integrated Science. There are fewer texts and documentaries on the concept of African sciences than what we have in Integrated Science. African sciences are indigenous based majorly on African culture while Integrated Science curriculum is both foreign and indigenous.

African science depend tenaciously on who is performing: Personality, parents are expected to pass on their knowledge of traditional herbs to some carefully selected children in their family. This principle of selectivity and exclusiveness in knowledge transfer is not teaching and learning of integrated science. The knowledge in integrated science is open to all who are willing to learn.

The concept of African science approach to problem is considering it as a whole and do not believe it is possible to isolate and control variables in all situations. This is the opposite in the Integrated Science approach to problem(s). African sciences accept paradoxes and work with them (Murfin, 1992). This is not true with Integrated Science.

Self-Assessment Exercise 2

Discuss the features of African science and integrated science which are common.
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3.4 Summary

Though African sciences and Integrated Science are both sciences, and are concerned with questions of “what?”, “How?” and “Why?” and finding solution(s) to problem(s), they differ in a number of ways. These include their strategies in imparting knowledge to learners and issue of science laboratories. They have different syllabi and curricula.

In this unit, you have been treated to the concept of African sciences and integrated science. There exist differences between African Science and

Integrated Science. African sciences are indigenisation sciences while integrated science more or less is foreign science. Other areas of their differences include teaching strategies and methods, and curriculum.

3.5 References/Further Readings/Web Resources

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3.6 Possible Answers to Self-Assessment Exercise(s) within the content

SAE 1

Some of the generally accepted definitions include:

- i. African concept of science is a systematised body of knowledge. This definition places emphasis on the product of African concept of science and processes involved in the acquisition of knowledge.
- ii. like modern sciences (American Science), African concept of science is defined as the process by which knowledge is acquired. This view, acknowledges African concept of science as “doing thing”. Therefore, African concept of science is human enterprise.
- iii. Furthermore, another definition of African concept of science is that, it is a way of life. Therefore, this definition associate’s African science with the culture of a people.

SAE 2

Concept of African science differ from Integrated Science in a number of ways though both tend to be a fundamental science which cuts across subject boundaries that provide meaningful work for the learners that give ‘birth’ to chemical and physical science, technology and other elated disciplines

UNIT 4 WAYS OF CURBING SUPERSTITIOUS BELIEF THROUGH INTEGRATED SCIENCE

Unit Structure

- 4.1 Introduction
- 4.2 Intended Learning Outcomes
- 4.3 Ways of Curbing Superstitious Belief through Integrated Science
 - 4.3.1 Meaning of superstitious belief
 - 4.3.2 Why we teach Integrated Science
 - 4.3.3 Curbing superstitious belief through integrated Science
- 4.4 Summary
- 4.5 References/Further Readings/Web Resources
- 4.6 Possible Answers to Self-Assessment Exercise(s)

4.1 Introduction

People around the globe hold on to certain ideas and Beliefs. Ideas and beliefs people stick to have their basis. For a people to discard their original ideas and beliefs there should be a new one they rationally discover superior to theirs. The unit exposes you to possible ways of curbing superstitious belief through Integrated Science.

4.2 Intended Learning Outcomes

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

- explain the meaning of superstitious belief
- define superstitious belief
- identify and discuss possible ways of curbing superstitious belief through Integrated Science.

4.3 Ways of Curbing Superstitious Belief through Integrated Science

4.3.1 Meaning of Superstitious Belief

Man's belief to a large extent is a product of his interaction with his environment and its component. Superstitious belief connotes many things to many people. Therefore, there is no one generally accepted meaning. To some, superstitious belief has to do with believing in magic. To others, they are beliefs that lack empirical proves.

Generally, accepted definitions of superstitious belief contains some of the following elements:

1. Superstitious belief is believing in magic.
2. An irrational abject attitude of mind towards nature or supernatural.
3. Belief based on fear of the unknown.
4. A belief and practice based on ignorance.

Basically, superstitious belief is based on lack of knowledge, inadequate information about something and ignorance. Superstition is attributable to any belief or practice considered by non-practitioners to be irrational or supernatural, attributed to fate or magic, perceived supernatural influence, or fear of that which is unknown. According to OED Online (2021), superstition defines religious belief or practice considered to be irrational, unfounded, or based on fear or ignorance; excessively credulous belief in and reverence for the supernatural and a widely held but irrational belief in supernatural influences, especially as leading to good or bad luck, or a practice based on such a belief. Damisch, (2010) defines superstition as irrational beliefs that an object, action, or circumstance that is not logically related to a course of events influences its outcome.

Superstitions were found in the early man's effort to explain nature and his own existence, to propitiate fate and invite fortune; to avoid evils he could not understand and to pry into the future (Adejobi, 2013). A superstition is a belief or a practice that is not based on facts or events that can be proven (Kagan, 2012). For instance, Adejobi, (2013) remarks that some people believe in the superstition that if a black cat crosses your path, you will have bad luck. The reason this is called a superstition is because no one can prove that any bad luck encountered arose from having a black cat cross on one's path and what it would mean to have bad luck is also something that cannot be defined (Encyclopaedia Britannica. 2009). Superstitions primarily represent the underlying inherent fear of mankind, caused by the uncertainties of this world. In a way, it is a sign of acceptance of our ignorance and limitations of our power. In another way, it is a sign of accepting the grandness of this universe and its scheme of operation, which is still largely beyond our comprehension and understanding (Kumar 2009).

Therefore, the term superstition is usually referred to as belief or influence that is incapable of being justified on rational grounds. They are the irrational beliefs that an object, action or circumstance not logically related to a course of events influences its outcome. It is designated to those beliefs that result from ignorance and fear of the unknown. Many superstitious practices are due to the false interpretations of the natural events (Valeed 2012). A superstition is a behaviour that has no rational basis or history or a history that is long-

lost. Many of them are age-old and inherited as part of our cultural heritage. Superstition lacks any evidence, but still it prevails in forms of religious, cultural or personal beliefs. It often emerges due to fear and to explain the unexplainable. People try to explain events like illness, accidents, etc. by relating them to the supernatural processes. On the other hand, science is based on investigations and it provides an organized study of a particular subject.

An example of superstition; in ancient times, the Chinese believed that solar eclipses occurred when a dragon ate the sun. On the other hand science has proved that solar eclipses occur when the moon is positioned between the earth and the sun.



Fig. 1: Solar eclipse based on superstition

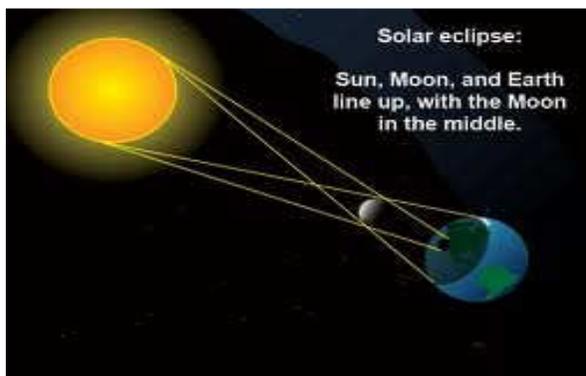


Fig. 2: Scientific Explanation of Solar eclipse

Table 1: Comparison between Superstition and Science:

	Superstition	Science
Definition	Superstition is an irrational belief or notion. It is not based on any reasoning or knowledge. It is often associated with blind faith.	Science is a branch of knowledge that particularly refers to the experimental knowledge. Science is based on investigations and it provides an organized study of a particular subject.
Evidence	Absent	Present
Categories	Religious, Cultural or Personal.	Pure or Applied.
Example	The Chinese in the ancient times believed that solar eclipses occur when a dragon eats the Sun.	Solar eclipse occurs when the Moon is in line between the Earth and the Sun.
Characterized by	Assumptions based on irrational beliefs and acts.	Knowledge and discoveries.
Elements	Superstitious beliefs, superstitious practices and the link between them.	Observations, laws and theories.
Arises due to	Ignorance or/and fear.	Curiosity to find evidence.
Reliability	Not reliable	Yes, very reliable

Self-Assessment Exercise 1

Distinguish between superstitious belief and science

3.2 Why we teach Integrated Science

Integrated science as an interdisciplinary curriculum deals with all approaches to the teaching and learning of science. Integrated Science is the science subject that is taught to the students at middle basic (formerly known as Junior Secondary (JS). It is aimed at introducing African child like any other child in the globe right from the beginning to start to develop basic scientific skills, abilities and attitudes such as

curiosity, manipulative ability, spontaneous flexibility, experimentation, initiative, industry, manual dexterity, mechanical comprehension and the coordination of hand and eye; in passing, how he/she wishes he/she could do this in his/her own mother tongue (Fafunwa, 1971; Atadoga, & Onaolapo, 2008).

Integrated Science teaching is aimed also at developing in students all round abilities that foster better citizenries who are potential leaders of tomorrow. It also affords the students the opportunity to contribute positively and intelligently in the technical, and agricultural and other science related sectors of their nation. Integrated Science is an approach to the **teaching** of science in which concepts and principles' are presented so as to express the fundamental unity of scientific thought and avoid premature or undue stress on the distinctions between the various scientific fields.

As we discussed in the previous units the aims and objectives of integrated science are:

- Develop interest in and maintain a sense of wonder and curiosity about the natural and technological world;
- Acquire a broad and general understanding of key science ideas and explanatory framework of science and appreciate how the ideas were developed and why they are valued;
- Develop skills for making scientific inquiries;
- Develop the ability to think scientifically, critically and creatively and to solve problems individually or collaboratively in science related contexts;
- Use the language of science to communicate ideas and views on science – related issues;
- Make informed decisions and judgments about science related issues;
- Be aware of the social, ethnical, economic, environmental and technological implications of science and develop an attitude of responsible citizenship; and
- Develop conceptual tools for thinking and making sense of the world.

Integrated science learning is therefore a good way to apply the essence of learning in the 21st century. In integrated science learning students are encouraged to connect the learning materials content to real-world contexts. Students are involved actively in exploring the real-world contexts which relevant to the learning material, conducting the collaborative investigation, and communicating the results of the investigation. Thus, the learning can be implemented holistically, authentically, meaningfully and actively.

Self-Assessment Exercise 2

List four aims and objectives of teaching integrated science?

3.3 Curbing Superstitious Belief through Integrated Science

Psychologically, children at JS (middle basic) level learn more by observing, touching, and interacting with environment and its contents. The integrated approach tends to afford the learners at all levels of education more consistent way of looking at the world round them thereby curbing superstitious belief.

Superstitious beliefs have been reported to inhibit the individual learner's learning from science. Superstitious beliefs have been found to exert negative influence in children (and even teachers!) learning from science. These beliefs are often held tenaciously and tend to impede an individual's conceptualization of scientific knowledge by creating an existing prior knowledge which is in contrast to science knowledge to be learned.

However, a vigorously implemented and balanced integrated science curriculum will significantly reduce individuals dependence on superstitious beliefs, since more and better science create scientifically literate individuals. The more scientifically exposed an individual is, the more readily she/he would discard these beliefs. Classroom teachers and school guidance counsellors should be sufficiently aware of the presence (and the type) of these beliefs. Students' difficulties in science arising from the presence of these beliefs can be appropriately ameliorated.

According to Ogunniyi (1986), teaching strategies and methods for integrated science should contain the following to create a greater forum for scientific literacy and attitude:

- i. Using of discovery teaching strategies. This means introducing students to concepts by broad definition and then encourage them to arrive at scientific knowledge and scientific understanding as a result of their own observation. In this context, the teacher's role is that of a facilitator, guide or motivator.
- ii. The inclusion of problem solving activities: This may be problem(s) identified by students through observations or interaction with materials or environment; or given by the teacher or found in the material (e.g. texts, online).

- iii. The involvement of students in open ended field and laboratory exercises or activities. This may be to verify, prove or confirm certain scientific laws and theories.
- iv. Using local examples and illustrations during class discussion. This will enable the students understand the realities of the things that happen in their immediate environment. This will reduce abstraction, ambiguity and misconception of scientific facts.
- iv. Engage students in community based projects and activities. This will help them to understand how things work in the community. It will help them to apply the scientific knowledge and skills they have acquired in solving everyday practical problems which could have been held as superstitious beliefs in the community.
- v. Helping students to acquire sound scientific attitudes during integrated science lessons. This will enable them make wise decisions in matters that relate to existence in their communities.
- vi. Help learners to understand the scientific principles, laws, theories behind some natural occurrences in their environment/communities. Understanding scientific explanations reduces superstitious beliefs.
- vii. Encourage students to participate in discussions during integrated science classes and express their opinions and experiences freely. This enable the class to clarify issues that relate to non-scientific and superstitious beliefs.

These approaches are some of the major approaches in the teaching-learning process of integrated science. Therefore, by these approaches which are emphasised and adopted in integrated science, assist the subject in curbing superstitious belief.

Bruner's learning theories emphasise discovery and problem solving approaches. And that transfer of concepts, principles and strategies from one learning situation to another should be done in mass, or unit. Therefore, integrated approach via integrated science would enhance transfer of learning that could give the students ability to use concepts and principles learned in one discipline in another related discipline. By this approach therefore, integrated science can be effectively used to curb superstitious belief.

Self-Assessment Exercise 3

Discuss 3 ways teachers can help curb superstitious beliefs through integrated science

4.4 Summary

Superstitious belief is born out from fear and ignorance. Integrated Science as an interdisciplinary subject with all approaches to teaching-learning process of science can be used to curb superstitious belief. This can be done through integrated approach strategies that are emphasised in the teaching-learning approach of integrated science.

This unit has exposed you to explanation of superstitious belief, why integrated science is taught. Also treated in the unit are ways integrated science could be used to curb superstitious belief. Some of the ways Integrated Science could be used to curb superstitious belief include among others; using discovery teaching strategies, inclusion of problem solving activities and the involvement of students in open ended field of laboratory exercises in teaching-learning approaches of the subject.

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4.6 Possible Answers to Self-Assessment Exercise(s) within the content

SAE1

	Superstition	Science
Definition	Superstition is an irrational belief or notion. It is not based on any reasoning or knowledge. It is often associated with blind faith.	Science is a branch of knowledge that particularly refers to the experimental knowledge. Science is based on investigations and it provides an organized study of a particular subject.
Evidence	Absent	Present
Categories	Religious, Cultural or Personal.	Pure or Applied.
Example	The Chinese in the ancient times believed that solar eclipses occur when a dragon eats the Sun.	Solar eclipse occurs when the Moon is in line between the Earth and the Sun.
Characterized by	Assumptions based on irrational beliefs and acts.	Knowledge and discoveries.
Elements	Superstitious beliefs, superstitious practices and the link between them.	Observations, laws and theories.
Arises due to	Ignorance or/and fear.	Curiosity to find evidence.
Reliability	Not reliable	Yes, very reliable

SAE 2

- i. Acquire a broad and general understanding of key science ideas and explanatory framework of science and appreciate how the ideas were developed and why they are valued;
- ii. Develop skills for making scientific inquiries;
- iii. Develop the ability to think scientifically, critically and creatively and to solve problems individually or collaboratively in science related contexts;

- iv. Use the language of science to communicate ideas and views on science – related issues.

SAE 3

- i. Helping students to acquire sound scientific attitudes during integrated science lessons. This will enable them make wise decisions in matters that relate to existence in their communities.
- ii. Help learners to understand the scientific principles, laws, theories behind some natural occurrences in their environment/communities. Understanding scientific explanations reduces superstitious beliefs.
- iii. Encourage students to participate in discussions during integrated science classes and express their opinions and experiences freely. This enable the class to clarify issues that relate to non-scientific and superstitious beliefs.

UNIT 5 AFRICAN CONTRIBUTIONS TO SCIENCE, TECHNOLOGY AND DEVELOPMENT

Unit Structure

- 5.1 Introduction
- 5.2 Intended Learning Outcomes
- 5.3. African Contributions to Science, Technology and Development
 - 5.3.1 History of African development
 - 5.3.2 African contributions to science
- 5.4 Summary
- 5.5 References/Further Readings/Web Resources
- 5.6 Possible Answers to Self-Assessment Exercise(s)

5.1 Introduction

Africa has the world's oldest record of human technological achievement. For instance, the oldest stone tools in the world have been found in eastern Africa, and later evidence for tool production by our hominin ancestors has been found across Sub-Saharan Africa. The history of science and technology in Africa since then has, however, received relatively little attention compared to other regions of the world, despite notable African developments in mathematics, metallurgy, architecture, and other fields. Sciences and technology began as early as the ancient days of the early man who produced fire from sparks of stones which he used for cooking and heating as a means for survival.

In this Paleolithic age, stone was the material used for most of the items they produced. Even though an explanation on how this happened was unknown, the application was very vital for their sustenance. Since then, man continued to acquire knowledge on how to exploit his natural environment for survival until the Neolithic days of early civilization with a rise in technology where blacksmith used metal such as iron, zinc to produce weapons against wars.

It is recorded in history that, modern man first developed in the Great Rift Valley of Africa, the first development of tools is found there as well: The Homo habilis, residing in East Africa, developed the first tool making industry, the Olduwan, around 2.3 million BC. Homo ergaster developed the Acheulean stone tool industry, specifically hand-axes, in Africa, 1.5 million BC. This tool industry spread to the Middle East and Europe around 800,000 to 600,000 BC. Homo erectus began to use fire. Homo sapiens sapiens or modern humans created bone tools and the back blade around 90,000 to 60,000 BC, in Southern and Eastern Africa. The use of bone tools and back blades became characteristic of later

stone tool industries. The appearance of abstract art is during this period. The oldest abstract art in the world is a shell necklace dated 82,000 years in the Cave of Pigeons in Taforalt, eastern Morocco. The second oldest abstract art and the oldest rock art is found in the Blombos Cave at the cape in South Africa, dated 77,000 years.

Africa has impacted much into humanity especially during the early times. The sustenance of this development has been a big problem facing African nations This unit, therefore, will discuss the history of science and technology development in Africa and African's contributions to science, technology and development.

5.2 Intended Learning Outcomes

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

- trace the history of African development in science and technology.
- identify and discuss African contributions to science, technology and development.

5.3 African Contributions to Science, Technology and Development

5.3.1 History of African Development

The first known hominids evolved in Africa. According to paleontology, the early hominids' skull anatomy was similar to that of the gorilla and the chimpanzee, great apes that also evolved in Africa, but the hominids had adopted a bipedal locomotion which freed their hands. This gave them a crucial advantage, enabling them to live in both forested areas and on the open savanna at a time when Africa was drying up and the savanna was encroaching on forested areas. Shillington (2005) has remarked that this would have occurred 10 to 5 million years ago, but these claims are controversial because biologists and genetics have humans appearing around the last 70 thousand to 200 thousand years.

Archaeological evidence has shown that by 4 million years ago, several australopithecine hominid species had developed throughout Southern, Eastern and Central Africa. They were tool users, and makers of tools. They scavenged for meat and were omnivores. According to Shillington (2005), approximately 3.3 million years ago, primitive stone tools were first used to scavenge kills made by other predators and to harvest carrion and marrow from their bones. The tools were classed as Oldowan.



Fig. 1: Four views of an Acheulean handaxe

Around 1.8 million years ago, *Homo ergaster* first appeared in the fossil record in Africa. From *Homo ergaster*, *Homo erectus* evolved 1.5 million years ago. Some of the earlier representatives of this species were still fairly small-brained and used primitive stone tools, much like *H. habilis*. The brain later grew in size, and *H. erectus* eventually developed a more complex stone tool technology called the **Acheulean**. Possibly the first hunters, *H. erectus* mastered the art of making fire and was the first hominid to leave Africa, colonizing most of Afro-Eurasia and perhaps later giving rise to *Homo floresiensis*

According to Henshilwood, d'Errico, and Watts (2009), the Blombos Cave site in South Africa, which is famous for rectangular slabs of ochre engraved with geometric designs., has been confirmed to be around 77,000 and 100–75,000 years old, using multiple dating techniques. According to Texier et al (2010), ostrich egg shell containers engraved with geometric designs dating to 60,000 years ago were found at Diepkloof, South Africa. Beads and other personal ornamentation have been found from Morocco which might be as much as 130,000 years old. The Caves of Hearths and Blombos in South Africa have yielded a number of beads dating older than 50,000 to 75,000 years ago. (Vanhaeren et al, 2013)

Specialized projectile weapons as well have been found at various sites in Middle Stone Age Africa, including bone and stone arrowheads at South African sites such as Sibudu Cave (along with an early bone needle also found at Sibudu) dating approximately 60,000-70,000 years ago and bone harpoons at the Central African site of Katanda dating to about 90,000 years ago. Evidence also exists for the systematic heat treating of silcrete stone to increased its flake-ability for the purpose of toolmaking at the South African site of Pinnacle Point. Early stone-tipped projectile weapons (a characteristic tool of *Homo sapiens*), the

stone tips of javelins or throwing spears, were discovered in 2013 at the Ethiopian site of Gademotta, and date to around 279,000 years ago. (Sahle, 2013)

In 2008, an ochre processing workshop likely for the production of paints was uncovered at Blombos Cave, South Africa which dates back to 100,000 years ago. Analysis shows that a liquefied pigment-rich mixture was produced and stored in the two abalone shells, and that ochre, bone, charcoal, grindstones and hammer-stones also formed a composite part of the toolkits.

A number of South African sites have shown an early reliance on aquatic resources from fish to shellfish. Pinnacle Point, in particular, shows exploitation of marine resources as early as 120,000 years ago

Humans in North Africa (Nazlet Sabaha, Egypt) are known to have dabbled in chert mining, as early as \approx 100,000 years ago, for the construction of stone tools. (Yvan 2014). According to Leverington, D. (2013), the earliest physical evidence of astronomical activity may be a lunar calendar found on the Ishango bone dated between 23,000 and 18,000 BC in what is now the Democratic Republic of the Congo.

In agriculture, Africans started the domestication of crops like wild millet, African rice and sorghum between 8000 and 6000 BC. The people started capturing wild cattle and holding them in circular thorn hedges, resulting in domestication. Within the same period, Niger–Congo speakers domesticated the oil palm and raffia palm. Two seed plants, black-eyed peas and voandzeia (African groundnuts), were domesticated, followed by *okra* and kola nuts. Since most of the plants grew in the forest, the Niger–Congo speakers invented polished stone axes for clearing forest.

Evidence of the early smelting of metals – lead, copper, and bronze – dates from the fourth millennium BC. In Africa (Nicholson & Ian, 2000).

Ivory has been desired since antiquity because its relative softness made it easy to carve into intricate decorative items for the very wealthy. During the days of the Roman Empire, the ivory exported from Africa largely came from North African elephants. These elephants were also used in the Roman coliseum fights and occasionally as transport in war and were hunted to extinction around the 4th century C.E. After that point, the ivory trade in Africa declined for several centuries.

Scientific discovery and the application of technology to the natural environment have been essential to the history of Africa and the development of the African Diaspora throughout the world and

especially in the Americans (Lovejoy, 2014). Africans migrated to America either under slavery or as voluntary travellers. They learnt to adapt successfully to specific ecological settings for survival.

Americans suffered severe population destruction through disease and European conquest after 1492. Europeans empires and the generation of enormous wealth depended upon the combination of the ingredients – virtually free and very fertile land, labour and technology, largely from Africa, and the ability to garner huge profits through the reliance on slavery. Major plantation crops in the Americas came from Africa.

Africa established “botanical gardens of the disposed”, in which they cultivated many familiar foods, including millet, sorghum, coffee, okra, watermelon and the “Asian” long beans. Africans in Diaspora planted many of the same crops that were grown in Africa for their own subsistence.

Self-Assessment Exercise 1

Narrate the history of ivory trade in Africa

3.2 African Contributions to Science, Technology and Development

Africa has contributed so much to the development of science and technology in the world. These developments span from Mathematics, architecture, engineering, agriculture etc. For instance, mathematics developed in Africa, as was the first method of counting. More than 35,000 years ago, Egyptians scripted textbooks about math that included division and multiplication of fractions and geometric formulas to calculate the area and volume of shapes. Distances and angles were calculated, algebraic equations were solved and mathematically based predictions were made of the size of floods of the Nile. The ancient Egyptians considered a circle to have 360 degrees and estimated π at 3.16.

Eight thousand years ago, people in present-day Zaire developed their own numeration system, as did Yoruba people in what is now Nigeria. The Yoruba system was based on units of 20 (instead of 10) and required an impressive amount of subtraction to identify different numbers. Scholars have lauded this system, as it required much abstract reasoning.

The technology and the science behind these were not realised but cut across many cultures.

Many ancient African cultures discoveries in astronomy are foundations on which we still rely, and some were so advanced that their mode of discovery still cannot be understood. It is the Egyptians that charted the movement of the sun and constellations and the cycles of the moon. They divided the year into 12 parts and developed a yearlong calendar system containing 365 $\frac{1}{4}$ days. They used moving water to make clocks. Based on the translation of 14 Timbuktu manuscripts, the following points can be made about Timbuktu astronomical science during the 12th–16th centuries:

1. They made use of the Julian Calendar.
2. Generally speaking, they had a heliocentric view of the Solar System.
3. Diagrams of planets and orbits made use of complex mathematical calculations.
4. Scientists developed an algorithm that accurately oriented Timbuktu to Mecca.
5. They recorded astronomical events, including a meteor shower in August 1583.

At this time, Mali also had a number of astronomers including the emperor and scientist Askia Mohammad I.

In about 300 B.C. a remarkable accurate calendar structure known as the African Stonehenge was constructed in the present-day Kenya. The Dogon people of Mali amassed a wealth of detailed astronomical observations. Many of their discoveries were so advanced that some modern scholars credit their discoveries instead to space aliens or unknown European travellers, even though the Dogon culture is steeped in ceremonial tradition centered on several space events. The Dogon knew of Saturn's rings, Jupiter's moons, the spiral structure of the Milky Way and the orbit of the Sirius star system. Hundreds of years ago, they plotted orbits in this system accurately through the year 1990. They knew this system contained a primary star and a secondary star (now called Sirius B) of immense density and not visible to the naked eye.

Today, South Africa has cultivated a burgeoning astronomy community. It hosts the Southern African Large Telescope, the largest optical telescope in the southern hemisphere. South Africa is currently building the Karoo Array Telescope as a pathfinder for the \$20 billion Square Kilometer Array project.

The Nok culture of what is now central Nigeria displays an antiquity in art forms that reveal knowledge of metallurgy and stone sculpture that has similarities to other parts of the world. Those who built the pyramids

include Africans from the middle and upper Nile River Valley, as well as people from the Mediterranean and elsewhere.

Africans could transfer the skills of blacksmithing to Americans because these skills were ancient in Africa. However, some skills were not transferred into Diaspora, such as the ability to work in other metals, including bronze and silver. Africans, many from today Ghana, constructed all the buildings in the colonial town Newport, Rhode Island, as they did in Kingston, Jamaica, and elsewhere.

Many advances in metallurgy and tool making were made across the entirety of ancient Africa. These include steam engines, metal chisels and saws, copper and iron tools and weapons, nails, glue, carbon steel and bronze weapons and art.

Advances in Tanzania, Rwanda and Uganda between 1,500 and 2,000 years ago surpassed those of Europeans then and were astonishing to Europeans when they learned of them. Ancient Tanzanian furnaces could reach 1,800°C which is 200 to 400°C warmer than those of the Romans.

In engineering and architecture, various past African societies created sophisticated built environments. These include the engineering feats of the Egyptians like the bafflingly raised obelisks and the more than 80 pyramids. The largest of the pyramids covers 13 acres and is made of 2.25 million blocks of stone.



Fig. 2: Egyptian pyramid

Later, in the 12th century and much farther south, there were hundreds of great cities in Zimbabwe and Mozambique. There, massive stone complexes were the hubs of cities. One included a 250-meter-long, 15,000-ton curved granite wall. The cities featured huge castlelike compounds with numerous rooms for specific tasks, such as iron-smithing. In the 13th century, the empire of Mali boasted impressive

cities, including Timbuktu, with grand palaces, mosques and universities.

Egypt's earliest known boat goes back to 5000 years. Early Egyptians knew how to assemble planks of wood into a ship hull as early as 3000 BC. Enemy vessels were to be "gripped" and boarded for hand-to-hand fighting. This negated initially superior Carthaginian seamanship and ships. The general believe by most people is that Europeans were the first to sail boats to the Americas. However, several lines of historical evidence suggest that ancient Africans sailed to South America and Asia hundreds of years before Europeans. Thousands of miles of waterways across Africa were trade routes and many ancient societies in Africa built a variety of boats, including small reed-based vessels, sailboats and grand structures with many cabins and cooking facilities. The Malians and Songhai built boats 100 feet long and 13 feet wide that could carry up to 80 tons.

Agriculture, including animal husbandry, evolved independently in Africa, which in a real sense was not only the origin of all people but also the cradle of food production, crop specialisation and experimentation in systems of agriculture and transhumance livestock management. These great advances in the technology and agricultural production demonstrate the contribution of Africa in the evolution of the ancient world into the modern world.

The first instances of domestication of plants for agricultural purposes in Africa occurred in the Sahel region c. 5000 BC, when sorghum and African rice (*Oryza glaberrima*) began to be cultivated. Around this time, and in the same region, the small Guinea fowl was domesticated. Other African domesticated plants were oil palm, raffia palm, black-eyed peas, groundnuts, and kola nuts. African method of cultivating rice was used in North Carolina introduced by enslaved Africans. African rice cultivation was a factor in the prosperity of the North Carolina colony. Yam was domesticated 8000 years BC in West Africa. Between 7000 and 5000 BC, pearl millet, gourds, watermelons, and beans, and farming and herding practices were spread westward across the southern Sahara

Africans played an important role in the development of the commercial rice industry in colonial South Carolina and Georgia. Enslaved labourers of the South Carolina rice plantations were skilled. Throughout the 18th century, planters placed a positive value on slaves brought from rice-growing regions, which is revealed in newspaper advertisements by South Carolina planters searching for runaway slaves.

An examination of the textile industry in West Africa demonstrates indigenous innovation and development. This is clearly seen in the development of indigo dyeing, including the development of dye pits using locally produced cement. Also, the production of indigo for industrial purposes spread to the Americans via the African Diaspora. Similarly, cotton production was also developed in the Americas, and especially in the United States in the 19th Century.

Salt were scarce in Africa before the 12th century. Salt was found in scattered deposits, mostly in the Sahara and in the desert area near the Red Sea but also released through rine springs in widely scattered locations. Salt was also extracted from sea water through evaporation. The most sophisticated production of salt developed in the Central Sudan and particularly in the area dominated by the State of Borno, and its predecessor, Kanem, in the basis of Lake Chad.

In medicine, Utsua, (2015) has remarked that, many treatments we use today were employed by several ancient peoples throughout Africa. Before the European invasion of Africa, medicine in what is now Egypt, Nigeria, South Africa and Ghana, were more advanced than medicine in Europe. He noted that, some of these practices were the use of plants with salicylic acid for pain (as in aspirin), kaolin for diarrhoea (as in Kaopectate), and extracts that were confirmed in the 20th century to kill Gram positive bacteria. Other plants used had anticancer properties, caused abortion and treated malaria and these have been shown to be as effective as many modern-day Western treatments. Furthermore, Africans discovered ouabain, capsicum, physostigmine and reserpine. According to Filer (1996), medical procedures performed in ancient Africa before they were performed in Europe include vaccination, autopsy, limb traction and broken bone setting, bullet removal, brain surgery, skin grafting, filling of dental cavities, installation of false teeth, what is now known as Caesarean section, anaesthesia and tissue cauterization. In addition, African cultures preformed surgeries under antiseptic conditions universally when this concept was only emerging in Europe.

Around 800, the first psychiatric hospital and insane asylum in Egypt was built by Muslim physicians in Cairo. In 1285, the largest hospital of the Middle Age and pre-modern era was built in Cairo, Egypt, by Sultan Qalaun al-Mansur. Treatment was given for free to patients of all backgrounds, regardless of gender, ethnicity or income. Tetracycline was being used by Nubians, based on bone remains between 350 AD and 550 AD

It is on record that, in 295 BC, the Library of Alexandria was founded in Egypt. It was considered the largest library in the classical world. Al-

Azhar University, founded in 970~972 as a madrasa, is the chief centre of Arabic literature and Sunni Islamic learning in the world.

Three philosophical schools in Mali existed during the country's "golden age" from the 12th to the 16th centuries: University of Sankore, Sidi Yahya University, and Djinguereber University.

By the end of Mansa Musa's reign in Mali, the Sankoré University had been converted into a fully staffed University with the largest collections of books in Africa since the Library of Alexandria. The Sankoré University was capable of housing 25,000 students and had one of the largest libraries in the world with between 400,000 and 700,000 manuscripts.

A stone circle located in the Nabta Playa basin may be one of the world's oldest known archeoastronomical devices. Built by the ancient Nubians about 4800 BCE, the device may have approximately marked the summer solstice.

Self-Assessment Exercise 2

Discuss the contribution of Africa to the development of agriculture

5.4 Summary

The exploration of technological innovation demonstrates the dimensions of African contribution to scientific discovery.

In this unit you have been exposed you to African contribution to science, technology and development. African transfer of skill was based on labour under slavery and exploitation. The African contributions of science and technology can be appreciated with respect to the impact on the development of the Americans.

5.5 References/Further Readings/Web Resources

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5.6 Possible Answers to Self-Assessment Exercise(s) within the content

SAE1

Ivory has been desired since antiquity because its relative softness made it easy to carve into intricate decorative items for the very wealthy. During the days of the Roman Empire, the ivory exported from Africa largely came from North African elephants. These elephants were also used in the Roman coliseum fights and occasionally as transport in war and were hunted to extinction around the 4th century C.E. After that point, the ivory trade in Africa declined for several centuries.

SAE 2

Agriculture, including animal husbandry, evolved independently in Africa, which in a real sense was not only the origin of all people but also the cradle of food production, crop specialisation and experimentation in systems of agriculture and transhumance livestock management. These great advances in the technology and agricultural production demonstrate the contribution of Africa in the evolution of the ancient world into the modern world.

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