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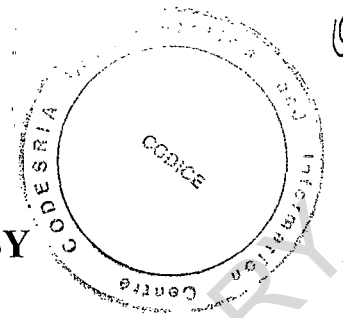
NSUKKA.

Effects on an Ethnoscience-based Instructional Package on Students Conception of Scientific Phenomena and Attitude to Science

NOVEMBER, 1998

EFFECTS OF AN ETHNOSCIENCE-BASED INSTRUCTIONAL PACKAGE ON STUDENTS' CONCEPTION OF SCIENTIFIC PHENOMENA AND ATTITUDE TO SCIENCE.



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BEING

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CERTIFICATION

ABONYI OKECHUKWU SUNDAY, A Postgraduate doctoral Student of the Subdepartment of Science Education of the University of Nigeria with Registration number PG/Ph.D/95/21741 has satisfactorily completed the requirements for the degree of Doctor of Philosophy in Measurement and Evaluation.

The work embodied in this thesis is original and has not been submitted in part or full for any other Diploma or degree of this or any other University.

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APPROVAL PAGE

This thesis has been approved for the Department of Education, University of Nigeria, Nsukka.

By

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DEDICATION

This work is dedicated to my mother Nwele, my wife Clara and my children: Okey, Chinasa and Ngozi.

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I am very grateful to the almighty God whose gift of knowledge, courage, good health and wisdom made it possible for this study to be concluded.

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ABSTRACT

This study was designed to investigate the effects of an ethnoscience-based instructional package on students conception of scientific phenomena and attitude to Science. The study employed a non equivalent control group quasi-experimental design. The sample for this study comprised of two hundred and forty three J.S.III students. The study was conducted in six secondary schools (2 boys, 2 girls and 2 co-educational). The schools were drawn through a stratified random sampling. In each school one intact class was drawn for the study through a simple random sampling. Out of the six schools three schools (one male, one female and one co-educational) were assigned to the treatment group while the remaining three schools were assigned to the control group. The treatment group was taught science using the ethnoscience based package while the control group was taught science using the conventional approach. Five research questions and three hypotheses guided the study. A Conception of Scientific Phenomenon Test and Attitude to Science Scale were used to collect data on conception and attitude respectively. The data on Conception of Scientific Phenomenon were analyzed qualitatively using categorizing and typologies. Data on Attitudes to science were analyzed quantitatively using mean, standard deviation and analysis of Co-variance (ANCOVA). The result revealed that the ethnoscience based Instructional package is superior to the conventional approach in facilitating modern science concept formation in learners, that the ethnoscience-based package has no differential impact on concept formation among males and females and that the ethnoscience based Instructional package is more effective than the conventional package in fostering attitude to science. The study also revealed that although with the ethnoscience based instructional package females showed higher attitude than males, the difference in the mean attitude of males and females taught science using the package is not statistically significant. There was no significant interaction between gender and instructional method on students attitude to science. The researcher, therefore, recommended that ethnoscience based instructional package be adopted in our school system and that teachers be trained on the proper use of the package. This study, therefore, calls for an urgent curriculum review to reflect the African culture and environment.

CHAPTER ONE

INTRODUCTION

Background of the Study

Glick (1986:273) defined ethnoscience as "the knowledge that is indigenous to a particular language and culture". Perceived from the same dimension, Ogunbunmi and Olaitan (1988) conceived ethnoscience as the study which approximates or reflects the natives' own thinking about how their physical world is to be classified. The views of Ogunbunmi and Olaitan are in consonance with the initial views of Obioha and Akimade (1984) that science as a discipline is not only a body of systematic knowledge, a method, a process, a product or a way of investigation but also a way of thinking. According to Sturtevant(1984) a vital point which an ethnoscientist should never lose sight of is the natives' point of view, his relation to life, to realize his vision of the world.

Science, generally, is an institution in which a community of people work and are bound together by certain social organizing relations to carry out certain tasks in society (Tindimubona 1993). Tindimubona (1993) shared the same view with Bernal (1992) that science is one of the most powerful sources of ideas moulding beliefs and attitudes to the universe and society and indeed man's whole pattern of thought, culture and politics. Both of them believe that science is the tool with which man learns about his environment, its resources and problems and how to control and utilize them both productively and sustainably.

Owing to the indispensability of science in national development, much emphasis has been placed on science instruction at all levels of the Nigeria's educational system. A great deal of literature exists concerning the status and plight of science education in Africa (Anderson 1974; Ohuche 1987; Fafunwa 1990). The lack of academic success in the educational acculturation process has long been a perplexing and frustrating problem to educators dealing with science education in Africa. Approaches to education that relate

to the cultural heritage, the environment, and the life style of the Africans have been considered vital and necessary by the emerging African leadership (Atwater 1993). One of such approaches to culture-related education in the areas of science is ethnoscience. The ethnoscience of the Africans refers to the materials, ideas, and beliefs from the African environment and technology. These are derived from the past and present cultural traditions of the people which in turn evolved from myth, supernatural, popular and mystical realities and beliefs as well as from an ongoing acculturation process.

Current studies on methods of science instruction in Africa have revealed that the existing instructional approaches are highly particularistic, hopelessly biased and guilty, not only of perpetuating a lack of understanding regarding indigenous fields of knowledge and cognition but also wrecking outright harm on them (Oppenheimer, 1983; Ajikobi and Bello, 1991; Atwater, 1993; Selin, 1993; Tindimubona, 1993). The current instructional approaches seem to have contributed to poor concept formation and attitude among beginners to science. This trend in concept formation and attitude is carried along as students progress in science (Fafunwa 1983). Adesoji and Akpan (1991; 70) already noted that science taught in Nigeria and Africa generally make us academic foreigners in our own country". They made reference to the handbook of Science Education Programme for Africa (SEPA) as saying that a tragedy of science education in Africa which children and adult have shared is that it has not always paid attention to the culture of the Africans both in methods and materials.

Fafunwa (1983:20) understood the dilemma quite well when he said that "the African Society today is in an ambivalent position and so is the child from this environment". He explained that between the ages of o and 5, the African children are wholly brought up in a traditional African environment. He further observed that as those children reach the primary school age they enter another educational system quite different and strange to the one they were brought up in and are already accustomed to,

that is, they grew up with certain cognitive (learning) style and suddenly found themselves in another environment with an entirely different approach". On the implications of such estrangement, Fafunwa (1983:20) wrote:

> The fact of the matter, however, is that the child's cognitive equilibrium has been disturbed and this abnormal situation (the deep gulf between traditional non-formal African system of education and the formal, Western oriented system of education) tends to retard the cognitive process in terms of the anticipated outcomes of the Western form of education.

Any assumption that an African child could be easily adjusted to such a dramatic change without creating a suitable link is bound to fail. For the child to accept and adapt to a new field of knowledge, the gap between him - his culture and the new field of knowledge has to be bridged.

Science, according to Oppenheimer (1983), starts with preconception, with the culture and with the common sense. The conceptualist view of science treats science as a quality in its own right. Kneller (1990) addressing the conceptualist view of science stressed that a child should construct the pictures of his environment in the light of his own experience provided that he finally reaches the objective picture of the universe. Kneller further emphasized that human nature and the general perception of the environment is relative to time and place. The prime virtues, then of any educational system, especially of those that must meet the unprecedented rate of change in modern industrial society, are flexibility and willingness to experiment. In his conception of reality, Spinder (1983) noted that even modern adults owe less to their direct experience and more to the experience of their culture.

The realization of the need for a culture based science curriculum and instruction capable of facilitating conception of scientific phenomena, science skill acquisition, and attitude to science started after the independence of some African States. This culminated in the Adis Ababa 1961; Tananarive 1962; and Lagos 1964 conferences, all channelled

toward the inculcation of indigenous elements in our science curriculum (Eshiet, 1991). Ohuche (1987:1) also explained that the plea made by Rev. Caulker at the Rehovoth conference in 1960 that "attention be paid to science and technology as instrument for development in Africa" necessitated the formation of numerous educational programmes meant for promoting science and technology in Africa. These programmes include African Primary Science Programme (APSP), which in 1970 grew into a bigger programme under African management known by the name Science Education Programme for Africa (SEPA). The Science Teacher Association of Nigeria (STAN) also emerged to face the challenges of building a virile science education programme for the country. The association also saw the need for a science education system that adds a cultural dimension to science education in Nigeria. In realization of this objective, their integrated science core curriculum is of the "thematic format, built around the theme: you and your environment" (Asun 1983:132).

Although efforts are geared toward the infusion/injection of indigenous elements in our curriculum, science concept formation, achievement and attitude to science continues to dwindle among secondary school students (Eze 1995; Soyibo 1991; Odunusi 1984). These efforts were geared towards improvisation and use of mother tongue in science instruction. Fafunwa's mother tongue approach to science instruction was built on the assumption that "meanings are found to be intimately connected with the linguistic" (Percival,1966). According to Percival (1966) if these modes of representing ideas are meanings and if meanings are psychological entities (as semantic theorists thought at that time), then it follows that speakers of different languages convey different meanings even when they are referring to same objective state of affairs in so far as the grammatical structures of the language they speak differs from one another. But that is not the case. Western model transmitted in Igbo, Yoruba, Hausa or whichever language is still western and completely alien. Also improvised materials patterned after western

models have been shown to function like their western counterparts and not necessarily an indigenized model (Balogun,1982).

The inadequacy of these two models (improvisation and mother tongue instruction) in achieving indigenized science instruction for Africa and also in establishing a culture-based science education capable of resolving the initial conceptual conflicts in African beginners in science which emanates from the spiralling differentials in European vis-a-vis African culture tends to generate some academic debates:

(a) What is an indigenized science instruction?

(b) What could be the most appropriate model for indigenization of science instruction?

Perchonock and Werner (1979:230) earlier noted that ethnoscience provides a useful way of systematizing certain aspects of anthropological data concerned with the problems of world view. Its relevance to education and social growth cannot be over emphasized and moreover it can serve as a Bridge through which children from varying cultural backgrounds cross over to our modern conventional science. Anthropologists (Berhim,1978; Bronowski 1990; and Douglas 1991) have suggested that the poor attitude to science, difficulty in science concept formation and low achievement in the conventional science among the third world pupils, especially the 'Blacks' is as a result of the wide gap that exists between their culture and the new field of knowledge. They believe that the non inter-penetration of our ethnoscientific thoughts into the western scientific practices may likely account for the difficulties encountered in mastery of scientific skills among our students. These anthropologists likened ethnoscience to the zoological Onychopora (an invertebrate whose recent discovery relieved evolutional scientists of the problem of establishing a link between Annelids and Arthropods).

Emphasizing the indispensability of an ethnoscience based instructional model as an alternative model for science instruction in Africa, Salio-Bao (1989:71) quoted Fanon's

argument that:

> If we wish to reply to the expectations of the people of Europe, it is no good sending them back a reflection, even an ideal reflection of their society and their thought with which from time to time they feel immeasurably sickened. For Europe, for Africa, for ourselves and humanity, comrades, we must turn a new leaf, we must work out a new concept and try to set afoot a new man.

This implies an urgent need to develop an instructional model that suits African culture and background - a model that recognizes the fact that an African child has come to western science classes with a substantially solid and often supernaturally reinforced view of his universe which cannot be simply dismissed with a wave of hand. Since ethnoscience-based instructional package has not been widely emphasized in our school system, the realization of a conflict free science instruction in Africa will depend on the extent to which such a package can prove its competence in ensuring effective conception of scientific phenomena and sound attitude to science. Boulding (1980), and Osia (1987) assumed that the introduction and infusion of the pupils' culture into the science curriculum and proper utilization of ethnoscientific concepts and paradigms during instructional process may facilitate conception and improve attitude science. Another interesting issue of academic debate is the issue of gender in indigenized science instruction. Owing to the esoteric nature of native science and conception, it has been argued that indigenized model may likely generate a bias in conception and attitude among male and female science students (Davidson, 1987; Hills, 1984; Spinder, 1983). In fact, the infusion of ethnoscientific concepts, theories and paradigms into the conventional science teaching may have an implication which is worth exploring.

Statement of the Problem

In Nigerian Secondary Schools, students' enrolment in science has not been quite appreciable. This situation coupled with poor formation of science concepts among

students (Eze, 1995) poor attitude to science (Achimugu,1995), and overall poor academic achievement of secondary school students in science raise doubts on the efficacy of the existing instructional approaches in science. In fact, the current approaches to science instruction in Nigeria have been criticized as hopeless and incapable of bridging the chasm between the initial background of the learners and the new field of knowledge (Fafunwa 1983). The current instructional models have been accused of estrangement and lacking in indigenized approaches (Adesoji and Akpan, 1991).

Although efforts at indigenizing science instruction have been made through improvised local instructional materials (Achimugu 1995) and use of mother tongue in science instruction (Fafunwa,1990) the status of science education in our secondary schools in terms of science concept development and attitude to science continues to dwindle (Balogun 1985; Salio-Bao 1989). Current emphasis in science instruction were geared toward indigenous knowledge system (Warren 1995). There are, however, widespread speculations that the introduction of ethnoscientific concepts, theories, and paradigms into the science curriculum and instruction may bridge the gulf between the culture of the learner and modern science (Ajikobi and Bello, 1991; Fafunwa, 1983; Oppenheimer, 1983). A contradictory view, however, was shared by some anthropological scientists (Adegbite, 1953; Levy-Bruhl and Clare, 1992). They argue that indigenous knowledge are primitive and therefore capable of generating more conflicts in learners when they are incorporated into science instruction. They believe that cultural knowledge has no relationship with advanced scientific knowledge and therefore unnecessary in science instruction. These speculations are, however, not backed up by any empirical evidence in which case, therefore, the exact role or implication of the infusion of ethnoscientific concepts, theories and paradigms into science instruction on pupil's attitude to science and conception of scientific phenomena is still in doubt. A

major issue of academic concern at this point is: what would be the effect of an ethnoscience-based instructional model on pupil's conception of scientific phenomena and attitude to science science?. This study, therefore, was faced with a problem of evaluating an ethnoscience-based instructional package in relation to conception of scientific phenomena and attitude to science

Purpose of the Study

The purpose of this study was to explore empirically the effects of an ethnoscience-based instructional package on students' conception of scientific phenomena and attitude to science. This study specifically:

(1) developed an Ethnoscience-based instructional package;

(2) explored the effects of the ethnoscience-based instructional package on pupils' conception of scientific phenomena;

(3) verified the effects of an ethnoscience based instructional package on pupil's attitude to science;

(4) assessed the response of males and females to the ethnoscience based instructional package in terms of attitude to science and conception of scientific phenomena.

Significance of the Study

The urge to develop a virile instructional approach capable of resolving the cognitive conflicts introduced in the minds of beginners in science as a result of differences between their cultural background and the new field of knowledge (modern science) triggered the need for this study. Fafunwa (1983) observed earlier that the failure of the current approach to science instruction to incorporate indigenous concepts and paradigms has led to numerous forms of conflicts in science conception, cognition and attitude. He emphasized that if science instruction is to improve and achievement in science is to be enhanced, the differences between the cultural background of the learners

and modern scientific concepts must be bridged. He introduced science instruction in mother tongue which was then understood as adding cultural dimension to science instruction. This approach, however, was unable to achieve the desired objectives of indigenized science instruction. Ethnoscience has been suggested as a better and a more functional approach to indigenization of science instruction (Atwater, 1993; Selin 1993). In view of this speculation, and the urgent need to revolutionalize science instruction in our educational system, it has become explicitly urgent to explore the efficacy of an ethnoscience based instructional package on students' conception of scientific phenomena and attitude to science. This will provide a basis for decision on the best instructional model to be adopted in our educational system.

The findings of the study has a lot of significance for science instruction in Africa. The study explored the extent to which ethnoscience can serve as a basis for construction of reality by linking culture with advanced scientific knowledge. As such, this study may likely trigger a powerful revolution that might usher in a radical dimension in curriculum innovation. This study has provided information on the extent to which an ethnoscience-based instructional package can facilitate conception of scientific phenomena and attitude to science. This will inform the policy makers of the education ministry and curriculum developers on the need for an ethnoscience-based curriculum and instruction and as such assist in deciding on whether to revert to culturally-based model or not. There may, therefore, be a need to review the current science curriculum so as to incorporate basic ethnoscientific concepts, theories and paradigms into the science curriculum.

This study also have some significance for teaching male and female science students. Some ethnoscientific concepts, theories and paradigms are esoteric in nature. Owing to their esoteric nature, male and females are not allowed equal access to their mastery. This, however, depends on the culture of the society. This study revealed the

responses of males and females to the instructional application of ethnoscientific concepts, theories and paradigms during science instruction and learning. The result of this study will help in deciding on whether to separate instructional techniques for male and female science students.

This study also created a general awareness on the efficacy of indigenous model in fostering cognitive re-orientation in children. That is to say that the study explored the extent to which the differences and disagreements in European vis-a-vis African culture and conception can be resolved by an ethnoscience based instruction. This study, therefore, creates a link or a bridge across the chasm between the African child and the western oriented science without generating any form of cognitive disequilibrium.

Scope of the Study

This study was limited to Nsukka Education zone of Enugu State. This was to ensure that the students used for the study share a common environment. The other reason is for the researcher's convenience - to enable the researcher a fair opportunity to monitor and supervise the experiment very regularly. The study was also restricted to integrated science. The reason is because Integrated Science is a fundamental course in science and it is in Integrated Science that concepts necessary for specialist studies in all sciences are studied. Since concepts in Integrated Science cut across all sciences, choice of Integrated Science for this study was made.

In terms of content coverage, the researcher selected content from Integrated Science core curriculum of the Federal Ministry of Education for J.S III. The selection of the content was based on the result of the pre-pilot survey of pupil's conception of scientific phenomena. The topics are those that the students exhibited strong culturally based concepts.

The topics are :

(a) Food storage

(b) Health

(c) Continuity of the family

(d) Man in space

(e) Controlling the weather

Research Questions

The following research questions guided the study:

1. What is the effect of the ethnoscience-based instructional package on students' conception of scientific phenomena?

2. What is the effect of the ethnoscience-based instructional package on conception of scientific phenomena among male and female students?.

3 What is the effect of the ethnoscience-based instructional package on students' attitude to science?

4. What is the effect of the ethnoscience based instructional package on the attitude to male and female students in science?.

5. What is the interactive effect of gender and instructional approach on students' attitude to science?.

Hypotheses

The following null hypotheses were formulated and tested at an alpha level of 0.05:

HO_1: There will be no significant difference in the mean attitude scores of students taught science using the ethnoscience-based instructional package and those taught science using the conventional package.

HO_2: There will be no significant difference in the mean attitude scores of male and females taught science using the ethnoscience-based instructional package.

HO_3: The interactive effects of gender and instructional approach on students' attitude in science will not be significant as measured by the Attitude to Science Scale (ASS).

CHAPTER TWO

REVIEW OF LITERATURE

This chapter presents a review of literature that relates to ethnoscience, attitudes in science, conception of phenomena and program evaluation. The literature were reviewed under two broad headings:

(1) Theoretical framework
(2) Empirical studies
(3) Summary

1. Theoretical framework

Literature reviewed under the theoretical framework include.

(a) Concept of Ethnoscience
(b) Scope of Ethnoscience
(c) Rationale for Ethnoscience
(d) Ethnoscientific versus western scientific paradigms
(e) Religion and Esoterism in Ethnoscientific studies
(f) Contribution of Ancient indigenous Africans to conventional sciences.
(g) Concept formation; An overview
(h) Theories of concept formation and learning
(i) Conceptions of scientific phenomena
(j) Attitude to in science
(k) Program Evaluation; An overview
(l) Models of program Evaluation

2. Empirical Studies

Literature reviewed under the empirical studies include:

(a) Empirical studies on ethnoscience
(b) Empirical studies on concept and concept development
(c) Empirical studies on attitude and attitude to sciences

Concepts of Ethnoscience

Ethnoscience has been perceived from an array of perspectives. It has been

perceived in relation to the folk systems (Roberts, 1990; Perchonock and Werner, 1969; Sarles, 1960); cultural classificatory system (Hunter and Whitter, 1990); culturally related perception of the physical world (Ogunbunmi and Olaitan, 1988) and folk medical systems (Ohaeri, 1988; Moerman, 1979; Ajose, 1957).

Perchonock and Werner perceived ethnoscience as the science which focuses on the discovery and description of the folk systems. According to them ethnoscience is concerned solely with classificatory principles as they are expressed by native speakers of the language, not as they are determined through anthropological observations. The issue of limiting the scope of ethnoscience to language has been very popular in recent research studies (Eshiet, 1991; Madu, 1991; Fafunwa,1983; and Jennifer,1972). Most of these researchers believe that ethnoscience simply means the expression of scientific facts in indigenous language or native language. In often cases they believe that the use of foreign language in conveying scientific facts is a complete deviation from ethnoscientific principles. Jennifer (1972) is one of the researchers that misconstrued ethnoscience as a set of linguistic techniques that attempt to discover through the elicitation of lexemes meaningful descriptions and classifications within the language of a particular culture. This misinterpretation was linked to Whorf's (1989 : 5) hypothesis which states that "all observers are not led by the same physical evidence to the same picture of the universe, unless their language and cultural background are similar or can in some ways be calibrated". Eshiet (1991) and his colleagues did not realize that although Whorf tied perception of the physical universe to language structure he was very explicit in stressing the role of culture in science. His acknowledgement of cultural background as a major factor in shaping perception of members of a particular society cannot be overemphasized.

Ethnoscience, according to Sarles (1966) is concerned with the set of concepts about the nature of a specified cultural universe which is shared by members of that

culture. Hunter and Whitter (1990) who focused mainly on taxonomies thought that the chief concern of ethnoscience so far has been the enumeration of what have been called the "folk taxonomies " which are models of analysis whose purpose is the description of particular types of hierarchical relationships between members of a given set of elements. Hunter and Whitter defined ethnoscience as the study of classification of physical system used by societies which includes such subdivisions as ethnobotany and ethnozoology. They stressed that ethnoscience also involves the study of the ranges of meaning attached to specific terms and classes or terms by members of a group. Hunter and his colleagues who sometimes used ethnoscience as a synonym for ethnosemantics failed to realize the inherent fact that ethnoscience does not restrict itself only to the use of language in the construction of reality. The idea that ethnoscience involves simple classification and taxonomies employed by different societies limits its scope and reduces it to mere folklore.

A more embracing view of ethnoscience was presented by Ogunbunmi and Olaitan (1988). They believe that the best definition of ethnoscience is that study which approximates or reflects the natives own thinking about how their physical world is to be classified, consciously or unconsciously, explicitly or implicitly, within the framework they accordingly act. They believe that classification into types is a discovery of combinations of attributes favoured by the makers of the artifacts, not an arbitrary procedure of the classifier. This classification system is believed to be non-artificial but corresponds to mental templates and folk classifications of the people. The views of Ogunbunmi and his colleagues are more embracing because they incorporate the totality of people's ideas and belief system which are part and parcels of the individuals in that particular society. In fact ethnoscientific analysis seeks to analyze culture (or part of it) in such a way that the resulting description would be comparable to a grammar which enables an investigator to learn to speak a language. Viewed from all perspective

it refers to knowledge that is indigenous to a particular culture and is concerned with natural objects and events so that it may have potentially the same branches as the Western science, in which case therefore, one may speak of ethnochemistry, ethnophysics, ethnobiology and so on. It will be evident, however, that the subject matter of research is not environmental phenomena as such but people's knowledge and interpretation of these phenomena. The purpose of research in ethnoscience, therefore, is to learn how people perceive, interpret and order their natural environment and how such perception influence their further learning and accumulation of modern scientific facts.

Ezeagbasili (1977) viewed ethnoscience from an African perspective. From an African perspective he used Africa science as a synonym for ethnoscience, and defined it as ' African account of nature and how it works' . According to him testing ground of all science (ethno or conventional) is utility. In this case, therefore, the utility can be measured in terms of the extent to which this indigenous knowledge provide a medium for further accumulation of scientific and technical knowledge within the immediate society. It should, therefore, be consistent with the essentials of its people's "common sense". Ethnoscience, so far concentrates on how people construe their world of experience from the way they talk about it. According to Sturtevant (1984) a vital point of which an ethnoscientist should never lose sight is the native's point of view, his relation to life, to realise his vision of the world.

Scope of Ethnoscience

Anthropologists have revealed the scope of ethnoscience to include such area as folk classification system or ethnotaxonomy (Perchonck and Werner, 1969; Seymour-smith, 1986; Turner, 1988; Glick, 1984; Berhim, Bredlove and Raven, 1973), Ethnomedical practices (Ohaeri, 1988; Moerman, 1979; Foster and Anderson, 1993

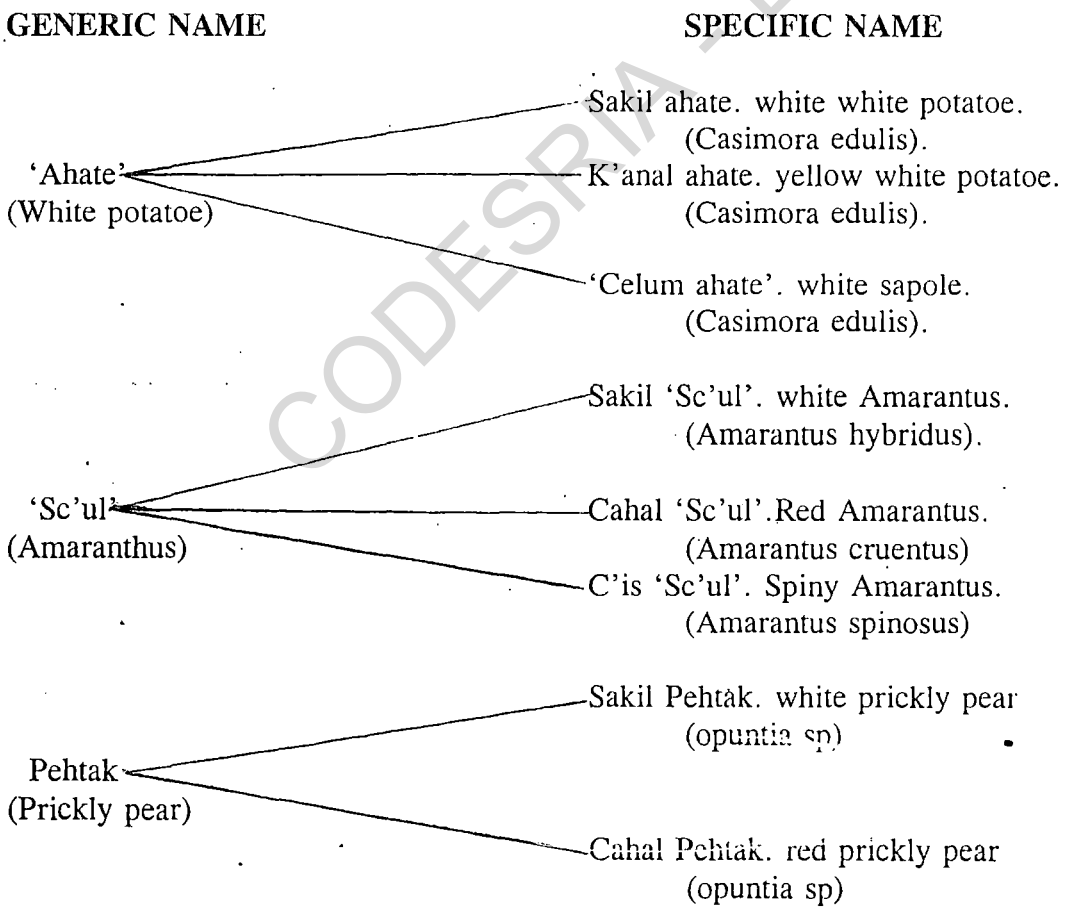
Maclean, 1966; Ajose, 1957), ethnomathematics (Seymour-smith, 1986) colour perception and interpretation (Evans, 1990; Cassirer, 1989) and ethnophysics (Ogunbunmi and Olaitan, 1988).

Ethnobiology according to Turner (1988) and Gal (1973) attempts to discover and compare the classification systems used by different groups of people to categorize their natural environment. According to Gal, it uses the methods of ethnographic semantics, along with collecting procedure of field biology, to discover native categories of plants and animals as well as native system of naming things. Berlin (1988) used folk taxonomy as a synonym for ethnotaxonomy and defined it as 'a system of monolexically labelled folk aggregates related by hierarchial inclusion . Seymour-smith (1986) subdivided ethnobiology into ethnobotany, ethnozoology and ethnoecology. According to him ethnobotany is a part of ethnoscience or ethnotaxonomy which studies the way in which a given human group classifies the botanical resources within its environment. This embraces the study of plants and the importance of plant classification in cosmological and mystic systems. On the other hand he defined ethnoecology as the study of indigenous knowledge of the ecological resources and their exploitations.

Glick (1984) studied the ethnoclassification system of the Gimi people of New Guinea. Both in their botanical an zoological classifications, they recognized morphological types and ecology as a vital factor in the classification of organisms. Most of the morphological and ecological features are also applied in modern classification model. In Gimi classification models, other factors like descent and metamorphosis was applied in classification of birds. To the Gimi of New Guinea, parentage and mothering is a continually renewing relationship in which one kind of bird arises solely and repeatedly from eggs laid by another. The 'fetote', a small brightly coloured bird, is an example. It develops exclusively from eggs laid by a bird called 'feretori' (Glick, 1984). Also the dark-feathered bird called 'ariola' lays exceptionally large eggs said to hatch

into a variety of other birds, but there is a disagreement on how many such possible offsprings they are. Some people know of only two or three, others cite a dozen (Glick, 1984). In contrast to 'fetote', these birds are at the same time able to reproduce their own kinds. All these features were employed by the Gimi people in their ethnoclassificatory model of birds.

Another interesting case of the ethnosystematics was noted in Tzeltal plant systematics, where the general nomenclature rule in specific name formation is to modify the generic name involved with a single expression. The resulting form is logically comparable to the linean binomial (Berlin, Breadlove and Ravin, 1973). Example of Tzetal ethnosystematic model is shown in the chart below as represented by Berlin and his colleagues.



A close examination of this Tzeltal ethnoclassificatory pattern reveals that the domain as a whole corresponds very closely with the botanically defined plant divisions of Western science.

According to Seymour-smith (1986) ethnobotanical studies reveal complexity and scientific nature of indigenous botanical classifications. He noted that in the Amazon basin rain forest, native people possesses botanical classifications more detailed than those of modern Western science, often distinguishing several different species where existing Western taxonomy recognizes only one. Also in Ethnoecology, ecological studies (Sturtevant, 1984) have shown that indigenous ecological knowledge is often complex and advanced, as for example in the case of Amazon basin rain forest environment where traditional systems of Swidden Agriculture have maintained intact the rain forest ecosystem for thousands of years, in sharp contrast to the devastating effects of non-native incursions into the same environment. Davidson (1987) also reported an interesting ethnobotanical systematics among the Dogons of Mali. Davidson stressed that to the greatest surprise of Linnaeaus, who is assumed to be the father of plant nomenclature, these Dogon priests had already classified the plants they know into twenty-two chief families of which some were further subdivided into as many as eleven subfamilies and numerous orders and species. The exact correspondence of the Dogon taxonomy with the Western pattern is a source of great concern to botanists. According to Davidson, the criteria employed by these ancient priests in the successful classification of these plants surprised Linnaeus.

The scope of ethnoscience also extends to ethnomedicine which involves the study of indigenous or popular healing practices and of belief, attitudes and strategies regarding health and diseases Ohaeri (1988). The term is also sometimes used as medical anthropology and this refers to the primacy of folk categories and interpretations in the study of health and diseases. Ethnoscience, according to Moerman (1979) extends to

ethnophamacology which involves the classification and use of medicinal plants in indigenous or popular culture, involving elements of ethnobotanical and ethnomedical methods; and ethnopsychiatry which relates to the study or conception of mental illness, in cross cultural perspective, including the study of the definition, classification and treatment of mentally ill persons in different cultural context.

Moerman (1979) stressed that the idea that one person can heal another is widespread, perhaps universal. It is an anthropological common place that Shamanism, not prostitution is the first profession and an interesting aspect of this is the ethnoscientific conception that song and dance are more vital portion of the healing process than drug (Foster and Anderson, 1993; Moerman, 1979). Ethnomedicine, according to Moerman, conceive healings as ritual process likened to a spiritual osmosis in which the evil in man and the good of deity penetrates the ceremonial membrane in both directions, the former being neutralized by the latter. Foster and Anderson (1993) explained that ethnomedicine embraces the health practices of the people and the associated belief system. This includes the health, belief, value, skills, and practices of the indigenous people, including all clinical and nonclinical practices, institutions and other activities that relate to health needs of the people.

Studies in ethnomedical health systems as systems of thought casualty and taxonomy reveals a complex belief system and the utilization of cultural knowledge in curing of diseases. In Yoruba culture, a background of Orisha worship, of faith in divination and belief in witchcraft and in the power of evil witches persist in spite of protestations of a new allegiances by both Moslem and Christians (Maclean, 1966). As Maclean rightfully puts it, 'an essential dichotomy or ambivalence prevails and it requires only the advent of illness or misfortune to cause people to resort to remedies in which their ancestors have found comfort since time immemorial .

In Yoruba ethnomedicine, the primarily herbalists (Onishegun) and priest of the

Ifa cult (Babalawo) are well recognized. Herbalists who have tried several mixtures empirically in a case will, if the patient does not regain his health, suspect supernatural or human malevolence and have recourse to divination to indicate its source. The prescription made by the 'onishegun' and 'babalawo' according to Maclean (1966) represents a fascinating combination of empiricism and sympathetic magic drugs, which may possibly have some pharmacological action being mixed, in a strictly regulated or ritual manner with other ingredients which bear a close symbolic affinity to the organ or illness treated. On their knowledge of medicine Maclean discovered that the traditional Yoruba healers and their children were able to identify eleven different kinds of fever.

According to Ohaeri (1988) indigenous Nigerians perceive diseases in their own scientific ways. These traditional 'healer according to Ohaeri apply incantations and sacrifices as a necessary adjunct. The validity of these practices and their efficacy cannot be directly challenged, rather, they can be sufficiently motivated to give these deities an outlook that is more suited for a healthy psychological growth in their client (Ohaeri, 1988). Throughout Africa, diseases were associated with divine powers. The concept of sacred diseases, widely upheld by traditional medical scientists go a long way to support the divine causes of diseases. To support this ethnomedical practice, Ghalongui (1973) explained that modern medicine accepts the fact that healing is a complicated psychic as well as physical process and may be amenable to an approach that touches the hidden areas of the psychic beyond the reach of rational therapy.

Morris (1986) stressed that although contemporary anthropological study of ancient African medical system have indicated their pluralistic and complex nature, studies still suggest a stark contrast between folk and cosmopolitan medicine implying that ethnomedicine is primarily concerned with mystical causation.

Ethnoscience further extends its scope to personal and group hygiene. In most part of Africa, left hand is used for filthy materials or associated with filth while right hand

is for noble work and for taking food. In Igbo tradition it is often regarded an insult to offer anything with left hand. Ethnohygienic practices also extends to the beliefs in the dangers of menstruation which does not permit a menstruating woman to cook food for people's consumption. This ethnohygienic practices cannot be alienated from their traditional knowledge of microorganisms and their activities in causing diseases. Also the ethnohygienic practice of isolating people with highly infectious diseases and restricting visits to those individuals who have once suffered the diseases is another dimension of ethnoscience which manifest the traditional awareness of disease transmission and immunity.

The scope of ethnoscience further extends to ethnomathematics which involves the study of systems of numbers and of mathematical operations within a given socio-cultural context (Seymour-smith 1986). Seymour-smith explained that there are two main strands of this type of inquiry : one which explores the rituals and symbolic significance of numbers and the others which explores the relationship between the complexity of the mathematical operations and the level and type of technological development of the group. Hill (1984) noted differences across culture in children's formation of mathematical concepts. He explained that from the standpoint of teaching of sciences, culturally determined differences are of utmost significance. The initial mistake of any teacher is the false assumption that the basic behaviourial process involved in learning are the same - they differ with culture.

Another dimension of the ethnoscience is colour perception. Colour terms are a part of the vocabulary of a particular languages and only the intracultural analysis of such lexical sets and their correlates can provide the key to their understanding and range of their applicability (Evans, 1990). Evans explained that the study of the isolated and assumed translations in other languages can lead only to confusion. Requirements of specification may differ considerably from one culturally defined situation to another.

The issue of colour category tends to dispute the fact that "reality is present in much the same form to all men of sound mind" (White, 1983). Whorf (1989) suggested that each language embodies and perpetuates a particular world view. According to Whorf, the speakers of a language are partners to an agreement to see and think of the world in a certain way - not the only possible way. He emphasized that the world can be structured in many ways and the language we learn as children directs the formation of our particular structure. Whorf, still emphasizing on the role of the language in construction of reality especially in colour perception and classification asserts that language is not a cloak following the contours of thought. Language are moulds into which infants minds are poured".

Cassierer (1989) noted that the world is differently experienced and conceived in different linguistic communities and is casually related to their psychological differences. For example, Brown and Linneberg (1984) noted that in the Eskimo Lexicon there are three words, not found in English, to distinguish three varieties of snow. In English the word 'snow' is used to describe all three indicating that as a result of their (Eskimo's) language structure they were able to perceive many forms of snow not yet observed by others. If language influences perceptual discrimination, there is also the tendency that it does not only influence colour perception but general scientific discoveries. Turner (1988) also discovered something similar to those of Cassierer and Linneberg. They found that some Africans (Ndembu) developed something comparable by reflecting on common qualities of juicy elements in men and trees. Different colour saps are classified with blood and milk and bile, and from their likeness a cosmic harmony is derived. These bushmen, by reflecting on the morphology of human and animal bodies have developed what Levi-Strauss (1989) referred to as anatomical totemism.

Ethnoscience also embraces ethnophysics or general conception of the physical universe. Ogunbunmi and Olaitan, (1988) noted that in a bid to understand the world in

which they lived "the early Yorubas built up some models to express their scientific ideas, thus creating a link between their scientific and cultural backgrounds". Ogunbunmi and his colleagues agree with the ethnoscientific principles that interpretation of physical phenomena certainly depends upon the structure of the society. In most cases the interpretation of nature is closely linked with religious beliefs and cultural practices. According to Ogunbunmi and Olaitan the ethnoscientific belief is that during a rainfall, carrying of metallic objects are forbidden. The belief also discourages people from stretching their fingers into the rain. Adekogbe, in a personal interview with Ogunbumni and Olaitan discussed the model for this ethnoscientific conception. According to the report "the metal is the symbol of Ogun 'the god of iron' who was regarded to be powerful. Equally powerful was the Sango 'the god of thunder and lightning'. Obviously Sango would be furious at the sight of the bearer of the symbol of Ogun in his domain when it is raining or about to rain. As such he would use the symbol of his strength (i.e thunder and lightning) to strike down the bearer and deter other possible violators of his domain". The relevance of this ethnoscientific thought with the Western scientific principles of electrocution which accompanies rain is quite interesting. Also the ethnoscientific practice of lying flat when in a thunderstorm is regarded by ancient Yorubas as an act of worship to sango (the god of thunder and lightning) who becomes appeased and consequently spares the life of the worshipper.

On gravity, Yoruba ethnoscientific thought has it that God (called 'Olodumare' in Yoruba) once fought with a less powerful god called 'Obaluaye' at the early period of creation. As a punishment Olodumare forced 'Obaluaye' to carry the earth including everything on it, and will not allow anything to lighten the burden so that whenever the object is lifted from the earth upwards, Olodumare will force the object down on the earth so that Obaluaye's burden will never be lightened. This is why the Yorubas say that whatever goes up must return to the earth.

"Lala to r'oke ile lo nbo" (Ogunbunmi and Olaitan, 1988).

Ogunbunmi and Olaitan (1988) also reported indigenous practice of rain prediction which involves the determination of speed at which dust particles disperse when thrown upwards and also the rate at which saliva which farmers spit on the back of their hands evaporates: Through the determination of the rate of evaporation a farmer can determine the imminence of rain. Ogunbunmi and his colleague also wrote that indigenous Nigerians especially the Yoruba's also predict rainfall by dipping their hands in deep stream or river and noting the variation of temperature with depth. If the temperature is not uniform, then it may not likely rain.

Douglas (1991) noted that the Dogons of Mali divide their universe between Nommo and Yourougou. Nommo is the heavenly power who represents right, reason, society, ritual and order in all its forms. Yourougou or the pale fox is his brother, fallen from grace by an initial act of disobedience. He represented engima and disorder. Dogon, according to Douglass classify speech into twenty-four forms belonging to Nommo and twenty-four belonging to the fox. The analysis of this classification shows that the speech attributed to the fox is the obverse of the speech attributed to the Nommo. This classification system permit the Dogon a clear and concise knowledge of the universe. It should be recalled that through their classification system and the use of natural foresight, they were able to discover that a billion worlds spiralled in space like the circulation of blood within the body of God" (Sertima, 1983). Adams (1983) also explained that these ancient people of Mali; using their ethnoclassificatory system were able not only to plot the orbit of the stars circling sirius but have revealed the extra-ordinary nature of one of its companion -sirius B which even the Western astronomers know as one of the tiniest and densest of the stars in our galaxy.

Rationale for Ethnoscience

Stressing on the rationale for ethnoscience which is grounded in a cultural base, Whorf (1989 : 5) puts forward a hypothesis which asserts that "all observers are not led by the same physical evidence to the same picture of the universe, unless their linguistic and cultural background are similar or can in some way be calibrated". A concise analysis of Whorf's hypothesis informs us that there are differences across cultures in the ways by which people categorize their physical and biological world. Whorf informed us that the way an English man perceives his world differs from the way an African, Indian or German perceives the world. The Chinese alchemy arose from traditional belief shared by all Chinese thinkers that earths mature within the terrestrial womb. This thought held by all Chinese thinkers made it possible for them not only to shrank the dimensions of the universe to fit their four walls but also compressed time to make the duration of the manipulation feasible (Sivin, 1976). Through this process they were able to force ordinary metal into maturity to gold. In other words, ethnoscience permits total exploration of one's environment using the cultural background.

Furthermore, since ethnoscience deals with knowledge indigenous to a culture, it serves as a base for the construction of reality by linking culture to advanced scientific knowledge. It therefore acts as an intermediate situation between fantasy and exact knowledge or between drama and technology, by sniffing a quarry in a cave where dogs cannot penetrate so that their baying and pointing may finally call the hunter to the spot. Ethnoscience, according to Mufford (1987) gives direction to creativity and both express the inner urge of the organism and conjures up appropriate goals. It creates a background for the successful growth of knowledge in many fields of endeavour by creating a conducive atmosphere for its development. In sum Mufford (1987) posits that ethnoscience, like magic, turns men's mind to the external world : it suggests the need of manipulating it, helps create the tool for successfully achieving it and sharpens

observation as to the results. For example, the herbalists or ethnopharmacologists, zealous in their quest for samples and cure-alls, led the way for the intensive exploration of the plants of the world and their various economic issues. As Mufford rightfully noted, as children's play anticipates crudely adult life, so did ethnoscience anticipate modern science and technology.

Ethnoscience and ethnotechnology conceived as a branch of knowledge concerned with the set of concepts about the nature of a specified cultural universe enhances the creation of a symbolic structure, uniformly embracing the entire universe and enhance its proper conceptualization. The most interesting aspects of ethnoscience according to Douglas (1991) is that the intellectual unity which they confer on experience is derived from reflecting on the nature, power and effect of the language. Language as we know is a common heritage within a particular group of people and should not be too embracing to include everything in ethnoscience. Language per se, is not the only aspect of ethnoscience but a medium through which the indigenous knowledge can be brought to light, and expressed more effectively. African ethnoscientific views, concepts and paradigms can be expressed in English language, in French, Latin or German without any form of distortion. It should also be understood that Igbo as a language, Hausa or Yoruba cannot in any way represent Nigerian ethnoscience. As a medium of communication, they can be used to communicate our ethnoscientific views and practices but should not be referred to as an essential arm of ethnoscience. The central theme in ethnoscience is culture. Since ethnoscientific concepts are embedded in culture of a specified group of people, Douglas warned that beginners should not be distanced from their cultural background. Douglas is of the opinion that ethnoscience seeks to discover the social determinants of cosmology. It is the field of human knowledge which links cosmos to social structure. Since ethnoscience according to Perchonock and Werner (1979) provides a useful way of systematizing certain aspects of anthropological data

concerned with the problems of world view its relevance to education and social growth cannot be overemphasized. It serves as a bridge through which children from various cultural background crossover to our modern conventional or Western science. Fafunwa (1983) noted that as children progress from non-formal to formal education system, they encounter a conflict that arise as a result of his exposure to the new Western knowledge which differs from his cultural knowledge and ideals. He noted that elements of the child's culture is necessary in the curriculum so as to establish a link between the non-formal indigenous knowledge and the new Western education.

Speaking on the rational for study of ethnoscience Anderson (1974) explained that Western science is like a smoke screen : while its force is directed at the resolution of Africa's most urgent problem, it makes those problems more numerous because it covers up the root of technical problem. In the rhetoric of harmony it enshrouds the reality of imperialism and in so doing it traps our traditional scientific growth. Anderson further revealed that the dominance of the capitalists technology and constant relegation of our ethnoscientific prowess coupled with the introduction of racist culture deform most attempts of our society and indigenous scientists to create in our own cultural ways. Moreover, most of the Western scientific productions only force us to become more dependent on them. The complete alienation of the Western scientific procedure to our ethnoscientific thoughts helps to widen the gulf between us and the west. Adams (1983 : 32) agreed with Anderson on this point when he said that "the danger when one adopts uncritically the science and paradigms of another people's culture is that one adopts their consciousness and also limit the arena of one's own awareness". What Adams meant here is that children who are taught scientific principles using the Western method and applying strictly concepts and paradigms that are complete aliens to the students are bound to experience mental disequilibrium. This is true because such children battle with two major obstacles : resolving the conflicts between the traditionally acquired concepts

and the modern concepts and also the problem of getting adapted to the Western orientation.

Lloyd (1992) further enumerated the rationale for ethnoscience. He noted that ethnoscience helps to clear the notion that science is that which modern scientist believe in and the methodologies with which they operate. Studies in ethnoscience helps to reflect the different intellectual traditions of the various culture as well as the scientific problems each society wants its scientists to address. As such its application in teaching and learning may likely cushion the effects of estrangement and conflict that often accompany the introduction of conventional science to our young children who had already acquired and are adapted to our cultural non-formal education.

Ethnoscientific versus Western Scientific Views and Paradigms

Willis (1972) and Kartz (1971) at about twenty-four years ago had already developed interest in the relevance of ethnoscience to Western science. Wallis reports that the Fipa of South Western Tanzania perceive the cosmic life process as the interaction of human society and wild nature. In the body structure the upper part of the trunk, and particularly the head (untwe) is identified with the dominant intellectual force which in Fipa cosmology is the characteristic of human society in relation to wild nature. In opposition to head and upper trunk, the lower body and the genital region form a morally and intellectually inferior area which is nevertheless the site of enormously powerful forces which it is the proper purpose of the intellect to control and rationally exploit. The Fipa ethnoscientists or indigenous thoughts, according to Kartz (1971) conceive the heart as the seat of emotion. Nevertheless the heart of a person whose social relations are in healthy state is conceived by Fipa as white or clear, whereas the heart of the sorcerer is black. The Fipa believes that the heart like the lower body should be under control of the intellect, even though its content are never entirely into the light of

consciousness.

The Western or conventional science agrees with the ethnoscientific views and paradigms of the Fifa people to some reasonable extent. They agree with Fipa that the upper part of the body, specifically the cerebral cortex of the brain is responsible for the dominant intellectual force and also agrees with the Fipa that the lower part is under the control of the upper part. The Fipa rightfully acknowledge the fact that the limbs are dependent on the upper part for direction. The brain and spinal chord of the upper region co-ordinates both voluntary and reflexes. The Fipa conception of the heart, however fails to link the Western view. While the Fipa views the heart in relation to emotion and overt social behaviour, the Western scientists perceive the heart as a pumping station playing a vital role in the circulation of blood in the body of vertebrates.

In Yoruba ethnoscientific myth, small pox is a deity, 'shopona'. The small pox emerged from the broken and gaping body of 'yemaga' who fell down when she was about to be ravished (Ajose, 1957). As Ajose explained, because small pox is personified as a supernatural being, any one suffering from the disease is treated with respect and is attended only by the small pox priest. If he recovers, he too is later in life allowed to minister to cases of the disease because according to the Yorubas 'oba ti ko' which means that the king has marked him. This belief is also widely held by the Ibos of Eastern Nigeria. Yoruba ethnoscience, according to Ajose, further tells us that small pox god (shopona) is aged and crippled but others say that he has paralysis. It happened that on the day that all the gods and goddesses in the land were making merry at the palace of the chief god called 'Obalete', shopona tried to join the dance but on the account of his deformity, he stumbled and fell. This made the other gods and goddesses to laugh at him. The sight of other gods and goddesses laughing at him made him (shopona) very furious. He strove to infect them with small pox but Obalete came to their rescue and drove'shopona' away into the bush and made him an outcast where he lived in a desolate

and uninhabited traits of land.

The modern conventional science agrees with these ethnoscientific thoughts to a great extent. The Western science agrees with the Yoruba ethnoscientific myth that small pox is highly infectious, that infected persons should be restricted to those who have survived the infection. This isolation of small pox cases and restriction of visits to survivors of the infection reveals their ancient knowledge of epidermology and immunity. Ajose further reports that those ancient people practised vaccination. Also among the Ishan tribe, during an outbreak of small pox, a drum is beaten and people play to please the 'oje' which is an Ishan name for small pox. After practising the vaccination which is usually done on the forearm, people are forbidden under a taboo to use an ordinary sweeping broom in the house. The twig of a particular tree is used instead.

Elements of Western scientific thought in the indigenous practices among the Ishan people is their knowledge of the fact that broom raises a lot of dust which is a medium of transport for the small pox virus. It might be supposed that sweeping will be banned altogether but the people are aware of the danger of attracting flies to a house during epidemics if the compound is unswept. Through ethnoscientific mythology and taboo, the importance of isolation, disinfection, destruction of fomites and other useful preventive measures have been inculcated. With such background it is easier to introduce modern methods even where the old faith in mystic forces is still retained.

Also the African ethnomedical practice of injection which involves making cuts on the chest or other parts of the body into which a specific powder was rubbed coincides with the Western immunization practice. The relevance of shamanistic songs used for traditional healing to Western procedures has been explored. Shamanistic songs are songs during healing ritual in which a shaman invites a specific deity to possess her and heal illness (Ishimori, 1987). On the relationship of shamanism to Western science, Ghalioungui (1973) stressed that even modern science concedes that healing being a

complicated psychic as well as physical process, may be amenable to an approach that touches the hidden areas of the psyche beyond the reach of the rational therapy.

Katz (1971) and Willis (1972) also inquired into the Fipa ethnoscientific conception of diseases and their causes. Willis observed that the Fipa people of South Western Tanzania like many other indigenous Africans have two major different causations of diseases. Lay Fipa, according to Willis and Katz generally explain sickness as resulting from the wilful contamination of food and drink and particularly the latter by a sinister and usually anonymous minority of their fellows in the village society. As Willis emphasized the sorcerer is conceived as being animated by an emotion of jealous resentment which prompts him to introduce a harmful ingredient which may be called in ethical neutral term poison (nsi).

The Western scientific thought agrees with the Fipa conception of disease as being caused through poisoning which can come from a neighbour or through natural sources. The Western scientific thought however stressed that all disease causes are not necessarily caused by the activities of an enemy. There are often physiological defects that can lead to sickness. The Western science, unlike ethnoscience does not have a place for witchcraft in its studies of human affliction.

Coursey and Coursey (1971) tried to offer explanation for the new yam festival as is widely held by the people of West Africa especially the Igbos of South Eastern Nigeria. According to Coursey and his colleague the traditional West African people believe that immature yam tubers are unwholesome. A festival, is therefore, organised to commemorate the maturity and this gives approval for them to begin eating the new yam. The relationship between this ethnoscientific practice and Western science is the recent discovery of toxic alkaloids called Steroidal Sapogenin in immature yam tubers (Coursey and Coursey, 1971). In view of this discovery, one can perceive the rationale behind the ethnoscientific belief that eating of immature yam tubers leads to demonic

affliction and diseases. The new yam festival which is an approval to commence eating the new yam is celebrated at the time all yam species are known to have matured.

On the science of reproduction, the Gimi knowledge of metamorphosis is that the larva of the grub type has no known parentage; it is said to arise from the soil appearing first as a very small 'kuri' and gradually developing to plump maturity. In time, it develops into a 'kiririana' pupa which is yet another kind of kuri. This in turn gives rise by metamorphosis to one of several 'kaba' : 'rukuru', a scarab beetle; 'karunasa', a large species of scarab beetle; 'esara' a cicada or 'kabidu', a dung beetle (scarab family). In constructing a kaba taxonomy, these four insects belong together because, as the Gimi explained, they are all children of 'karioko'.

The Gimi ethnoscientific conception that larva of the grub type has no known parentage agreed with the earliest theory concerning the development of organisms - spontaneous generation widely held by ancient Western scientists. With the discovery of microscopes, the tiny eggs of some organisms can be observed as they hatch into wriggling organism which is entirely different from the parents. The conception that some animals metamorphose into an entirely different organism has no relevance with popular Western scientific teaching. In any case, genetic variations in colour pattern, phase of growth or specialization as is seen in termites may force ethnoscientists to argue that one organism gives rise to entirely different organisms. Viewed from this dimension the Gimi ethnoscientists are by all measure of truth very accurate.

The African ethnoscience, according to Ogunbunmi and Olaitan (1988 : 14) "forbade the carrying of pointed metallic objects during rainfall". They also warn people against stretching their finger out into the rain. Ogunbunmi and Olaitan discussed in detail the relevance of such ethnoscientific practice to Western scientific thought. The model of the Yoruba ethnoscience in relation to this practice is that 'sango' the god of thunder and lightening often gets annoyed on seeing 'ogun' the god of iron, often

represented by metal, in his (sango's) domain when it is raining or about to start raining. As a consequence, sango will often use the symbol of his greatness (thunder and lightening) to strike the person bearing a metal which symbolizes ogun.

The Western scientists agree with this African ethnoscientific thought to some reasonable extent. The Western scientists believe that during rainfall thunder arise as a result of atmospheric instability which often results to a rapid convention of mass of moist air, to great heights (Ogunbunmi and Olaitan, 1988). According to Ogunbunmi and Olaitan the Western scientists believe that the "thunderstorm is marked by towering anvil shaped cumulonimbus cloud with a dark turbulent base". Rain drops often break down under such turbulent conditions. During the separation of rain drops, electric charges are also separated. The breakdown in the air insulation results in lightning which in often cases remain in the cloud but sometimes from the cloud to the earth. Lightning on passing through the air gives rise to a great heat which forces the air to expand and contract resulting in what we hear as thunder (i.e sound waves). To the Yorubas, this indicates that sango is angry.

The relationship of this phenomenon to the Western scientific thought is the phenomenon of 'point discharge'. Ogunbunmi and his colleague wrote that a pointed metallic object has a curvature which increases strongly over the surface and becomes maximum at the pointed end. They further explained that when charged the surface charge density increases rapidly over the surface and also becomes maximum at the pointed end, thus producing a strong electric field strength just outside the point which is high enough to cause the dielectric breakdown of the surrounding air (Ogunbunmi and Olaitan (1988 : 14). The strong field accelerates the few free electrons or charged atoms (naturally present in the surrounding air) to such an energy that they can produce further ionization by bombardment. The cloud which is highly charged during a thunderstorm often induces opposite charges on the earth. The pointed metallic objects or the pointed

finger forms a conducting system through which charge from the earth escape to neutralize the charge in the sky before a lightning stroke occurs. Ogunbunmi and his colleague rightfully noted that if a lightning stroke occurs before neutralization of cloud charges the conducting system offers a path through which the electric charges from the cloud flow into the earth. In both cases the movement of electric charges through the human body distorts the human physiology leading to sudden shock which often results to death of the victim. To the Yoruba's, the sango has acted in fury. The Western scientists agree with the Yoruba's that a pointed metallic object or pointed finger acts as appointed conductor which makes the shock very possible. This also explains our local practice of lying flat with face covered on the ground during lightning. To the Yorubas it is a respect to sango , to the Igbos it is a respect to 'Amadioha' who becomes appeased and consequently spares the life of the person. By lying flat, the individual has refused to provide a path through which electric current can pass and therefore cannot suffer shock.

The ethnoscientific belief among the Yorubas and Igbos is that lightning can never strike a blacksmith's shop. In our early childhood, during rainstorm, we often run to the house of a blacksmith (i.e his workshop). The traditional belief is that blacksmith's shop is a shrine where sacrifices are made to the god of thunder and lightning and are always secured in time of heavy thunder and lightning. Olaitan and Ogunbunmi (1988) offered a concise explanation which relates this ethnoscientific conception to Western scientific knowledge. According to them there are many pointed metallic objects in a blacksmith's shop such that in a thunderstorm, a lightning stroke is always perverted before it occurs, by heavy neutralization due to multiplicity of escape path for electric charges from the earth".

Eggert (1977) noted that ethnoscience or folk reality and scientific reality are related in a peculiar way. The folk conception of reality, though this reality may,

according to certain criteria, be fictitious, influences the thinking and/or behaviour of the group which is holding it. Therefore, the folk reality becomes effective toward creating phenomena which are to be analyzed both in terms of their respective conceptualization by the group in question. Malinowski's (1992 : 138) analysis of myth in primitive psychology provides a good example for this kind of interrelationship. According to him:

> An intimate connection exists between the world, the myths, the sacred tales of a tribe, on the one hand, and their ritual acts, their moral deeds, their social organisation and even their practical activities on the other. Myth as it exists in a savage community, that is, in its living primitive form is not merely a story but a reality lived ... It is a living reality believed to have happened in primeval times, and continuing ever since to influence the world and human destinies.

The implications of the relationship of ethnoscience and Western science in the development of a viral science education in Africa is very interesting. Since there is a link or some relationship between the indigenous views and the Western views its proper utilization and manipulation during instructional process may likely reduce the conflict that may arise in the children during modern science classes. An articulate and proper application of indigenous scientific concepts will help children understand the rationale behind some Western laws and theories which otherwise may result to conflict and cognitive equilibrium among the children during the early introduction of alien Western science.

Ethnoscience and the Western Conceptual Method

The issue of scientific method and its applicability in the development of ethnoscience has been very controversial in the current studies of ethnoscience (Pingree, 1992; Adams, 1983; Boulding, 1980). The Western scientists have constantly played down the validity of ethnoscience based on the assumption that it does not submit totally to their laid down method and procedure of verification. But according to Adams (1985:44)

"Nobody has a monopoly on truth. There is no correct way of knowing; there are ways of knowing. And Western conceptual methodology cannot discover any more basic truth to explain the mysteries of creation than a symbolic/intuitive methodology".

Stressing that science must have to stern from universal and culturally independent base, Adams further emphasized that science viewed from whichever dimension "is the search for unity or wholeness within or without all human experience". To buttress this point he reminded us of the famous statement of Wade Nobles, that "science is a formal reconstruction or representation of a people's shared set of systematic or cumulative ideas, belief, and knowledge stemming from their culture". In view of these ideas held by Nobles and Adams, one could begin to perceive the shallow mindedness of the Eurocentrics who restrict the method of knowing to the already known. This annoying restriction prompted Bohm (1980) to argue that if you have a fixed criterion of what fits, you cannot create something new because you have to create something that fits your old idea and that limit what you can think and your overall arena of awareness.

The Western scientists who inquired into the ancient African knowledge of the solar system were caught between two standards to accept that the Dogon did not know what they know or that they really knew what they know, considering the fact that they never applied any Western standard in knowing what they knew about the galaxies. Their dismay about the scientific and astronomical prowess of the ancient indigenous Africans who never applied the Western scientific method prompted Griaule and Dieterlen to say that "the problem of knowing how, with no instruments at their disposal men could know the movement and certain characteristics of virtually invisible stars has not been settled or even posed" (Adams, 1983). But for Griaule and Dieterlen to think that the question about how they know what they know has not been posed is to prolong further the glorification of ancient Africans and also to further delay the dismissal of Eurocentric or Western method as the only method of verification. If they had not questioned how the

ancient Africans acquired their ethnoscientific prowess, it becomes share extravagance to assert that the Western procedure is the most appropriate way of knowing about nature. In the same vein, Adams explained that Jean Rouch together with his colleague Carl Sagan who were exposed to the science of the dogon did not accept the authenticity of what they learnt from the dogon "even though they could not explain how they knew what they knew".

These Western scientists are very adamant to the golden fact that scientific testing should come both by logic and by organised input of information from outside the person or the object, from the senses directly and from the trustworthy records of others and that within the scientific community there is a great variety of methods (Boulding, 1980). Boulding went further to explain that many ethnoscientific methods are not submissive to the Western scientific method - "the alchemists had experiment, the astrologers had observators, the neomancers and diviners had measurements and the theologians had logic".

Learning began long before science and by then science was a part of people's daily life and since science according to Boulding (1980), " is fuzzy set within the fields of human knowledge", its boundaries are somewhat arbitrary. In recognition of the fact that western scientific procedure cannot answer all the questions posed by ethnoscience, Boulding warned that questioning the legitimacy of people's science has been "precarious or dangerous".

Albert Einstein quite understood the dilemma perfectly when he said that "there is no inductive method which can lead to the fundamental concepts of physics". He felt that "there is no logical path to these laws : only intuition, resting on a sympathetic understanding of experience can reach them" (Einstein, 1978). Einstein discovered the theory of relativity simply by seeing himself riding on a beam of light. He never knew anything about the scientific method when he discovered the theory of relativity.

Pingree (1992) used the term 'Hellenophilia' to describe those affected by a defect - a brain defect which limits their ability to imagine many significant questions that legitimately should be addressed in science and which prevent their judgement. Pingree, who defined science as "a systematic explanation of perceived or imaginary phenomena" dismissed the imposition of the Western conceptual method in Davidson's (1974) words as "later-day mystification of the racialist sort". According to Pingree, the Western scientists, in their tendency to sermonize their method and pontificate our indigenous or ethnoscientific thoughts displays marked similarities to the church who persecute those who disagree with its dogma than of rational argument. He argued that since different scientists reflect the various intellectual tradition of their own culture as well as the peculiar problems of the particular society, there can be no single method that will adapt to various culture. Pingree (1992 : 558) wrote:

> Indeed, they-and we-have not one, but many scientific methods; biologists, physicists and astronomers went and go their separate methodological ways ... Those who deny the validity of alternative scientific methods must somehow explain how equivalent scientific truths can be arrived at without Greek methods and in their denial they clearly deprive themselves of an opportunity to understand science more clearly.

Lloyd (1992 : 574) also agrees with Pingree when he asserts that "there cannot be any set of data in reality to which we have unrestricted access". What Lloyd meant is that there is no data which the scientists can describe in theory free terms and then be used to check theories suggested to explain them. Lloyd who warned against the Western claim "to have understood" and claim "to have reached satisfactory explanations" emphasized that such claims do not lead to a greater scientific heights especially when one considers the fact that there still remains a lot of facts to be explored.

Singer (1956) blindfolded by the Western empirical method, dismissed the ethnomedical practices of ancient Africans and earlier Greeks. Singer believes that the ethnomedical practitioners had very little knowledge of the position of vital nerves,

muscles, artery and important veins and as a result they are more likely to be responsible for the death, than for the savings of their patient. The belief that science cannot proceed without the application of Western procedure is one of the major source of cognitive imbalance among the African pupils who view the conventional science as a complete alien that has come in complete opposition to their culture.

Among the victims of 'Hellenophilia' is Otto Neugebauer, a defender of ethnoscience and enemy of racism. The symptom was manifested in his blind claim that the accurate astronomical alignment of the pyramids and the temples in Egypt and the ancient use of π and θ could all be explained as a "result of practical knacks rather than of profound thought" (Bernal, 1992 : 600). Neugebauer's (1962) regard of ethnoscientific prowess of Africans as primitive was prompted by the fact that they never applied the Western conceptual standard - the scientific method, but as Adams (1983 : 32) rightfully noted:

> Their narrow vision cannot alter the fact but their writing do cast light on the root of their problems: they were trying to deal with the Dogons, Egyptians, Samarians and Dravidian knowledge as they would to Western scientists way of knowing. To arrive at truth, they fell, one must use the experimental method, so that as political scientist Jacob Carruthers puts it - "no mountain will be unscaled, no fact remain unexplained".

In science the human mind speculates ahead into the future before going into the laboratory for tests, thus there is speculative metaphysics underlying science. On the same vein, Momoh (1988) explained that the method of science is nothing more or less than the proper method of acquisition of any knowledge.

This current imposition of Western method has implications for science education programme in Nigeria. As has been stressed a Nigerian child between the age of 0 - 5 years is brought up completely in Nigerian indigenous background or culture. His knowledge and skills are embedded in the culture of his people but as he progresses to primary and secondary school age, he becomes exposed to modern sciences which are

entirely different from his initial perceptual model. Fafunwa (1983) noted that such introduction of the Western methods often lead to cognitive disequilibrium among the Nigerian students. Such conflicts and disequilibrium can only be resolved if we appreciate the golden facts that the introduction of our indigenous models can help in resolution of such conflicts. In fact it is very necessary to establish a bridge to link the indigenous conceptual model to the Western model by resolving the conflicts through instructional utilization of indigenous concepts and paradigms so that our students, already grounded in our cultural practice, can perceive the rational for some Western scientific concepts and theories. There is a need to de-emphasize the catholic insistence on the Western model as the only way to knowledge.

Religion and Esoterism in Ethnoscientific thought

The Longman Encyclopedia defined religion as a system of thought, feeling and action shared by a group that gives members an object of devotion; a code of ethics governing personal and social conducts; and a frame of reference relating individuals to their group and the universe, and also an acknowledgement of the extraordinary, the mysterious and the supernatural. Brown (1988), quoted Whitehead as saying that religion is the "vision of something which stands beyond, behind and within; the passing flux of immediate things; something which is real and yet waiting to be realized; something which is a remote possibility, and yet the greatest of the present fact; something which gives meaning to all that pass, and yet eludes comprehension".

In 450 B.C. Anaxagoras was accused of impiety because of his teaching about the sun and his radical claim that the truth concerning the natural world can be guaranteed by the authority of the divine revelation as against the claim of science that it can only be guaranteed by human experience (Brown, 1988). The early teaching of the black scholars and the involvement of spiritual practices in ethnoscience has been an issue of

controversy. While the Western scientists distance science from religion, studies in ethnoscience reveal that they are inseparable (Fadahunsi, 1988; Blocker, 1987; Finch, 1983).

The efficacy and relevance of religion in ethnoscience is manifested in incantation. Incantation according to Fadahunsi (1988) "may connote ritual recitation of verbal charms or spells to produce a magical effect". According to Fadahunsi incantation has direct link with physical objects/preparations which cannot function effectively without the oral incantation. Stressing the relevance of incantation in ethnoscientific practices, Fadahunsi (1988 : 45) quote Fapido say that ethnoscience

"is ruled by supernatural being or gods and satisfies aesthetic and religious emotions. Causes of events are explained purely in terms of personal entities... In Western scientific philosophy, causes of any event must be sought in mathematics or statistics of chance, not in gods".

It should be noted that the reality of this practice is highly dependent on the people's belief (faith) and consequently this sets limitations in the extent to which empirical analysis is possible (Fadahunsi 1988). Blocker (1987) also argued that if incantation, magic or sorcery is empirically false, and if the people have not been achieving anything by it, belief in and practice of it, should not have persisted in which case, therefore, the truism of incantation according to Fadahunsi "is in its efficacy and its substance is in the people's adamant belief that its workability has been consistent".

The Western scientists in their laboratory operate as if nature is all matter, contrary to the ethnoscientific view of nature which holds that everything is "embedded in or filled with mystical forces (spiritual or mind) which dominates the whole world (Momoh, 1988). The total negligence of the role of spiritual forces in control of the universe on the part of the Western scientists and the incompetence of Western scientific procedure in offering solution to most problems of nature is evident in what Roszak

(1973:151) said, that

> Our science (like our technique) is maniacal because it bears the cultural burden of finding in our society where meaning cannot be found... Nevertheless science continues to thrust its way fanatically into denser regions of being, hoping to strike through to some ultimate truth which will vindicate its quest... The secret of life concocted in a test tube... the origin of universe, the mechanism of intelligence, but all it finds are reductionist caricatures, nihilistic know-how.

To further emphasize the wastefulness of time and resources in alienating religion from science and continued insistence that scientifically testable procedure will characterize all sciences, including astronomy, Brown (1988) quoting Wienberg, asserts that "the more the universe seems comprehensive the more it seems pointless"

In ethnomedical practices, Lloyd (1992) noted cases of people who practised medicine in the shrines of healing gods. Throughout Africa Lloyd note that a lot of diseases were associated with divine powers and most ancient healers do apply divine healing processes in healing. The concept of 'sacred diseases' widely upheld by all ancient medical scientists support the claim that diseases have natural causes and can be treated with natural therapies. Finch (1983) also reported a missionary doctor Felkin say that the Banyoro surgeon of the ancient Uganda often utter some incantation before undertaking any caesarean operation. Although the relevance of these incantations cannot be explored empirically, its religious and practical utility cannot be dismissed. Lloyd further noted, in appreciation of supernatural involvements in ethnoscience that "natural phenomena is not a result of random or arbitrary influences but regular and governed by determinable sequence of cause and effect". He further expressed that even hypocritic medicine which is generally regarded as being rational, was instructionally controlled on the religious cult of 'Asclepius' and his serpent, which laid great emphasis on the religious practice of incubation.

To further emphasize the role of religion and supernatural forces in ethnoscience, Adams (1983) reports Jean Rouch say that the "Dogon astronomers of Mali also made

use of natural foresights and hindsight in their observation". The Dogon also admitted they got their astronomical sense from a god called 'Nommo'.

Finch (1983) quoting Ghalioungui, reminded us that Egyptian medicine "baffles scholars because of the complete interpenetration of magico-spiritual and rational elements". Ghalioungui (1983) stressed that even modern medicine concedes that healing, being a complicated psychic as well as physical process may be amenable to an approach that touches the hidden areas of the psyche beyond the reach of the rational therapy.

On Ethnoscience and esoterism, Morris (1981) defined esoterism as "that which is intended for or understood by only a small group". He explained that it has to do with that which is abstruse, not publicly disposed and very difficult to comprehend or understand. Esoterism, according to Morris, pertains specifically to that which is understandable only to those of special knowledge or power of perception.

Davidson (1987), speaking on esoteric science noted that we cannot begin to understand the drift and logic of ethnoscientific apprehension of reality unless, for example we have grasped the reason why appointed ancestors should have become guardians of the highest moral values... the axiomatic values from which the ideal conduct have been deemed to follow". There are evidence to prove that some ethnoscientific practices were restricted to a particular group who guard the knowledge very jealously and restrict its level of expansion (Bernal, 1992, Adams, 1983). Bernal (1992:600) quoting Lauer said:

> Even though up to now no esoteric Egyptian mathematical document has been discovered, we know, if we can believe the Greeks that the Egyptian priests were very jealous of the secrets of their science and that they occupied themselves... It seems then reasonably probable that they had been in possession of esoteric science erected, little by little in the secrecy of the temple during the long centuries that separate the construction of the pyramids...

We should also be reminded of the fact that what prompted Euxodus to translate 'the Egyptian book of the dead' into Greek was specifically to understand the esoteric science

they suspected should be in it (Bernal, 1992). This raises the important suggestion that African religious and mystical writings and drawings may well contain esoteric and mathematical wisdom.

Adams (1983) also revealed that Griaule and Dieterlen, French scholars who went through the 'Dogon system of education' so as to acquire the secrets of the universe from those priests admitted that they first received "simple knowledge" otherwise called the "word at face value" and later the esoteric knowledge referred to as the "clear word". they expressed that the esoteric knowledge is the Dogon's most sacred knowledge which they are very reluctant to expose. The inability of the Western scientists to discover the procedure employed by these ancient Africans is due to the fact that the African ethnoscientific knowledge were kept exclusively to one class of the population namely the priests and their close associates (Brown, 1988). As a result, the general populace regard such ethnoscientific knowledge as amounting to magic.

Since these beliefs sharpens and helps to shape human perception, there is the need to explore the religious and esoteric thoughts in detail so that their application in teaching and learning can assist students in tackling the problems of conflicts that may arise as a result of the introduction of the alien science as they progress in academics.

Contributions of the Ancient Indigenous Africans to Conventional Sciences

Archaeologists have begun to pick the debris left of Africa after the catastrophic destruction of Africa and the associated treasure hunts by the Europeans which made it almost look like Africa never existed with any scientific and technological brilliance in the past. As Sertima (1983:8) stressed "no human disaster with the exception of the flood can equal in dimension of destructiveness and cataclysm that shook Africa".

The African genius, however was not to remain buried forever. Archaeologists have revealed Africa's former brilliance in the fields of astronomy (Adams III 1983;

Robins 1983), Agriculture (Wendorf, Schild and Close, 1983; Webster, 1983); Architecture and Engineering (Lumpkin 1983; Wendorf et al 1979), Aeronautics (Messiha, et al 1983), Mathematics (Lumpkin 1983; Wendorf, et al 1979), Medicine (Newsome, 1983; Finch, 1983; Ohaeri, 1988; Fadahunsi, 1988; Norman 1969), Metallurgy (Shore, 1988; Anderson, 1979; Schmidt and Avery, 1978), Navigation (Malloy, 1983; Green-Hill, 1976; George, 1972; Sertima, 1977), Physics (Pappademos, 1983; Ogunbunmi and Olaitan, 1988; Neugebauer, 1962; Snowden, 1970) and communication (Sertima, 1983).

The prowess of the ancient Africans in the field of astronomy was manifested in the brilliance of the ancient people of Mali from where the famous ancient University of Timbuctoo once lay. The complex knowledge of the Dogon of Mali about the sirius star system is sending shock waves around the scientific world. Speaking on the astronomical greatness of these ancient black Africans, Sertima (1983:11) wrote

> They (Dogons) knew a billion worlds spiralled in space like the circulation of blood within the body of God. They knew that the moon was a barren world. They said it was dry and dead, like dried blood... They plotted its orbit almost up until the year 2000. And they did all these between five and seven hundred years ago.

Adams (1983) further stressed that these West African people have not only plotted the orbit of the stars circling sirius but have revealed the extraordinary nature of one of its companion -'sirius B' - which they claimed to be one of the densest and one of the tiniest stars in our galaxy. The most surprising aspect of their revelation is the fact that the so called 'sirius B' is very invisible to the naked eye. Adams further explained that many African families, using the astronomer priests were able to determine dates of festivals, rituals, planting and harvesting seasons and further develop a comprehensive calendar. These Africans from Mali according to Robbins (1983) also acquired indepth knowledge about the component of the tiny star and its annual rotation on its axis which is still unknown to Western astronomers.

With the discovery of spherical lenses used by the Egyptians in the 8th century B.C. and considering the fact that such a lens placed in front of another one can make a simple telescope, one should therefore begin to readdress the earlier statement by Galileo that "the ancients were aware of the telescopes". It is therefore most likely that these ancient temple priests used the telescopes. It is also well known that many thousand years ago the Dravidians were aware that mercury did not rotate on its own axis with respect to the sun - a fact that the Western astronomers using their so called modern instruments discovered only recently (Adams, 1983; Lynch and Robbins, 1983).

Lynch and Robbins (1983) also gave account of ancient African knowledge of astronomy which dates to about 300 B.C. They explained that the people of 'Namorantunga' of Kenya used an alignment of 19 basalt pillars which are non randomly oriented toward certain stars and constellations to calculate accurate calendar.

In the field of Agriculture Archaeological finds from the arid sand of Egypt has come to challenge the earlier assumptions about the origin and development of Agricultural science. Initially it was thought that Agriculture started in South Western Asia in the region where the wild strain of wheat and barley grew up till this day. (Wendorf, Schlid and Close, 1979). Wendorf, Schlid and Close (1979:1346) said

> Our excavations at Wadi Kubbaniya, a desolate region in Egypt's Western Desert throw all this into doubt. We have found that between 17,000 and 18,500 years ago when ice still covered much of Europe, African people were already raising crops of wheat, barley, lentils, chickpeas, capers and dates. They were doing this in the flood plains of the Nile, much as people will continue to do for another 13,000 years until the classical Egyptian civilization arose and on into modern times.

Schlid and his colleagues further discovered various sizes of grinding stones including milling stones used to grind grains to flour. They also found mortars and pestles in addition to cutting blades, engraving burins and hide scrapers which are real indicators of farm settlement. Webster (1983) also revealed the findings that the earliest domesticated cattle lived in East Africa, some fifteen thousand years ago, thereby

shattering the long held theory "that the cradle of civilization lies in the middle East where domesticated cattle, a hallmark of civilization was known to exist some eight thousand years ago". It was suggested after the discovery of bones and teeth of cattle in three separate sites in the Lukenya district dating back to the pre-iron age that these organised and civilized African people of those days "could have spread its mores, living modes and philosophy, eventually reaching the fertile crescents of the Euphrates River valley, where the present day regions of Iraq, Syria, Lebanon, Jordan and Israel are often referred to as the cradle of civilization" (Webster, 1983).

> In the field of architecture and engineering, Lumpkin (1983:67) summarized that The pyramids and other great stone monuments of Egypt and Sudan are the product of long development of African science and technology... This development which proceeded from African beginnings, on African soil, by African people eliminates any need to fabricate an external, foreign source for pyramid building or for the ancient Egyptian civilization as a whole.

Most of the pyramids were built under the reign of the Menes who happened to be the first king to unite all Egypt. Lumpkin explains that one of the seven wonders of the world was the great pyramid at Giza which was built as a tomb for Khufu, "a black king whose status in the Cairo museum show classic black African features" (Diop, 1974). Also the mathematical calculations involved in building of the pyramid is a great source of discomfort to the Europeans who claim that mathematics did not originate from Africa. Lumpkin informed us that the modern mathematicians are faced with the puzzles of trying to reconstruct the method employed by the Egyptians to discover their formula for the volume of a truncated pyramid "as given in the problem 14 of the square base sides 'a' cut off at a height 'h' with a square top of side 'b'.

$$V=\frac{h}{3}(a^2+ab+b^2)$$

This formula cannot by any measure be termed primitive. With this in mind, modern historians of mathematics should find ways of reconstructing the Egyptian method. Also discovered include written plans which portray scale drawings showing both front and side view. Another mystery to the Europeans is the temple of great Zimbabwe which has withstood constant raid by European treasure hunters, souvenir seekers and plunderers - rogues. Also included in the ancient architectural display is the ancient wall of Kano in Nigeria (Asante and Asante, 1983).

In the field of Aeronautics, a clear and unbiased account of its origin cannot be given without the ancient Africans. Messiha et al (1983:92) reported that "the Egyptians were experimenting with flying machines as early as the 4th or 3rd century B.C". As Messiha and his colleagues explained " this extra ordinary scientific model was placed in room number 22, bearing number 6347 in the Egyptian museum". Messiha and his associates revealed that the 2300 year old glider discovered in Saqqara and taken to Egyptian museum in 1898 was mistaken for a bird because no one there knew anything about aeroplane, and that accounts why the model was kept in a glass box with other birds, until a young Egyptian physician and artist noticed that it was different form the birds. Khali Messiha further discovered another model of sail plane which after cross-examination by his brother Guirguis Messiha, a flight engineer, commented that the aerofoil shape of the body would lessen the drag effect. This is a fact which the Europeans discovered very recently after many years of intensive research in aeronautics engineering.

On the contribution of ancient Africans in the fields of mathematics and physics, Lumpkin (1983:100) discussed Africa as being in the main stream of the mathematical

history. She summarized that mathematics begun with the first written numerals of the ancient Egypt and the progress "continued on the African continent through three great periods, ancient Egyptian, Hellenistic, and Muslim". Lumpkin further stressed that the "Renaissance in Egypt was triggered by the science and mathematics brought to Spain and Italy by the Moors of the Northern Africa". Kline (1978) earlier dismissed the existence of mathematics before the Greeks because he bluntly and purposefully turned deaf ear to the archaeological findings indicating that the Egyptian calendar dates back to 4241 B.C. The assumption that mathematics started in Greek was dismissed by Sarton (1988:31) who explained that "it is childish to assume that science began in Greece. The Greek Miracle was prepared by the millennia of work in Egypt Mesopotamia and possibly other regions. Greek science was less an invention than a revival".

The accuracy of the dimension of the pyramid and great stone complex of Zimbabwe are all living evidence of Africa's ancient knowledge of pure and applied mathematics. Lumpkin (1983:102) further discovered that the "Egyptian value of pi (π, the constant ratio of circumference to diameter of any circle) was 3.16, much closer to the modern 3.14 than the biblical value of 3.0". The development of the deductive axiomatic method by the Greeks in 4th century establishing the logical foundation on which mathematics rest today does not mean that the ancient Africans were not familiar with these principles and probably taught it to the Greeks. According to Struve (1967:18), "the Moscow papyrus... confirms in a striking way the mathematical knowledge of the Egyptian scholars and we no longer have any reason to reject the claim of the Greek writers that the Egyptians were the teachers of Greek in Geometry".

Despite the development of axiomatic method by the Greeks, Neugebauer (1970) continued to remind us that Greek mathematics is an "outgrowth of Egyptians and Babylonians". These Egyptians were notably the people of Alexandria who are mainly African people of Egypt with a few immigrants from Greece, Western Asia and

neighbouring African countries. The most interesting aspect of it is the discovery by Sarton (1988:9) that the "Greek emigrants were very few in pre-christian times and too little interested in science and scholarship to affect and change Eastern minds". There are a lot of evidence to affirm that Euclid and Ptolemy are black Egyptians and we know Euclid developed the logical deduction of theorems from accepted definitions and axioms while Ptolemy dominated astronomy until finally replaced by Corpenicus theory of a sun centred planetary system (Lumpkin, 1983).

Zavasky (1983) also gave a detailed account of the Yoruba numbering system and evidence of development in mathematics among the Yoruba people of Western Nigeria which dates back to several thousands of years. According to Zavasky, the Yoruba numbering system relies upon subtraction to a very high degree.

In the field of physics, the European distortion of the ancient African contribution is being excavated. The exact prediction of seasoning and annual overflow of Nile by ancient Egyptians many thousand years ago which the Eurocentrics neglected is another outstanding evidence of Ancient African knowledge of physics and astronomy. Also, the ability of the Africans to control humidity and cause the atmosphere to send rain should not be overlooked.

Pappademos (1983) revealed that the Greek students like Thales of Miletos (600 B.C), Democritos, Pythagoras and Euxodus (408-355 B.C) travelled all the way to Egypt to study sciences which included planetary motion and astronomy. As Pappademos (1983 : 183) further stressed " the technological progress of the Ancient Egyptian are of importance to any student of the history of physics, since it is well known that advance in theoretical physics not only give rise to technological progress, but are themselves stimulated by advances in technology". The Eurocentrics honour Archimedes as the inventor of Lever to the discredit of Imhotep of Egypt, the adviser of king Zoser. Imhotep who designed a step pyramid of Saqqara, the worlds first large stone building

according to Fraser (1948) must have been a master of physical principles such as the lever and inclined plane. Addressing the famous Pythagorean theorem, Lumpkin (1983) asserts that Pythagoras studied in Egypt and is not known to have proved the theorem, rather he merely announced it to the world. Lumpkin in 'Historia Mathematica' explained that knowledge of the theorem has severally been applied in problems presented in a papyrus which dated back to 200 B.c and also that the idea of the so called Pythagorean theorem is implied by the Egyptian use of the double remen as a unit of length measure. Pappademos (1983) further reminded us that the water clock which Galileo used in his experiment on accelerated motion was invented in Egypt about 2000 B.C. The use of shadows cast by obelisks in time keeping is also another good evidence of the ancient African knowledge of physics and as Pappademos explained, obelisks date back to 3100 B.C.

Gow (1973) also offered a solid evidence to confirm that Hero who invented numerous devices based on principles of mechanics; Hero's fountain; and the first steam engine is a black Egyptian. According to Taton (1957) more than sixteen thousand years before the birth of the famous French physicist Fermat, who is always accredited with the discovery of the least time in optics, Hero used the principles of the least optical path to explain reflection. To further emphasize the ancient African prowess in physics, Pappademos (1983:191) reported that between 10th - 11th century A.D "the great physicist Alhazen lived in Egypt and gave a scientific explanation of refraction, reflection, focusing with lenses, the pin-hole camera, spherical abberation and binocular vision". Pappademos went further to explain that Alhazen "built spherical and parabolic mirrors and was the first to calculate the height of the atmosphere using a correct conception of the air pressure".

In medicine, the ancient African prowess cannot be overemphasized. In fact, available evidence confirm that ancient Africans pioneered research in medicine.

Newsome (1983) described Imhotep as the African father of medicine. He lived in 2980 B.C during the reign of Pharaoh Zoser of the third dynasty. Imhotep, as we noted earlier was the man who designed the step pyramid at Saqqara over the centuries. Newsome informs us that Egyptians in need of healing flocked to shrines and temples erected in his honour. According to Rogers (1972:39), the greatness of the black Imhotep was manifested in the inscription on the temple erected in his honour "Turn thy face towards me, my lord Imhotep, son of Ptar. It is thou that dost work miracles and who are beneficent in all deeds".

As Newsome went further to explain, even the Greeks new Imhotep (Imouthes) as a god of healing. Massey (1973:734) also reported that the early Roman christians identified Imhotep with Jesus Christ. He said

> Jesus, the divine healer, does not retain the black complexion of Iu-em-hotep in the canonical gospel, but he does in the church of Rome when represented by a black bambino. A jewelled image of Child Christ as a black moor is sacredly preserved at the headquarters of the Franciscan order to visit the sick and demonstrate the supposed power of the Egyptian Aesculapius thus christianized.

Egyptian document in the field of medicine also included magic, religion and herbal pharmacology (Newsome, 1983). The Edwin papyri according to Magno (1977) produced some excellent anatomical correlations; probably the first tapes and sutures; the beginning of hermostasis by cantery and the beginning of antisepsis with copper salt. Most of the medical procedures applied by the Greeks were attributed to Pythagoras who was a disciple of the Egyptian priests and the disseminator of their teaching and culture among the Greeks. This made it possible for the Greek to acquire the knowledge of the ancient Egyptian medicine. Newsome (1983:132) reports Isocrates say that "on visit to Egypt he (Pythagoras) became a student of the religion of the people and was the first to bring to the Greeks all philosophy".

Another glaring evidence of the ancient African practice in the field of medicine

is their practice of circumcision from the earliest times. Finch (1983) further confirmed that the Egyptians were writing medical textbooks as early as five hundred years ago. He further observed from the ancient African papyri on medicine that the procedure employed in examining a patient is as sophisticated as those employed by the modern physicians. An astonishing aspect of it is the pulse taking and analysis of urine and nasal secretion employed by these ancient African healers. The Edwin Smith papyrus also reveal ancient African surgical practices which include brain surgery, eye surgery, and caesarean operations. Newsome gave an account of ancient surgical practices among the Banyoro of Uganda and Lukundu of Central Africa. The knowledge of contagiousness of some diseases like small pox and chicken pox is wide spread in all parts of Africa. In the pre-historic days, they developed a 'sick bush', or 'evil forests ' where people with such illness are isolated to avoid the spread of the disease. Ancient Africans also had genius in bone setting. These indigenous Africans handle all cases of bone fracture.

Finch (1983) gave an account of caesarean section performed by a Banyoro surgeon in Uganda as was witnessed and expressed by a missionary doctor named Felkin in 1879. The missionary, according to Finch explained that the woman and the child survived the operation which looked more sophisticated than can be imagine of ancient people of the pre-colonial days.

In the field of metallurgy, Shore (1983) also gave evidence of steel making in ancient Africa about two thousand years ago. This was discovered by Schmidt and Avery (1978) who told the world that they have found a technological process in African iron age which is exceedingly complex. This discovery was made among the Haya of North Western Tanzania - a practice which have been estimated to have been in place about 1,500 to 2,000 years ago. Also in Zimbabwe, it was discovered that many thousand years ago, the ancient people were highly involved in iron smelting.

According to Robinson (1974) one of the earliest revolutionary technological

development that moved mankind in general and our African ancestral brothers and sisters in particular, into a new social order (the city state) was the development of iron smelting in Zimbabwe (Rhodesia) at least 40,000 years ago. This discovery of forty thousand years old Zimbabwe iron smelting implies that scientific and technological information moved from Southern Africa to Northern Africa, then to Europe. This would completely shatter influential racist historians like Arnold Toynbee and his study of history (6 volumes) where Egypt is depicted as a white nation and the rest of Africa a mere savage pre-historic foot note.

Ancient Africans also featured prominently in the field of Navigation. Sertima (1977) gave a detailed account of the African involvement in navigation and exploration of European countries and many parts of America long before Columbus was born. She presented a detailed evidence of a linguistic, cultural, horticultural and archaeological nature which confirmed continued contact and interaction between Africa and Meso America in pre-columbian times. This contact according to Sertima can only be possible with their wide knowledge of watercraft. Malloy (1983) also reported that Cadamosto in 1455 found the coastal inhabitant of the Senegal River using three-to-four men dug outs for fishing and ferrying goods from place to place. The size of boats built by the ancient Africans were significantly large and can be estimated from what Everyman (1974:151) reports that Mongo Park wrote in 1796: " ...they are therefore very long and disappropriately narrow and have neither decks nor masts; they are however very roomy; for I observed in one of them four horses and several people crossing over the river."

In the field of communication, Sertima (1983) reported Charles Breadsted, the son of the most celebrated American Egyptologist say the following about the ancient Nubians:

> We never ceased marvelling at their ability to converse with one another across great stretches of water. Again and again in places where the Nile had suddenly widened to a breath of almost two miles so that we could

> have to inquire locally regarding possible inscription or ruins. Along the farther shore we could watch a man address a friend so far away on the opposite bank as to be a mere speck wholly out of earshot. He would stand at the very edges of the river, perhaps ten feet above its surface and cupping his hand some four inches in front of his lips, would talk into the water at an angle of about 45 degrees, in a loud voice but without shouting. At interval he would stop and listen while the distant man evidently replied in kind. But we who stood close by heard no sound.

Sertima noted that this advanced technology of communication was developed by indigenous Africans before the advent of the Europeans to enhance proper administration of empires.

The Dogon of Western Sudan according to Davidson (1987) also delved into the field of natural history and taxonomy. To the greatest surprise of Linnaeus, who is accredited as the father of plant nomenclature, these Dogon priests had already classified the plants they know into twenty-two chief families of which some were further subdivided into as many as eleven sub-families and numerous orders and species. According to Davidson, the criteria used by these ancient priests in successful classification of these plants surprised Linnaeus because they were very different form the ones employed by him. This also lends credence to the fact that scientific truth can be arrived at using different conceptual procedure.

These numerous achievements of ancient indigenous Africans long before the Europeans stepped their toes on the African soil reveals that science can be studied in isolation of the Western concepts and techniques. Since the Africans could attain such scientific and technological greatness in isolation of the West, the poor status of Africans in science and technology is attributable to the Western influences in our recent scientific studies. In view of these facts, therefore, there is need to re-address the matter more critically and explore the need for a more viral instrument for a national growth. Researchers (Fafunwa, 1983; Selin, 1993) have discovered cases of estrangement, conflicts and mental disequilibrium associated with the use of Western model in African

soil where the young learners were brought up in traditional model and customs. Such conflicts and cognitive disequilibrium may likely be resolved if we can appreciate the need for our indigenous model. Sertima (1983:6) wrote " there are certainly other ways of knowing, but until we can state with a fair amount of certainty what these ways are, we should not encumber this virginal field with pseudo academic dream-models and science fiction".

Concept formation: An overview

According to Nelson (1974:270) conceptual and concepts refer to "cognitive organizations of information about objects and events encountered in the world." He assumed that the organization or structure of a concept can change as the individual progresses in life and that invariably the organization of relations between concepts may also change. Sokolov (1963) earlier identified that concepts serve the individual by increasing predictability in a way that is supplementary to that of the perceptual models. That is simply to say that many more things are known about a new object that may be identified as an instance of an already formed concepts than the set of perceptual attributes that serve to identify it.

Nelson (1974) identified three essential levels of concept formation processes. These include concepts, instances, and attributes. These, according to Nelson proceed from whole to part. It is only the instance that appear in the child's world as perceptual wholes. Like we already know, concepts and attributes which are essential levels of concept formation are simple cognitive constructions, one the product of synthesis and the other being the product of analysis. According to Nelson (1974:275) "every theory (on conceptions) must suppose that the child (like the adult) engages in both of these constructional activities, thereby reducing the environmental variability with which he must contend and that the function of the concept is to produce fewer wholes (by

combining instances) than would otherwise be present for analysis". Piaget (1974) proposed four component processes in concept formation in children. They are:

(a) Identification of an individual whole

(b) Identification of important relationships of objects and assessing individuals on the basis of their functional relations to a synthesized cognitive "chunk" or concept.

(c) Identification of new concept instances by noting the salient stable ("invariant") characteristics of members included in the concept on functional grounds and forming a hierarchy of identificational attributes therefrom.

(d) Attaching a name to the concept so formed.

Nelson (1974) emphasized that the order in which these processes are listed implies a usual temporal or sequential order for initial concept formation and naming. Nelson further explained that in order to form a concept of an object, (eg a ball) or the "idea of ballness" rather than ball as many different objects in different relationships, the child must synthesize over time the various relations into which the ball enters.He therefore presented the following arguments:

1. The concept develops on the basis of the experience of a single instance; it does not depend upon comparing instances and finding similarities.

2. The concept emerges directly from the child's interaction with the world; it does not depend upon cuing through words.

3. The concept depends upon a prior notion of the boundaries of objects, events, and their relationships.

Parmentier (1993:191) rightfully pointed out that "for many practitioners, modern cultural anthropology came of age with the historical relativization of the Kantian categories - that is, with the recognition that the creative, apperceptive power of human symbolic representation is largely the product of cultural circumstances rather than the result of the transcendental potentialities of our cognitive hardwiring". This implies that concept acquisition is directly tied to some ethnographic variables. It would, therefore,

be very erroneous for one to begin any study on concept formation or acquisition without due consideration to the child's cultural background. Parmentier emphasized very clearly that people's iterative actions and utterances are performed only on the basis of specific memories of prior occurrences. This then coincides with Nelson's (1974) observation that concepts depend upon a prior notion of the boundaries of objects, events and their relationships. The ethnoscientific relevance to concept formation is then the relationship between cultural ideas and practices and their symbolic representations in the minds of children.

Theories of concept formation and learning

A lot of theories have been proposed to explain concept formation and learning. The theories include:

(a) Abstraction theory

(b) Semantic feature theory

(c) Piagetian theory

(d) Relational concept theory

Abstraction Theories

According to Nelson (1974:270) "the traditional psychological theory of concept formation is based on the abstraction of common elements or attributes". The abstraction theories assume that the analysis comes first: that invariant attributes are abstracted and combined into definitional sets as instances and their attributes are accreted. Bolton (1972) earlier observed from Locke's (1924) postulates that it is by a process of abstraction that concepts are formed. Concepts, according to Locke are formed when objects are classified. Bolton (1972) went further to elaborate that there are two aspects of this process and not only must we notice similarities to form a general idea, but we

must also set aside particular differences, which are not relevant to the concept in question. The former corresponds to what is now referred to as generalization, the later to discrimination.

There are, however, a lot of objections to this abstraction theory. A fundamental objection or disagreement to this theory is that it pre-supposes what it is meant to explain: namely, the principles by which common elements are abstracted as common and thereby the definition of the concept itself. A second critical point is that what we mean by concept ordinarily implied principled organization, not solely the association of diverse elements with an arbitrary response, and the theory of abstraction cannot account for this organization (Nelson 1974). According to Nelson, the proposed definition of concept as "a common response to dissimilar stimuli" solves the first problem but not the second. In fact, Cassirer's (1953:14-15) critique is quite relevant to this problem. He noted that:

> The concepts of the manifold species and genera are supposed to arise for us by the gradual predominance of the similarities of things over their differences, i.e the similarities alone by virtue of their many appearances imprint themselves upon the mind, while the individual differences which change from case to case fail to attain like fixity and permeance. The similarity of things, however, can manifestly only be effective and fruitful, if it is understood and judged as such... The psychology of abstraction first of all has to postulate that perceptions can be ordered for logical considerations into "series of similars". Without a process of arranging in series, without running through the different instances, the consciousness of their generic connection and consequently of the abstract object could never arise. This transition from member to member, however, manifestly presupposes a principle according to which the form of dependence between each member and the succeeding one is determined.

Cassirer (1953:17) went further to assert that "the concept, however, is not deduced thereby, but pre-supposed; for when we ascribe to a manifold, an order and connection of elements, we have already pre-supposed the concept, if not in its complete form, yet in its fundamental function". This theory, is therefore, assumed to have failed to account

for concept selection and generalization by children. It only accounted for identification of concept instances specified by the parent. Also the abstraction process itself is one that places an extreme load on the information processing capacity of the child.

Semantic feature theory

This theory assumes that the child builds up concepts gradually by progressively more differentiated analysis from a single feature to a complex set of features. According to Nelson (1974:272) "the common assumption of all semantic feature models is that meanings of lexical items (ie words) can be specified in terms of a set of elementary components". Clark (1973) earlier made the proposition that children initially attach word to only one or two features of the word's referents and gradually adds to the set of features in accordance with adult usage, thus acquiring the appropriate 'fixed set' of features that define the adult meaning. Bierwisch (1970:181-182) rightfully noted "that all semantic structures might finally be reduced to components representing the basic dispositions of the cognitive and perceptual structure of the human organism". According to this hypothesis, semantic features cannot be different from language to language but are rather part of the general human capacity of language. Hence what is learned during the process of language acquisition, is not the semantic component, but rather their particular combinations in special concepts, and the assignment of phonemic forms and morphological properties to these concepts. This theory accounts for the identification of referents in the same way that abstraction theory can, but it cannot account for conceptual meaning independent of lexical items.

Piagetian Theory

In Piagetian theory Nelson (1974) noted that permanent objects develop through the child's exercise of his sensorimotor schemes; the first notions of object are tied to the

child's own actions, as well as to the spatial and temporal locations of the object. Thus the object is embedded in a set of schemes: it is not identified in isolation but within a system of possible relationships. The cognitive categories of agent, object, causation, space and time are shown by Piaget to develop through the child's interaction with the environment. Speaking on the Piagetian theory, Sinclair-dezwart (1972:14) explained that:

> Knowledge of objects, their properties and their behaviour develops - moving toward more and more specificity... The development of logic and that of knowledge of the physical world are contrastive and complementary. A logical structure is more powerful when it becomes more general and less linked to a particular content, whereas understanding of object properties is more powerful when it becomes more specific and differentiated.

For Piaget, there is a functional relationship between the sensorimotor scheme and the pre-concept characteristic of the operational child, and finally, the true concept which is established only in the operational period. Although Piaget (1962) has devoted considerable thought to the characteristics of pre-concepts and their reflections in the language of the young child, there is no link established between the specific action scheme or the pre-concept and the general categories of thought that develop in infancy. Piaget's sensorimotor schemes provide an important principle of similarity for the young child to operate with: those things are similar that can be acted upon in the same way. With some modifications, this can serve as the foundation stone for a complete model of the child's early concepts and can help to illuminate both his word learning and sentence construction.

Relational Concept Theory

This theory of concept formation was proposed by Cassirer in 1953. This theory assumes that the essence of a concept is function rather than substance. According to this theory a concept is conceptualized in terms of logical relationships (or logical acts) rather

than in terms of common elements. Thus concept acquisition involves the attempt to comprehend the exemplars of the concept within a function or relational rule rather than through the specification of a set of critical attributes (Nelson, 1974). According to Nelson, Cassirer not only emphasizes essential function at the expense of the structural similarity of things but also makes an important related distinction between what the concept means and how it can be identified. Cassirer (1953:25) states that:

> By the side of what the content is in its material, sensuous structure there appears what it means in the system of knowledge, and thus, its meaning develops out of the various logical acts' which can be attached to the content

And

> The content of the concept cannot be dissolved into the elements of its extension, because the two do not lie on the same plane but belong in principle to different dimensions.

It is noteworthy, however, that this linguistic application of Cassirer's theory has defined the development of sentential relationships, just as the linguistic application of Piagetian theory has been the definition of essential relationships based on the semantic roles.

Conceptions of Scientific Phenomena

Brunner (1986) earlier noted that concepts constitute basic elements one should understand in order to teach or learn science effectively. According to Frank (1982) concepts constitute an idea underlying a class of things or notions. Viewed from this perspective, concepts therefore are the meaning attached to scientific terms which convey special meanings and are used in the formation of laws and theories about regularities in nature.

From physiological perspective, Okafor (1988:143) states that "concepts originate as a result of sensation which is the transmission of neural impulses to the cerebral cortex of the brain. The image of the object which generated the stimulus is formed".

Studies on conceptions of phenomena started several years ago. In fact, the study centred most on how people perceive their physical universe and the factors influencing the perceptions of the universe (Jennifer, 1972; Selin, 1993). Major factors implicated in conceptions of scientific phenomena are language (Fafunwa, 1983), culture (Lloyd, 1992), and the physical environment of the individual (Perchonock and Werner, 1979). The Whorf's (1989:5) hypothesis provided an interesting basis for a clear appreciation of conceptions of phenomena. According to Whorf, "all observers are not led by the same physical evidence to the same pictures of the universe unless their linguistic and cultural backgrounds are similar or can in some way be calibrated". This implies that individuals perceive scientific phenomena in different ways depending on the person's language, culture and immediate environment. Hawking and Pea (1987) hold that children are active interpretative learners who bring their prior understanding and frames of interpretations and other events occurring in their life to the learning situation. These different conceptions held by science students about a given scientific concept are referred to as alternative conceptions. Eze (1995) summarized alternative conception of scientific phenomena as an idea or conception which may be held by the learners about that object which is different from the accepted scientific conception of that object at that point in time. Eze (1995) emphasized that such alternative concepts may not be entirely a wrong idea or notion but might have been discarded due to advances in science. In often cases, these alternative concepts are scientific concepts that originate from the peoples culture. These alternative concepts are scientific concepts that originate from the peoples culture. These alternative concepts are in some cases referred to as misconception by some imperialists, who call themselves the realists. The empiricist call it alternative conceptions in science.

The constructivist posit that developments in the field of science is through the process of constructing theories which are sets of abstractions that represents experience

of the senses. We also understand that experience of the senses are highly dependent on the individual environment and other manifestations. That is to say that the constructivist also believe that culture has some relevance in conceptions of scientific phenomena. Although the conventional sciences may question some indigenous conceptions, their utilization and analysis during science instruction may have an interesting significance in conceptual change and attitude to science.

Attitude to Science

Attitude has been conceptualized from an array of perspectives. It has been perceived in relation to internal state of mind (Gagne, 1972), reactions to external environment (Ewer, 1989), or predisposition to experience (Smith, 1990). Gagne (1977) defined attitude as the readiness to react toward or against a situation, person or things in a particular manner, for example with love or hate or fear or resentment to a particular degree or intensity. Gagne (1977) argued that attitude is a state of mental and emotional readiness on the part of an individual to respond to an educational situation in a manner that gives first place to the attitude of the society and the profession. Gagne believes that attitude is an internal state, that influences the individual's personal actions. This definition assumes that attitude to science implies the reactions, impressions and feelings an individual has to science and science related tasks.

Ewer (1989) perceived attitude as modes of emotional regard for objects and motor sets' or slight tentative reactions toward them. It involves a tendency to act towards or against something in the environment which becomes thereby a positive or negative value. Perceived from this point of view, attitude to science involves modes of emotional regards to science based tasks and activities. It therefore involves the predisposition of individuals to evaluate some symbols or objects of the scientific domain in a favourable or unfavourable manner

Smith (1990) conceptualized attitude in relation to experience. According to him attitude is a predisposition to experience, to be motivated by, and to act towards, a class of object in a predictable manner. Sherif and Sherif (1977) gave a more operational analysis of attitude. They viewed attitude as an individual's set of categories for evaluating a stimulus domain, which he has established as he learns about that domain in interaction with other persons and which relate him to various subsets within the domain with varying degrees of positive and negative effects. Attitude to science is a predisposition to respond to science rather than an actual capability or response to science. It is, according to Carter (1989:295), "a subjective-objective attitude, concern, or condition involving a percept or an idea in attention and a combination of intellectual and feeling of consciousness, based on native curiosity, conditioned by experience". This implies that any preference displaced when choices are available has to do with attitude.

Husen and Neville (1989) dichotomized attitude into two kinds: basic attitudes, that is, the kind of things that a person likes to do, and occupational attitudes, or the degree to which an individual is similar in likes and dislikes to individuals who are happily employed in a particular occupation. These two kinds of attitudes have led to different methods of measurement and assessment. Husen and Neville (1989) also conceived attitude in relation to a state of motivation. They viewed attitude as state of motivation which directs activity toward certain goal and which are resultants of emotional (affective) and motivational (appetitive) processes. Attitude to science, viewed from these perspectives are the mental and emotional disposition of individuals to engage in science related studies and activities. Although there are arguments that attitude does not involve mental disposition since it has not much to do with the actual capability or response, it must be appreciated that attitude is not a spontaneous response rather it evolves from mental processes.

Research studies (Odunusi, 1984; Makinde, 1982) have revealed a dwindling

attitude to sciences over the years. The poor attitude to sciences culminated in the poor enrolment in science subjects at the secondary and tertiary level of education, and also in poor performance in sciences. Since attitude guides readiness to act It should be understood that its effect on scholastic achievement will not be minimal. Okebukola (1986) noted that students' attitude to sciences has always contributed to scholastic achievement in sciences.

Although a lot of studies have been centred on the nature of attitude and ways of creating healthier attitude to sciences (Offiah, 1987) Students' attitude to sciences continued to dwindle and this affects the level of enrolment into science courses both in secondary and tertiary institution (Baiyelo, 1990; Soyibo, 1991). An immediate source of academic distress at this point is, how can attitude to sciences be sustained among our young scholars. Carter (1989) earlier noted that attitude has to do with the combination of intellectual and feeling of consciousness based on native curiosity conditioned by experience. As such, the most appropriate ingredient in all attitude ointments will be the one that touches on the individuals native curiosity and experience. Viewed from this perspective, a package that incorporates the individual's native curiosity and experience within his immediate environment may have a worth-exploring implications in science attitude developments. It would, therefore be very appropriate to explore the influence of an ethnoscience-based instructional package on students' attitude to sciences.

Programme Evaluation: an overview

According to Carter (1989:209) evaluation refers to "the process of ascertaining or judging the value or amount of something by careful appraisal; the process of determining the relative significance of phenomena of the same sort in terms of some standard". He further emphasized that evaluation involves the consideration of evidence in the light of value standards and in terms of the particular situation and the goals which

the group or individual is striving to attain. Program evaluation, therefore, consists of worth or utility of a program in improving some specified aspects of an educational system. Program evaluation, according to Husen and Postlethewaite (1991) may embrace curriculum evaluation and instructional program evaluation.

Some program evaluators (Worthen, 1990; Madey, 1982) are of the opinion that program evaluation can be utilized for formative purpose (helping to improve the program), for a summative purpose (deciding whether a program should be continued) or for prescriptive purpose (deciding on whether a program should be recommended for use in a given system). Anderson and Ball (1978) described the capabilities of a program evaluation in terms of the following purposes:

1. to contribute to decision about program Installation;
2. to contribute to decision about program Continuation, expansion or Certification;
3. to contribute to decision about program Modification;
4. to obtain evidence to rally support for a program;
5. to obtain evidence to rally opposition to a program;
6. to contribute to understanding of basic psychological, social and other processes.

Worthen and Sanders (1993) rightfully observed that a large number of persons serving in the evaluation roles were educational and psychological researchers. As such it should not be surprising that the experimental tradition quickly became the most generally accepted evaluation approach. The work of Campbell and Stanley gave enormous impetus to predominance of experimental or quasi experimental approaches to program evaluation. Husen and Postlethwaite (1991) emphasized clearly that although some evaluators cautioned that correct use of the experimental model may not be feasible, the elegance and precision of such a model led most programme evaluators to view the experimental method as an ideal model for programme evaluation.

Wolf (1991) identified several approaches to evaluation in general. They are the

goal free evaluation, decision oriented evaluation, responsive evaluation, illuminative evaluation, naturalistic evaluation and the qualitative evaluation. The goal free evaluation is an approach to evaluation in which merit is determined from an examination of program effects without reference to goals or objectives. It focuses on results rather than intentions. The decision-oriented evaluation is a process that produces information for selecting among alternative courses of action. An evaluation is decision oriented if it services a decision, implies a choice among alternatives and is used in committing resources for the next interval of time before another decision is to be made. The next evaluation approach is the responsive evaluation. According to Wolf (1990) this approach is an approach which compared to most other approaches is oriented more to the activity, the uniqueness and the social plurality of the program. On the other hand, the illuminative evaluation is an investigation and interpretation of a variety of educational practices, participants' experiences, institutional procedures and management problems, in ways that are recognizable and useful to those for whom the study is made. Another aspect of evaluation is the naturalistic evaluation which is the act of gathering information and juxtaposing it with some set of criteria to make judgements regarding the strength and weaknesses, merits or worth of an educational innovation, program or product while the qualitative evaluation involves a reflective effort to develop the fullest possible range of knowledge about specific educational situations, and to derive meanings and valuations about situations within the fullest possible range of knowledge about their contexts in order to enlarge understanding and to promote moral action (Lewy, 1991).

Although several approaches have been identified for evaluation in general, specific models have been developed for program evaluation. Such models include performance objective congruence, decision management, judgement oriented, adversarial and pluralist intuitionist models.

Models of Program Evaluation

A number of models have been identified in program evaluation. For the purpose of this particular study, the models reviewed are:

1. Performance - Objectives Congruence Model
2. Decision - Management Model
3. Judgement Oriented Model
4. Adversarial Model
5. Pluralist-Intuitionist Model.

1. Performance - Objectives Congruence Model

This approach was originally proposed by Raph Tyler, who conceived of evaluation as the process of determining the extent to which the educational objectives of a school program or curriculum are actually being attained. In this approach, he proposed a process in which broad goals or objectives would be established or identified, defined in behaviourial terms, and relevant student behaviours would be measured against this yardstick, using either standardized or evaluator constructed instrument (Husen and Postlethwaite, 1991). In this approach the outcome data are compared with the behaviourial objectives to determine the extent to which performance was congruent with expectation's. Discrepancies between performance and objectives would lead to modifications intended to correct the deficiency.

This model proposed by Tyler is logical, scientifically accepted especially by those whose methodological upbringing was very compatible with the pretest-post test measurement of student behaviours.

2. Decision - Management Model

In this approach, objectives are eschewed as the organizers of the study and the

decision to be made by program managers becomes pivotal. In this decision oriented model, the evaluator working closely with the program manager would identify the decisions the latter must make and collect sufficient information about the relative advantages and disadvantages of each decision alternative to enable the decision maker to make a judgement about what is best in terms of specified criteria (Smith, 1981). Thus, evaluation became an explicitly shared functions dependent on good team work between evaluators and decision makers. This approach, however, appears to be dependent on somewhat unrealistic assumption's about the orderliness and predictability of the decision making process.

3. Judgement Oriented Model

This model is dependent upon expert's application of professional expertise to yield judgement about a program being observed. In this approach the relative worth of a program would be assessed by experts who would observe the program in action, examine its products or, in some other way, glean sufficient, information to render their considered judgement about the program (Hussen and Postlethwaite, 1991). Examples of this model are site visits initiated by funding agencies to evaluate programs they support and visits by accrediting agencies to schools. This approach generally emphasize the central role of judgement and human wisdom in the evaluative process and have focused attention on the important issues of whose standards should be used in rendering judgement about educational programs.

4. Adversarial Model

According to Hussen and his colleague, the adversarial evaluation is a rubric which embraces a collection of divergent evaluation practices which might loosely be referred to as adversarial in nature. In its broad sense, this approach refers to all

evaluations in which there is planned opposition in the points of view of different evaluators or evaluation teams- a planned effort to generate opposing points of view within the overall evaluation. One evaluator or team would serve as the program's advocate, presenting the must positive view of the program possible from the data, while another evaluator or team would play an adversarial role, highlighting any extant deficiencies in the program. Incorporation of these opposing views, according to Smith (1981), will reflect a conscious effort to assume fairness and balance and illuminate both strengths and weaknesses of the program. Approaches within this model include the judicial, congressional hearing and debate.

5. Pluralist - Intuitionist Model

In this approach to program evaluation, the evaluator is a portrayer of different values and needs of all the individuals and groups served by the program, weighing and balancing this plurality of judgements and criteria in a largely intuitive fashion. Thus the best program is largely decided by the values and perspectives of whomever is judging (Smith, 1981)

So far, five models of program evaluation have been reviewed. The use of these models, to some extent, is dependent on the nature and objectives of the program being evaluated. For this present study which evaluates an instructional program (Ethnoscience-Based) with the specified objectives being conception of scientific phenomena and interest in science, the researcher employed the performance-objectives congruence model. The choice of this method is because of its compatibility with pretest-post test measurement of student behaviours.

2. Empirical Studies

This section presents a few empirical studies on ethnoscience, conception and

concept development and interests in science. Literature reviewed under the empirical studies includes:

(a) Empirical studies on Ethnoscience

(b) Empirical studies on concept and concept development

(c) Empirical studies on interest and interest in sciences

Empirical Studies On Ethnoscience

A lot of empirical research have been conducted which have interesting relevance to the current study on ethnoscience (Albert, 1974; Rose and Philip, 1974; Albert, 1975; Morman, 1979; Etkin, Rose and Mauzzamu, 1990).

In an interesting empirical research titled "American Indian Ethnoscience: A study of its effects on student achievement", Albert (1974) determined whether the use of ethnoscience exemplars in science concept development would increase the academic achievement of Navajo students at the Many Farms High School in Many Farms, Arizona. The major hypothesis of the study was that the mean of the academic achievement of Navajo students in ethnoscience treatments as measured by teacher-constructed examinations was greater than the mean of the science treatments as measured by teacher constructed examinations. Six conservation units utilized in the Many Farms High School biology programme were selected to test the effectiveness of the ethnoscience exemplars.

The sample of Navajo high school students used in the study was selected in a non bias manner and placed into six biology classes. Two teachers were involved in the planning, test construction and implementation of the study. After each unit was presented, a short multiple choice examination was administered and the test data collected. The teachers themselves were evaluated to determine teaching methodology with a scale that indicated expository to discovery characteristics. Both teachers scored

essentially the same and approximately midway between the extremes. An attitude survey relating to the students attitude toward science was administered at the close of the study. This survey was given to determine if ethnoscience topics and materials might have a negative effect on attitude. Result of the survey indicated an overall positive attitude toward science.

The statistical processing of the data involved the use of repeated measures design, two factors with the repetition of the ethno and non ethnoscience treatment only (Lidguist type-one Design). The major hypothesis was not accepted at a 0.05 level of significance. In addition, six post hoc studies were made to test the ethnoscience effect for each unit. Only unit II conservation: water pollution I, proved to be significant at the 0.05 level. The unit also utilized the greatest number of ethno-exemplars, so it would be possible that the effectiveness of ethnoscience was related to the number and type of ethno-exemplars.

In another research development, Rose and Philip (1974) studied the relationship between the ethno-physiological classification of head bones among the Bella Coola people and the western scientific or English approach. The point of emphasis is the extent of correspondence of the primitive approach and the English approach with special reference to linguistic categories. In the study the toponymy of head bones in Bella Coola is described and compared with the corresponding English scientific system. The differences between the two systems reflect the different evolutionary stages to which each system belongs. The Bella Coola system remains in a topographical stage, while the English scientific system has passed through this stage to a morphological one. In addition the following were observed:

(a) Bella Coola has a system of head bone names not merely a random array of head bone names,

(b) that a system exists is shown by evidence of a non linguistic or linguistically neutral nature, namely the results of the part-whole test,

(c) that a system exists is also manifest in the linguistic data that constituted the nomenclature,

(d) that the systems of **b** and **c** are, with one exception, identical and that the only exception is a semantic difference.

This implies that the English scientific approach may have been an offshoot of the so called primitive approach indicating that a close examination of the indigenous system will permit a better and clear understanding of the western scientific systems.

On colour classification, Albert (1975) experimented on colour classification, among the Canadian Eskimos. In his study, nine middle aged Eskimo-speaking persons (three female and six male) of Rankin inlet were interviewed for colour terminology. Testing materials were the Berlin-Kay colour Chart, the Munsell Books of colour and the Ishihara colour Blindness Test. Results indicated that:

(a) not all Central Eskimos have the same colour systems. Their systems differ in some significant details

(b) the colour identification is very much related to the language of the individuals

(c) colours are described with reference to naturally occurring phenomenon and objects within the immediate environment of the subjects used for the study.

The findings of this study, therefore, suggest that individual's perception of the universe is a function of his immediate environment and that linguistic differences have some influence on description of objects and events. This lends credence to the popular Whorf's (1989:1) hypothesis, that all observers are not led by the same physical evidence to the same picture of the universe unless their linguistic and cultural background are similar or can in some ways be calibrated.

Empirical studies were also conducted in the field of ethno-medicine and ethno-pharmaceutics. Morman (1979) studied the traditional healing practices and their relevance to some physiological evidences. In his study titled 'Anthropology of Symbolic healing', he sought to explore the scientific implications of shamanism in healing

practices. A number of investigators agreed that the popular medical systems of tribal, peasant and allied people are effective. Most of the literature closely examining that effectiveness focuses on the ethnopharmacological dimensions of the healing systems and generally ignores psychosocial factors. This study offered insight into these neglected areas. The specific idea revealed by the study is that successful general medical treatment or symbolic healing by either the Shaman or Physician, is based in part on a psychosocial mobilization of the patients' biochemical response system.

On ethno-pharmaceutics. Etkin, Ross and Mauzzamu (1990) studied the indigenization of pharmaceuticals with special emphasis on the therapeutic transition in rural Hausaland. The study which was conducted in Northern Nigeria illustrates how indigenous understanding of disease and therapeutics may influence the utilization of biomedicines. The study observed, however, that these indigenous West African people have indept knowledge of diseases and their symptoms and can even categorize diseases in relation to species of the causative agent. Although the knowledge of such diseases and local therapeutic procedures influence their acceptance of biomedicines, a closer analysis of their drugs revealed close resemblance with the biomedicines in terms of active ingredients indicating that the Biomedicines were produced from cultural knowledge of the drugs. The point of interest, however, is that local knowledge need not be dismissed with a wave of hand especially when there are enough evidence to convince us that the so called 'pure science' is an offshoot of cultural realities.

Finally, Kidwell (1973) compared pure science with ethnoscience with a view of identifying the obvious differences between the two. According to her, most of the practices of American Indian tribes in relation to nature cannot be considered scientific in terms of modern science. When she picked a sample of the American Indian tribes and studied them in these terms, misconceptions arose. She viewed ethnoscience as an entirely new philosophical framework within which to explore the rational and mystical

processes of thought characteristic of a society. The examination of the Chippewa society in these terms reveals Chippewa ideology as indeed scientific, a coherent response to the environment which dictates mode of subsistence, medical practices, supernatural beliefs etc. Within this world view, the Chippewa have achieved a synthesis of the physical aspect of nature with their system of belief in the spirit-forces of nature.

Empirical Studies on Conception and Concept Development

Some empirical studies have been conducted on conception and concept development in children (Dachler, Perlmutter and Myers, 1976; Beeker, et al, 1979; Steinberg 1988; Henley 1989).

Dachler and his co-researchers concerned themselves with the kinds of perceptual and conceptual information that are extracted and stored by very young children in a discrimination learning task. The study was guided by the fact that models of concept development differ widely in crediting the very young child with perceptual, semantic, functional or relational operations (Nelson, 1974), irrespective of the fact that there are surprisingly few data on what is learned by children under three years and to what extent such learning transfers to stimuli varying in systematic ways. In the experiment twenty four children at each of three age levels (mean 24, 29, and 45 months) participated in the two discrimination transfer tasks. Each subject was trained with objects as training stimuli for one problem and with colour photographs of objects as the training stimuli for the other. After reaching criterion on the discrimination learning phase of the task subjects were presented with twelve test trials which include:

(a) same stimulus set as training (SE-SF)

(b) same stimulus set as training, but in different form (ie photographs of objects used during training, or the objects rather than their photographs) (SE-DF)

(c) different exemplars of the training set stimuli in the same form as the originals (DE-SF), and

(d) different exemplars of the training set stimuli in the different form (DE-DF).

The pattern of performance on the four types of test trials was very similar for all three age groups. Different forms of stimuli (object vs picture) were almost always responded to equivalently, while significantly less correct responding was found for new exemplars of training items. A clear finding of the experiment was that children as young as twenty four months of age show remarkably good transfer to new forms and new exemplars of stimuli used in original discrimination learning.

In another interesting empirical study, Becker, Rosner and Nelson (1979) explore stimulus mode and concept formation in preschool children. In this experiment, effects of stimulus mode (objects vs pictures) on the acquisition, generalization and transfer of novel concepts were examined. Sixty five preschool children were taught animal-like and machine-like concepts and then given generalization and recognition tests. On these tests, item mode was either consistent or inconsistent with training mode (object-object; object-picture, picture-object, picture-picture). Neither training nor recognition was affected by stimulus mode. On generalization, however, modality interacted with training mode and level of elaboration. At low elaboration levels, generalization was less for objects than for pictures and was depressed by object training.

The fact that object training lowered identification of the unelaborated objects could imply that concept acquisition with objects is qualitatively different from that with pictures. One form of this proposal rests on the assumption that children interpret objects as complete representations, whereas they expect pictures to be incomplete, suggestive and evocative. This implies that picture training may have established a more abstract representation of the concepts and thereby facilitated identification of unelaborated items. Still on form recognition and concept formation, Nelson (1972) studied the relation of form recognition to concept development. In the study children 18-24 months of age were required to identify pictures of objects in representations at three levels of language

familiarity and two levels of perceptual definition. It was hypothesized that more familiar and more ambiguous concepts would be less readily named in their less detailed representations. Eighteen subjects participated in this experiment. Of these eighteen, fifteen were used in the actual experiment (10 girls, 5 boys); two boys and one girl did not attend to the stimuli sufficiently to provide usable data. Three of the subjects participated twice at two different age levels, yielding a total of eighteen observations.

The stimuli were three-inch-square black and white photographs of representative concept exemplars for each of the twelve concepts. A black and white ink line drawing ("outlines") of the outline form only (no interior detail) was traced from the corresponding photograph for each object and mounted in similar fashion. Black and white drawings including interior details (detailed) were similarly prepared and mounted. The stimulus displays were prearranged and presented to each child in the same order, which counterbalanced pictorial mode. Thus the first three displays were: set I, outline; set II, detailed; set III, photograph. The result revealed that more familiar and more ambiguous concepts were less readily named in their less detailed representations. It was shown that, as predicted, in the early stages of concept development, more familiar (thus more differentiated) concepts require more detail for identification, while less familiar concepts do not require as much detail. This holds particularly for those concepts with ambiguous forms.

Empirical Studies on Attitudes and Attitude to Sciences

Some interesting empirical studies which concerns attitude in general and attitude to science were reviewed in this section. Although some of the studies were not quite recent, they provide necessary background for this particular study.

Omar (1975) conducted an empirical study on factors affecting science attitudes of secondary school students. The purpose of the study was to determine the influence

of some selected variables (instruction, student home and social) on the development of student attitude to science. The study was guided by four null hypotheses. The sample consisted of 340 science students ranging in age from 16-19 years. Students were randomly selected from four secondary schools. There were 166 boys and 174 girls in the sample. Students attitude to science was measured by the Attitude to Science Scale consisting of 140 trial statements. The scale measured student preference for science topics, school science lessons and activities and leisure time science activities. The result of data analysis indicated that some off the variables investigated differentiated significantly between high and low science interest students. Male student with high attitude to science science as compared with male students with low attitudes seem to participate in more science activities, have a better image of their science capabilities, rate their science teachers as better motivators, have more desire to follow a career in science and have parents who exhibit more desire to see them follow a career in science. Female students with high attitude as compared with female students with low attitude to science seem to have parents who exhibit more desire to see them follow a science career, better perceived science and scientists as socially desirable, possess a better image of their science capabilities and have more desire to follow a career in science. It is important to point out that none of the cultural variables examined differentiated significantly between high and low science attitude students. Thus it is reasonable to conclude that students with high attitude to science come from families whose educational levels do not differ from those of families from which students with low attitude to science come.

Some of the variables found to differentiate significantly between high and low science attitude students seem to be sex dependent. The variables: students career desired by parents, career desired by students, and students' perception of his science abilities operate on male and female students. The two variables: motivation of science teachers

and students participation in science activities seem to operate only on male students. The social desirability science variables seem to operate on female students only.

In another empirical study, Smith and Pittman (1978) explored reward, distraction and the over justification effect. The competing response hypothesis predicts that both reward and non reward distraction will produce decreases in attitude that will weaken over repeated trials. The attribution interpretation of the over justification effect, while making no prediction concerning the short term effect of distraction, predicts that reward will produce a decrease in attitude that does not weaken over trials. The study of Smith and Pittman was designed to test these differing predictions by manipulating the number of trials with a target activity and the presence of reward or irrelevant distraction. The design was a 4 x 3 complete between-groups factorial. The experiment involved manipulation of three levels of the reward/distraction variable (reward, nonreward distraction, and a non reward-no-distraction control) crossed with three levels of initial trial participation (10, 25, or 50 trials). The results indicated that rewards produced a constant decrease in attitude over trials, consistent with the attribution explanation. While there are some evidence for a temporary disruption in intrinsic attitude due to no reward distraction, no support was obtained for a distraction interpretation of the effects of rewards on free choice behaviour.

In the same vein, Enzle and Ross (1978) in their empirical study titled "Increasing and Decreasing Intrinsic Attitude with contigent rewards; A test of cognitive evaluation theory", sought to examine Deci's (1975) Intrinsic motivation hypothesis regarding the effects of contigent rewards on Intrinsic task attitude. During the experiment 72 male university students were utilized. They were made to work on a series of puzzles and were offered either a high value reward or a low value reward. The rewards which are in money terms were given either contigent upon the simple execution of the task (task contigent), contigent upon the ostensible attainment of a performance criterion level

(criterion contigent), or noncontigent and unexpected (control). Compared to the high payment control subjects, subjects who received the criterion-contigent high reward rated it as more interesting. Also, subjects expressed less interest in the task after receiving the high task-contigent reward than the low task contigent reward, but indicated greater attitude after receiving the high criterion-contigent reward. The study, therefore drew the conclusion that substantial support was obtained for Deci's (1975) cognitive evaluation theory. Evidence was obtained that contigent rewards may either decrease or increase intrinsic interest depending on whether the control aspect or the competence information aspect of the reward is made salient.

Summary of the Review

So far the review has presented a fair analysis of studies that relate to ethnoscience conception of scientific phenomena, attitudes to science and their relevance to science education both from the theoretical and empirical dimensions. The review dealt with basic concepts of ethnoscience and exposed ethnoscience as the science that is indigenous to a particular culture. Viewed from that perspective the researcher feels that the utilization of its basic concepts and paradigms during instructional process may have an interesting implication for a virile science education program in Nigeria. The review further explored the scope of ethnoscience as embracing some elements of physics, Chemistry, biology and medicine in a culturally standardized form. As such, its application during teaching and learning may help students get acclimatized to the Western Science which is to some extent strange and conflicting with the pupil's initial knowledge.

The review further explores the rationale for studies in ethnoscience and presented an interesting evidence to show the linkage or relationship between ethnoscience and conventional science. With such relationships in mind, one may begin to appreciate the

fact that its application during instructional process in conventional science may likely help in closing up the gulf or bridging the chasm between the Nigeria pupil who were brought up in our traditional environment and conventional sciences which is completely alien to the pupils both in content, materials and methods. As such the review presents a need for research into the efficacy of an ethnoscience-based instructional package in resolving the conflicts and cognitive disequilibrium that arise among African Children as a result of the introduction of conventional science into their school program. The review also analyzed models of concept formation and attitudes to science. Concept formation was viewed from an array of theoretical perspectives especially as it concerns the child's background. The review, though not quite extensive provides necessary background for the current investigation on ethnoscience, conception of scientific phenomena and attitude to science.

CHAPTER THREE

RESEARCH METHOD

This chapter presents the general method and procedure the researcher adopted in the experimentation, collection of data and data analysis which made it possible for the researcher to answer the research questions and test the hypotheses that guided this study. This chapter is subdivided into the following units: Design, Area of study, population of study, sample and sampling procedure, instrument for data collection, validation of the instruments, Reliability of the instruments, Experimental procedure, control of extraneous variables, method of data collection and method for data analysis.

Design

This study is a quasi-experimental study. In a quasi-experimental study there is no random assignment of subjects. Intact classes were, therefore, used for the study. The specific design the researcher used for the study is a non equivalent control group design. There was an experimental group and control group. The design is represented thus:

$$\frac{Y^b \quad X \quad Y^a}{Y^b \quad \sim X \quad Y^a}$$

Where

Y^b = measurement taken before treatment

Y^a = measurement taken after treatment

X = treatment

$\sim X$ = No treatment

The choice of this design is because of its compatibility with the Performance - Objective Congruence model of program evaluation which this study adopted.

Area of Study

This study was conducted within the Nsukka Education zone of Enugu State. The researcher used Nsukka Education zone only to ensure that all the students in both the experimental and control group share a common environment

Population of Study

The population for this study comprised of all J.S III students in all secondary schools within the Nsukka Education zone of Enugu State. The choice of JS III students is to ensure that students used for the study are already familiar with the course.

Sample and Sampling Procedure

The sample for this study comprised of two hundred and forty three JS III students drawn from six Secondary Schools out of the one hundred and one Secondary Schools in Nsukka Education zone of Enugu State. The six secondary schools (2 boys, 2 girls and 2 co-educational) were drawn through a stratified random sampling. In each school one intact class was drawn for the study through simple random sampling. Out of the six schools, three schools (one male, one female and one co-educational) were assigned to the treatment group while the remaining three schools were assigned to the control group. The assignment of the schools to the treatment and control group was done through a stratified random sampling. In each school, one intact class was drawn for the study through a simple randorn sampling.

The distribution of research subjects in the intact classes for the study is shown in the table below.

Table I: *Distribution of research subjects (students) in the various intact classes used for the study.*

GROUP	NAME OF SCHOOL	NO OF MALES	NO OF FEMALES	ROW TOTAL
TREATMENT GROUP	Q.R.S.S. Nsukka C.S.S. Uda S.T.C. Nsukka	- 13 42	46 18 -	46 31 42
SUB-TOTAL		55	64	119
CONTROL GROUP	B. H. S. Orba M.S.S. Nsukka G.S.S Ibagwa	39 12 -	- 29 44	39 41 44
SUB-TOTAL		51	73	124

For the experimental group a total of one hundred and nineteen J.S III students were used (55 males and 64 females) while for the control group a total of one hundred and twenty four J.S. III students (51 males and 73 females) were used.

Instrument for Data Collection

The instruments the researcher used for data collection are

(a) Conception of Scientific Phenomenon Test (CSPT)

(b) Attitude to Science Scale

The Conception of Scientific Phenomenon Test (Appendix III) is a twenty item multiple choice test with some provisions for comments on the views/opinions of the respondent which will back up the choice of options made. The instrument contains four options A-D for each of the twenty items in addition to a separate column for those who have no opinion/view for individual items. The items were designed to reflect the following views: mythology, supernatural, mystical, popular and western scientific or modern scientific. The distribution of response options in relation to world views is shown in appendix IV.

The instrument was designed to explore students' conception of scientific phenomena. The instrument was used for both pretest and post test. Since the instrument is a conception test there was no fear of testing effect.

The second instrument is the Attitude to Science Scale adapted from Baggaley (1973). The Instrument is a 20-Item likert-type Instrument designed to assess students atttude to science. The instrument was designed to suit this particular study through the following procedures:

(a) Grammar and Syntax were altered for each item so that each item will remain clear and relevant.

(b) The items on the scale were examined and substitution of some irrelevant items were made.

(c) Since the Baggaley (1973) instruments contained several negatively stated items, the same order were maintained.

The instrument was scored on a 4-point basis: strongly agree, agree, disagree and strongly disagree. The Conception Test and Attitude Scales are shown in appendices III and V respectively.

Validation of the Instruments

The Conception of Scientific Phenomenon Test was face validated by experts in research and Science Education. During face validation the items were scrutinized in terms of relevance, general test format, suitability, and clarity. After the face validation the instrument was completely overhauled to reflect the expert contributions of the validators.

The Attitude to Science Scale was also face validated by experts in science education and research. Since the Attitude Scale is an adaptation of already standardized and universally accepted scales, the researcher deemed it very unnecessary to go into further factorial validation of the instrument.

Reliability of the Instruments

The reliability of the Conception of Scientific Phenomenon Test was assessed using a qualitative approach. The researcher employed the retest typology analysis. Result of the test is shown in appendix VI. The Baggaley attitude scale has a retest reliability of 0.86 and an alpha of 0.78 on the internal consistency measure.

Experimental Procedure

Two instructional packages were used for this study. The first package is the ethnoscience based package developed by the researcher. The second package is the conventional package drawn from the Integrated science curriculum module of the Federal Ministry of Education. The ethnoscience based package is identical to the conventional package in terms of content, basic instructional objectives and mode of evaluation. The only difference is in the instructional activities where ethnoscience package deviates from the conventional approach by employing ethnoscientific principles, paradigms and theories during the instructional process. The ethnoscience based package was used for the treatment group whereas the conventional package was used for the control group.

Before the onset of the experiment, subjects in both treatment and control groups were given the pre-test. After the pre-test the regular Integrated science teachers started the experiment in their respective schools adhering strictly to the lesson procedure developed from the packages during the pre-experimental conference. The experiment was conducted during the normal school periods, following the normal time table of the school. At the end of the experiment which lasted for one term (14 weeks) the teachers administered the post-tests to the subjects in the two groups. Data collected from the pretest and post-test on the two measures (Conception and Attitude) were kept separately for the two groups and were used to answer the research questions and test the

hypotheses which guided this study.

Control of Extraneous Variables

The researcher adopted the following procedures to ensure that extraneous variables which may introduce bias into the study are controlled.

(a) Teacher Variable

In order to control the errors which may arise as a result of teacher difference, the researcher organised a pre-experimental conference for the teachers that were used for the study. Separate conferences were conducted for teachers in the two groups (treatment & control). The conference helped to establish a common instructional standard among the instructors. All topics for the study were treated in detail at the respective conferences. The researcher also used the opportunity of the conference to detect individual problems of the teachers that may introduce errors to the study (eg not being interested in the specific objectives, contents and activities as specified in the module and also in sequencing of the Items). It was agreed at the conference that everyone involved in the study will adhere strictly to the specifications of the package to ensure uniformity. The teachers conducted the experiment in their individual schools and individual classes. The study was regularly monitored by the researcher to ensure that teachers do not deviate from the normal procedure of instruction.

(b) Instructional Situation Variable

To ensure that instructional situation is the same for all the schools, the researcher issued out instructional guides to the teachers in each group. The teaching was conducted in all classes of JS III in the various schools used for this study and not just in the intact classes drawn for the study. This is to avoid Hawthorne effect. Pre-test was also

administered to all the classes but post test was restricted to the intact class chosen for the study.

(c) Intergroup Variable

Because intact classes were used for this study it is implied that initial equivalence was not achieved for the research subjects in the two groups. In order to eliminate the errors of non equivalence arising from the non randomization of the subjects, the researcher used the analysis of co-variance (ANCOVA) for data analysis. This corrected for initial difference among the research subjects.

(d) Subject Interaction

The researcher did not select treatment and control group from the same school to ensure that the students in the treatment and control groups do not mix up at all. This is to reduce the errors arising from interaction and exchange of ideas among research subjects from the two groups and further eliminates the possibility of a John Henry Effect.

Method of Data Collection

At the onset of the experiment, the researcher administered the pre-test (for both the conception and attitude) to the students. Scores of the students on the pre-test were recorded and kept behind for use after the experiment. At the end of the experiment, the post-test for both the attitude and conception were administered to the entire members of the class. Although all the classes received equal treatment in terms of receiving the pretest and being taught along with other, data for the study was restricted to the intact classes that were drawn for the study. For each of the groups, data for the pre-test and post test were recorded separately.

Method of Data Analysis

Data were analyzed both qualitatively and quantitatively. Qualitatively, the researcher employed categorizing and typologies in analyzing the data on conception of scientific phenomena. Concepts were categorized into two: Western scientific catergory and ethnoscientific category. For the ethnoscientific category, there are four conceptual types: Type A - Mythology, Type B - Supernatural, Type C - Mystics and, Type D - Popular. The Western scienific category was assigned Type F. Data on attitude to science were analyzed quantitatively using mean, standard deviation and analysis of Co-Variance (ANCOVA).

CHAPTER FOUR

RESULTS

This chapter presents results of data analysis based on the five research questions and three hypotheses that guided this study.

Research Questions

Research Question I

What is the effect of the ethnoscience based instructional package on students' conception of scientific phenomena?

For this research question, data collected with the Conception of Scientific Phenomenon Test for both the treatment and control groups were analyzed qualitatively in terms of conceptual shift patterns. The concepts were categorized into two: western scientific category and ethnoscientific category. Within the ethnoscientific category, four conceptual types were isolated. They are mythological, supernatural, mystical and popular views. The western scientific category was not subdivided into conceptual types since its verification is mono-methodological ie scientific method. The specification of the typologies for each of the items of the conception test is shown in appendix iv. The major response types utilized in this study are:

Type A = mythology

Type B = supernatural

Type C = mystics

Type D = popular

Type F = Western Scientific

Since there is a provision for respondents who have no notion for any of the response options, No NOTION was included as a type of response ie type E'. Detailed

description of explanatory responses that qualifies a response as mythology, supernatural, mystics, popular and western scientific are also presented in appendix IV.

Summary of conceptual shift from each of the topological strata for both the treatment and control group is presented in Table 1.

Table 1: *Summary of conceptual shifts from response types A-F for the control and treatment groups (Percentages were approximated to the nearest whole number).*

CONTROL GROUPS

	A	B	C	D	E	F
1A	-	-	-	-	-	-
B	-	36 29%	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	58 47%	-	3 2%
E	-	-	-	-	6 5%	-
F	-	-	-	-	-	18 15%
2A	43 35%	-	16 13%	-	-	2 2%
B	-	-	-	-	-	-
C	-	-	26 21%	-	-	-
D	-	-	-	4 3%	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	13 11%
3A	20 16%	-	-	-	-	-
B	-	33 27%	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	19 15%	-	-	47 38%	-
F	-	-	-	-	-	4 3%
4A	18 15%	-	-	-	-	2 2%
B	-	-	-	-	-	-

EXPERIMENTAL GROUPS

	A	B	C	D	E	F
A	-	-	-	-	-	-
B	-	-	-	-	-	15 13%
C	-	-	-	-	-	-
D	-	-	-	4 3%	-	80 67%
E	-	-	-	-	-	-
F	-	-	-	-	-	18 15%
A	-	-	-	-	-	40 34%
B	-	-	-	-	-	-
C	-	-	-	-	-	52 44%
D	-	-	-	-	-	-
E	-	-	-	-	-	7 6%
F	-	-	-	-	-	15 13%
A	2 2%	-	-	-	-	14 12%
B		-	-	-	-	27 23%
C	-	-	-	-	-	-
D	-	-	-	11 9%	-	26 22%
E	-	-	-	-	-	21 18%
F	-	-	-	-	-	14 12%
A	-	-	-	-	-	42 35%
B	-	-	-	-	-	-

	A	B	C	D	E	F
C	-	-	34 27%	-	-	-
D	-	-	-	21 17%	-	-
E	-	-	15 12%	-	-	-
F	-	-	-	-	-	8 6%
5A	29 23%	31 11%	-	-	-	-
B	-	43 35%	-	-	-	3 2%
C	-	-	-	-	-	-
D	-	-	-	20 16%	-	4 3%
E	-	-	-	-	-	-
F	-	-	-	-	-	16 13%
6A	-	-	-	-	-	-
B	-	15 12%	-	-	-	12 10%
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	30 24%	2 2%
F	-	-	-	-	-	61 49%
7A	37 30%	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	76 61%	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	10 8%
8A	33 27%	6 5%	-	-	-	-
B	-	17 14%	-	-	-	-
C	-	-	51 41%	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-

	A	B	C	D	E	F
C	-	-	-	-	-	37 31%
D	-	-	-	-	-	4 3%
E	-	-	-	-	-	6 5%
F	-	-	-	-	-	8 7%
A	-	-	-	-	-	4 3%
B	-	-	-	-	-	40 34%
C	-	-	-	-	-	-
D	-	-	-	-	-	57 48%
E	-	-	-	-	-	4 3%
F	-	-	-	-	-	10 8%
A	-	-	-	-	-	20 17%
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	17 14%
F	-	-	-	-	-	77 65%
A	-	-	-	6 5%	-	76 64%
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	26 22%
E	-	-	-	-	-	2 2%
F	-	-	-	-	-	8 7%
A	-	-	-	-	-	11 9%
B	-	-	-	-	-	16 13%
C	-	-	-	-	-	71 60%
D	-	-	-	-	-	-
E	-	-	-	-	-	6 5%

	A	B	C	D	E	F
F	-	-	-	-	-	10 8%
9A	24 19%	5 4%	-	25 20%	-	-
B	-	7 6%	-	-	-	3 2%
C	-	-	-	-	-	-
D	-	-	-	39 31%	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	8 6%
10A	24 19%	-	-	28 23%	-	-
B	-	-	-	-	-	-
C	-	-	16 13%	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	16 13%	-
F	-	-	-	-	-	39 31%
11A	14 11%	-	-	-	8 7%	17 14%
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	44 35%	20 16%
F	-	-	-	-	-	15 12%
12A	39 31%	-	-	-	-	-
B	-	15 12%	-	-	-	
C	-	-	44 35%	-	-	3 2%
D	-	-	-	-	-	-
E	-	-	-	-	10 8%	-
F	-	-	-	-	-	13 11%
13A	12 10%	-	-	-	-	3 2%
B	-	-	-	-	-	-

	A	B	C	D	E	F
F	-	-	-	-	-	10 8%
A	-	-	-	-	-	1 1%
B	-	-	-	-	-	26 22%
C	-	-	-	-	-	-
D	-	-	-	-	-	73 61%
E	-	-	-	-	-	6 5%
F	-	-	-	-	-	10 8%
A	-	-	-	-	-	56 47%
B	-	-	-	-	-	-
C	-	-	-	-	-	39 33%
D	-	-	-	-	-	-
E	1 1%	-	-	-	-	9 8%
F	-	-	-	-	-	14 12%
A	-	-	-	-	-	21 18%
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	19 16%
E	4 3%	1 1%	-	-	-	4 3%
F	-	-	-	-	-	67 56%
A	-	-	-	-	-	18 15%
B	-	-	-	-	-	58 49%
C	-	-	-	-	-	21 18%
D	-	-	-	-	-	-
E	-	-	-	-	-	9 8%
F	-	-	-	-	-	10 8%
A	-	-	-	-	-	-
B	-	-	-	-	-	-

	A	B	C	D	E	F
C	-	-	-	-	-	-
D	-	-	-	76 61%	-	8 6%
E	-	-	-	16 13%	-	-
F	-	-	-	-	-	9 7%
14A	26 21%	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	75 60%	-	-	2 2%
D	-	-	-	-	-	-
E	-	-	-	-	3 2%	-
F	-	-	-	-	-	11 9%
15A	34 27%	-	-	-	-	3 2%
B	-	-	-	-	-	-
C	-	-	25 20%	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	12 10%	8 6%
F	-	-	-	-	-	38 31%
16A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	84 68%	-	6 5%
E	-	-	-	12 10%	7 6%	-
F	-	-	-	-	-	8 6%
17A	12 10%	-	-	-	-	-
B	-	26 21%	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	54 44%	-	6 5%
E	-	-	-	-	11 9%	-

	A	B	C	D	E	F
C	-	-	-	-	-	-
D	-	-	-	-	-	99 83%
E	-	-	-	-	-	5 4%
F	-	-	-	-	-	12 10%
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	74 62%
D	-	-	-	-	-	-
E	-	-	-	-	-	20 17%
F	-	-	-	-	-	23 19%
A	-	-	-	-	-	6 5%
B	-	-	-	-	-	-
C	-	-	-	-	-	8 7%
D	-	-	-	-	-	-
E	-	-	-	-	-	13 11%
F	-	-	-	-	-	87 73%
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	3 3%	-	81 68%
E	-	-	-	-	-	2 2%
F	-	-	-	-	-	27 23%
A	-	-	-	-	-	13 11%
B	-	-	-	-	-	25 21%
C	-	-	-	-	-	-
D	-	-	-	-	-	60 50%
E	-	-	-	-	-	4 3%

	A	B	C	D	E	F
F	-	-	-	-	-	13 11%
18A	10 8%	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	31 25%	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	68 55%	5 4%
F	-	-	-	-	-	9 7%
19A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	6 5%	-	-	-	-	8 6%
D	-	-	-	-	-	-
E	-	-	-	-	31 25%	7 6%
F	-	-	-	-	-	68 55%
20A	29 23%	-	-	-	-	-
B	-	43 35%	-	-	-	-
C	-	-	28 23%	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	24 19%

	A	B	C	D	E	F
F	-	-	-	-	-	13 11%
A	-	-	-	-	-	1 1%
B	-	-	-	-	-	-
C	-	-	-	-	-	23 19%
D	-	-	-	-	-	-
E	-	-	-	-	-	77 65%
F	-	-	-	-	-	15 13%
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	11 9%
D	-	-	-	-	-	-
E	-	-	-	-	-	22 18%
F	-	-	-	-	-	80 67%
A	-	-	-	-	-	29 24%
B	-	-	-	-	-	36 39%
C	-	-	-	-	-	23 19%
D	-	-	-	-	-	-
E	-	-	-	-	-	1 1%
F	-	-	-	-	-	27 23%

Result present in Table 1 reveals that Ethnoscience based instructional package facilitates conceptual change from mythology. supernatural, mystical and popular to western scientific while still strengthening already acquired western scientific concepts among students. In item '2' of the Conception Test, 40 research subjects shifted their views from mythology to western scientific following the treatment. For the group that received no treatment (control group) 43 research subjects retained their mythological views, 16 shifted from mythology to mystics while only 2 shifted their views to western

scientific. As shown in table 1, most research subjects in the control groups retained their mythological views, some shifted to supernatural, mystics and popular views with only very insignificant number shifting toward western scientific. For the treatment group, the case is different. Except for item 3 where two students retained mythological views and item '7' where six students shifted from mythology to popular view, a very large number of students (see Table 1) shifted from mythology to western scientific.

Result presented in table 1 also reveal an interesting pattern of conceptual shift from concept type 'B' (supernatural) to the various conceptual typologies for both the control and treatment groups. The result presented in table 1 on shift from supernatural reveal that for the control group most students/research subjects who indicated supernatural views for the items retained their views. On the other hand, all the students who indicated supernatural views for the experimental group or treatment group shifted to western scientific.

Results presented in Table 1 also reveal conceptual shift from mystical views (concept type) to the various conceptual types. For the treatment group (group taught science using the ethnoscience based package) all students whose concepts, based on the conception test were mystically oriented, shifted to western scientific views following treatment. In the control group almost all the students whose views were mystically oriented retained the same view with only 3, 2, and 8 research subjects for items 12,14 and 19 respectively shifting to western scientific (see Table 1).

Table 1 also present conceptual shift patterns from concept type D (popular views) to the various conceptual strata for both the treatment and control groups. Result presented in the table indicate that for the ethnoscience based package concept shifted to western scientific. A glance at Table 1 reveals that for the control group all the students who indicated a popular view retained the same view except in items 1, 5, 16 and 17 where only 3, 4, 6 and 6 research subjects respectively shifted their views to western

scientific. This number is comparably very small when one considers the large number of students that retained the popular views (see table 1). For the treatment group, the reverse was the case because all the students who earlier indicated popular views shifted to western scientific at the end of the study except in items 1,3, and 16 where only 4, 11 and 3 students respectively retained their popular views at the end of the study.

Results of conceptual shift patterns presented in table 1 also reveals that for the treatment groups, students who earlier indicated no notion had a shift toward western scientific views except in items 10 and 11 where only one and four students respectively shifted from no notion to mythology. On the other hand, summary of data analysis shown in table 1 indicate that for the control group most students who had no notion for the various items of the conception test retained their views. For the control group only a few students (two for item 6, twenty for item 11, eight for item 15, five for item 18 and seven for item 19) shifted to western scientific, while a few also shifted to supernatural, mystical and popular (see Table 1).

Finally, result presented in Table 1 interestingly reveals that for both the control and treatment groups, students who indicated western scientific views retained the same views at the end of the study. This indicates that although the conventional package does not facilitate conceptual shift toward western scientific, it has no deteriorating effect on already formed western scientific concepts.

Research Question 2

What is the effect of the ethnoscience based instructional package on conception of scientific phenomena among male and female students?

Data collected from the treatment group only on conception of scientific phenomena were considered for male and females. Summary of conceptual shift following treatment are shown in table 2. In the table the columns labelled 'm' is for

males while the columns labelled 'f' is for females.

Table 2 : *Summary of conceptual shift from concept type A-F for males and females following treatment.*

POST TEST

	A		B		C		D		E		F	
	M	F	M	F	M	F	M	F	M	F	M	F
1A	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	5 9%	10 16%
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	1 2%	3 5%	-	-	36 65%	44 69%
E	-	-	-	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-	-	11 20%	7 11%
2A	-	-	-	-	-	-	-	-	-	-	16 29%	24 38%
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	24 44%	28 51%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	7 13%	-
F	-	-	-	-	-	-	-	-	-	-	4 7%	11 17%
3A	-	2 3%	-	-	-	-	-	-	-	-	9 16%	5 8%
B	-	-	-	-	-	-	-	-	-	-	16 29%	11 17%
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	11 20%	-	-	-	15 27%	21 33%
E	-	-	-	-	-	-	-	-	-	-	9 16%	12 19%
F	-	-	-	-	-	-	-	-	-	-	6 11%	8 13%

	A		B		C		D		E		F	
	M	F	M	F	M	F	M	F	M	F	M	F
4A	-	-	-	-	-	-	-	-	-	-	18 33%	24 38%
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	21 38%	16 25%
D	-	-	-	-	-	-	-	-	-	-	4 7%	-
E	-	-	-	-	-	-	-	-	-	-	3 5%	3 5%
F	-	-	-	-	-	-	-	-	-	-	5 9%	4 6%
5A	-	-	-	-	-	-	-	-	-	-	-	4 6%
B	-	-	-	-	-	-	-	-	-	-	17 31%	23 36%
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	27 49%	30 47%
E	-	-	-	-	-	-	-	-	-	-	4 7%	-
F	-	-	-	-	-	-	-	-	-	-	4 7%	6 9%
6A	-	-	-	-	-	-	-	-	-	-	9 16%	11 17%
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	7 13%	10 16%
F	-	-	-	-	-	-	-	-	-	-	36 65%	41 64%
7A	-	-	-	-	-	-	3 5%	3 5%	-	-	36 65%	40 63%
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	10 18%	16 25%
E	-	-	-	-	-	-	-	-	-	-	2 4%	-

	A		B		C		D		E		F	
	M	F	M	F	M	F	M	F	M	F	M	F
F	-	-	-	-	-	-	-	-	-	-	3 5%	5 8%
8A	-	-	-	-	-	-	-	-	-	-	4 7%	7 11%
B	-	-	-	-	-	-	-	-	-	-	6 11%	10 16%
C	-	-	-	-	-	-	-	-	-	-	28 51%	43 67%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	6 11%	-
F	-	-	-	-	-	-	-	-	-	-	6 11%	4 6%
9A	-	-	-	-	-	-	-	-	-	-	1 2%	-
B	-	-	-	-	-	-	-	-	-	-	10 18%	16 25%
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	30 55%	43 67%
E	-	-	-	-	-	-	-	-	-	-	6 11%	-
F	-	-	-	-	-	-	-	-	-	-	6 11%	4 6%
10A	-	-	-	-	-	-	-	-	-	-	25 45%	31 48%
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	17 31%	22 34%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	9 16%	-
F	-	-	-	-	-	-	-	-	-	-	3 5%	11 17%
11A	-	-	-	-	-	-	-	-	-	-	5 9%	16 25%
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-	-

	A		B		C		D		E		F	
	M	F	M	F	M	F	M	F	M	F	M	F
D	-	-	-	-	-	-	-	-	-	-	9 16%	10 16%
E	4	-	1	-	-	-	-	-	-	-	4 7%	-
F	-	-	-	-	-	-	-	-	-	-	30 55%	37 58%
12A	-	-	-	-	-	-	-	-	-	-	7 13%	11 17%
B	-	-	-	-	-	-	-	-	-	-	25 45%	33 52%
C	-	-	-	-	-	-	-	-	-	-	8 15%	13 20%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	9 16%	-
F	-	-	-	-	-	-	-	-	-	-	4 7%	6 9%
13A	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	42 76%	57 89%
E	-	-	-	-	-	-	-	-	-	-	5 9%	-
F	-	-	-	-	-	-	-	-	-	-	5 9%	7 11%
14A	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	33 60%	41 64%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	12 22%	8 13%
F	-	-	-	-	-	-	-	-	-	-	8 15%	15 23%
15A	-	-	-	-	-	-	-	-	-	-	2 4%	4 6%
B	-	-	-	-	-	-	-	-	-	-	-	-

	A		B		C		D		E		F	
	M	F	M	F	M	F	M	F	M	F	M	F
C	-	-	-	-	-	-	-	-	-	-	2 4%	6 9%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	8 15%	5 8%
F	-	-	-	-	-	-	-	-	-	-	40 73%	47 73%
16A	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	2 4%	1 2%	-	-	30 55%	51 80%
E	-	-	-	-	-	-	-	-	-	-	2 4%	-
F	-	-	-	-	-	-	-	-	-	-	16 29%	11 17%
17A	-	-	-	-	-	-	-	-	-	-	5 9%	8 13%
B	-	-	-	-	-	-	-	-	-	-	13 24%	12 19%
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	27 49%	33 52%
E	-	-	-	-	-	-	-	-	-	-	4 7%	-
F	-	-	-	-	-	-	-	-	-	-	4 7%	9 14%
18A	-	-	-	-	-	-	-	-	-	-	1 2%	-
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	10 18%	13 20%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	36 65%	41 64%
F	-	-	-	-	-	-	-	-	-	-	5 9%	10 16%
19A	-	-	-	-	-	-	-	-	-	-	-	-

	A		B		C		D		E		F	
	M	F	M	F	M	F	M	F	M	F	M	F
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	5 9%	6 9%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	12 22%	10 16%
F	-	-	-	-	-	-	-	-	-	-	32 58%	48 75%
20A	-	-	-	-	-	-	-	-	-	-	12 22%	17 27%
B	-	-	-	-	-	-	-	-	-	-	16 29%	20 31%
C	-	-	-	-	-	-	-	-	-	-	8 15%	15 23%
D	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	1 2%	-
F	-	-	-	-	-	-	-	-	-	-	15 27%	12 19%

The summary of result presented in Table 2 reveal an almost uniform pattern in conceptual shift for both males and females. Both males and females shifted from mythology, supernatural, mystics, and popular views to western scientific. Also both males and females who earlier had no notion did shift to western scientific views following treatment (ethnoscience based instruction).

A closer look at the table may suggest that for females there is a slightly greater shift to western scientific concept. Although on a general note, conceptual shift to western scientific concepts were in favour of females, for some response types (eg type A of item 3, 7, and 12; type B of items 3 and 17; type C of item 4; type D of item 5 and type E of items 14, 15 and 19) percentage conceptual shift to modern scientific concepts were sligtly in favour of males.

Except on a very close observation, it would be difficult to notice this very minor

difference in conceptual shift to western scientific views for male and females.

Research Question 3

What is the effect of the ethnoscience based instructional package on students attitude to science ?

Data obtained from the Attitude to Science Scale administered to research subjects in both the treatment and control groups were used to answer the research questions. Summary of result obtained for the two groups is show in table 3.

Table 3 : Mean attitude to science scores of students taught science using the ethnoscience based and conventional package.

GROUPS	MEAN (X)	STD. DEV.
GROUP 'A'(Group taught science with the ethnoscience based package).	67.73	7.48
Group 'B'(Group taught science with the conventional package).	49.18	12.60

Summary of result presented in table 3 reveal that ethnoscience based package is superior to the conventional package in fostering attitude to science. The ethnoscience based package yielded a mean attitude score score of 67.73 with a standard deviation of 7.48 while the conventional package yielded a mean of 49.18 and a standard deviation of 12.60.

Research Question IV

What is the effect of the ethnoscience-based instructional package on science attitude of male and female students?

For this research question, the science attitude scores of males and females taught science using the ethnoscience-based package were separated. The summary of result is shown in Table 4.

Table 4: Attitude to science scores of males and females taught science using the ethnoscience based instructional package.

GROUPS	MEAN (X)	SD
Males taught science using the ethnoscience-based package	63.44	8.32
Females taught science using the ethnoscience package	72.02	6.64

Result in table 4 reveal that the ethnoscience based package yields a higher attitude to science among females than for males. The mean science attitude scores of females taught science using the ethnoscience based package is 72.02 with a standard deviation of 6.64 while the males had a mean attitude score of 63.44 with a standard deviation of 8.32.

Research Question 5

What is the interaction effect of gender and instructional approach on students attitude to science?.

The adjusted mean for the two levels of gender who were taught science with the ethnoscience-based package and conventional package was used to assess the interaction. Summary of the result is presented in table 5.

Table 5: Interaction between gender and instructional approach on students attitude to science.

GENDER GROUPS	x for Ethnoscience based	x for conventional
MALES	63.44	48.38
FEMALES	72.02	49.95

Summary of result presented in table 5 reveal clearly that there is no interaction between gender and teaching method on students' attitude to science. Result presented in the table indicate that the ethnoscience based approach is superior to the conventional approach at the two levels of gender (male and female).

Hypotheses

HO_1 : *There will be no significant difference in the mean attitude scores of students taught science using the ethnoscience-based instructional package and those taught science using the conventional package.*

HO_2 : *There will be no significant difference in the mean attitude scores of males and females taught science using the ethnoscience based instructional package*

HO_3 : *The interactive effects of gender and instructional approach on students attitude to science will not be significant.*

These hypotheses were tested using analysis of co-variance. Summary of the analysis for the three hypotheses is shown in Table 6.

Table 6: Analysis of Co-Variance (ANCOVA) for students overall attitude scores by instructional approaches and by gender.

Sources of Variation	Sum of Squares	df	Mean Squares	F	F_{CV}
Covariate	699.331	1	699.331	3.237	
Main Effects	54408.711	2	27204.355	125.927	
Gender	650.486	1	650.486	3.011	3.84
T. method	49284.172	1	49284.172	228	3.84
2- way interaction (Gender & T. method)	715.725	1	715.725	3.313	3.84
Explained	55823.767	4	13955.942	64.601	
Residual	51415.863	238	216.033		
TOTAL	**107239.630**	**242**			

For hypothesis 1, the ANCOVA table shows that the F-cal (228) is greater than the critical value (3.84) at an alpha level of 0.05. The decision rule is to reject the null hypothesis when the calculated value exceeds the critical value at a given probability level. Since the calculated value is greater than the critical value, the null hypothesis was rejected. The researcher, therefore, concludes that there is a significant difference in the

mean attitude scores of students taught science using the ethnoscience based instructional package and those taught science using the conventional package.

For hypothesis 2, Table 6 reveal that F-cal (3.011) is less than the F_{CV} (3.84) at an alpha level of 0.05. Since the calculated value is less than the critical value at the given alpha level, the null hypothesis is not rejected.

The researcher, therefore, upholds the null hypothesis and concludes that the difference between the mean science attitude scores of male and female students taught science using the ethnoscience based instructional package is not significant.

For hypothesis 3, result in Table 6 also reveals that for the two way interaction, the F-calculated is 3.313 while the critical value at 5% probability level is 3.84. Based on the decision rule, the researcher upholds the null hypothesis and concludes that there is no significant interaction between gender and instructional approach on students attitude in science.

Summary of Results

Results presented in this chapter reveals the following:

1. Ethnoscience based instruction facilitated conceptual shift to western Scientific concepts and also fostered higher attitude in science while the conventional package did not. Ethnoscience-based instructional approach therefore is superior to conventional approach in facilitating modern science concept formation and also in fostering higher attitude to science among students.

2. Both males and females taught science using ethnoscience based approach showed almost identical pattern in conception but on the attitude pattern, females showed an insignificant higher attitude to science than males.

3. The science attitude scores of students taught science using ethnoscience based approach is significantly higher than those taught with conventional package.

4. There is no significant interaction between teaching method and gender on student attitude to science.

CHAPTER FIVE

DISCUSSION, CONCLUSION, IMPLICATION AND RECOMMENDATION.

In this chapter the researcher discussed the findings of the study based on the five research questions and three hypothesis that guided the study. The researcher also made some recommendations, discussed the limitations of the study and finally suggested areas for further research.

Research Questions

Research question 1

What is the effect of the ethnoscience based instructional package on students conception of scientific phenomena?.

All data collected with respect to conception of scientific phenomena were analyzed qualitatively in terms of concept shift. Summary of results presented in Table 1 unfolds an interesting pattern of concept drift from ethnoscience-based to western conceptual for the group taught science with the ethnoscience package while the group taught science with the conventional package retained their initial concepts/notions even after instruction with the conventional package.

Table 1 reveals that with the ethnoscience based instructional package, conception shifted from mythology to western scientific while with the conventional package conception remained static, with only very few students shifting their concepts from mythology to supernatural, mystics, popular and western scientific.

Table 1 also reveals an interesting drift from supernatural to western scientific concepts for the group taught science with the ethnoscience-based package. For the group taught science with the conventional package, conception was not sensitive to instruction. Even when there is a drift, the shift in concept tends toward ethnoconceptual types. The

same pattern was observed in concept type C and type D where concepts shifted from mystic and popular to western scientific for the ethnoscience based group while concepts remained same i.e mystical and popular respectively for the students taught science using the conventional package. Also for the ethnoscience based package, students who indicated 'No Notion' for the items during the pretest, drifted to western scientific while for the control group, the 'No Notion' was maintained. The summary of result presented in table 1 also revealed that students who initially had western scientific notions retained them after the experiment both for the treatment and control groups indicating that western scientific concepts are treatment independent.

Fafunwa (1983) earlier identified a form of conflict which distort learning processes among Africans when they are exposed to modern science. He observed that the non-interpenetration of African culture into the learning process tend to distort the cognitive processes in terms of anticipated outcome in western science. This is because indigenous concepts are culturally based and supernaturally re-enforced. As such, a shift from such concept to western notions demands an adequate explanation which only a culture based science instruction can provide. Nelson (1974) in her, analysis of concept development noted that concepts emerges directly from the child's interaction with the world. It should, therefore, not be surprising that an African child acquires his concepts from the African environment. Parmentier (1993), observed that the modern cultural anthropology has come of age with the historical relativization of the Kantian categories- ie with the recognition that the creative, apperceptive power of human symbolic representation is largely the product of cultural circumstances rather than the result of the transcendental potentialities of our cognitive hardwiring. The piagetian theory of concept formation also present the same view that concepts depends upon a prior notion of the boundaries of objects, events and their relationships within a given environment. It would, therefore, be emphasized that elements of the child's culture be fused into the

current science curriculum. An environment relevant to the one the child grew up in is quite necessary at the moment new concepts are introduced to them. This will reduce conflicts arising in their minds as a result of the alien concepts introduced during modern science instruction.

Research Question 2

What is the effect of the ethnoscience based instructional package on conception of scientific phenomena among male and female students?.

Summary of data analysis in table 2 of chapter four reveal that the ethnoscience based instructional package has no differential influence on conception of phenomena among male and female students. The tables reveal that for both males and females, concepts drifted from type A (mythology), type B, (supernatural), type C (mystics), type D (popular) and type E (No Notion) to type F (western scientific).

It has been assumed that owing to the esoteric nature of native science it could be possible for conception to vary for male and female (Davidson, 1987; Hills 1984). Hills (1984) assumed that since females are made to face some hidden or prohibited realities, it could be possible that the influence the ethnoscience based package will have on them will be greater. It could also be possible that females may have already acquired some of the esoteric knowledge so that their detailed discussion and explanations during science instruction may not have any differential effect on females. Although females showed higher conceptual drift to modern scientific concepts, the difference is very negligible.

Nelson (1974), however, gave an interesting explanation for the non differential effects of ethnoscience on males and females in terms of concept development. She observed that concept emerges directly from the child's interaction with the world, and not upon cuing through words. Both males and females are born into the same

environment and also interact with each other and the environment. It would, therefore, be concluded that Davidson (1987) did not really appreciate the powerful influence of the child's interaction with the environment on concept formation and that females now interact freely with their environment. Ethnoscience which is environmentally based and culturally standardized should, all things being equal, influence both male and females alike.

Research Question 3

What is the effect of the ethnoscience based instructional package on students' attitude to science?.

Result presented in Table 3 of chapter four reveal that ethnoscience-based instructional package facilitate attitude to science better than the conventional package. With the conventional package, the students had adjusted mean of 49.18 and a standard deviation of 12.60 while the ethnoscience based package yielded a mean of 67.73 and a standard deviation of 7.48.

Ewer (1989) perceived attitude as modes of emotional regard for objects and motor 'sets' or slight tentative reaction's toward them. It involves modes of emotional regards to science based tasks and activities. The findings of this study is quite consistent with the findings of Albert (1974). Albert (1974) assessed the extent to which ethnoscience based instruction can facilitate attitude of students toward science. His study revealed that with the ethnoscience package their is an appreciable increase in attitude scores of the students.

Ethnoscience based instruction embraces the ideas, concepts, objects and materials within the child's cultural environment. Considering the alien nature of western science, the incorporation of ideas, objects and materials within the child's immediate environment into its instructional processes and the use of such ideas in the clarification

of scientific processes will invariably boost attitude to the study of science.

Research Question 4

What is the effect of the ethnoscience based instructional package on science attitude of male and female students?.

Summary of data analysis on science attitude of students who were taught science with the ethnoscience-based package shown in Table 4 reveal that the ethnoscience based package is more effective in fostering attitude among females than for males. For the males the mean interest score is 63.44 with a standard deviation of 8.32 while for the females the mean attitude score is 72.02 with a standard deviation of 6.64.

The effect of ethnoscience based package on attitude of male and females can further be traced to the esoteric nature of some indigenous concepts. Some indigenous concepts have for long been restricted from females. The exposition and analysis of such concepts in a normal classroom setting where girls are part and parcel of, will undoubtedly thrill the females who may just be understanding the secrets for the first time more than the way it may thrill the males who have been jealously guarding them from the females.

Spindler (1983) was of the opinion that females will benefit more from instruction that incorporates culture and totality of the environment. Davidson (1987) also identified that culture at times isolates females from some practices necessary for the complete awareness of their environment and mastery of its functioning. With the unbiased culture based science instruction, the females will begin to appreciate the inherent realities in some natural phenomena which their culture has alienated them from, and also the relationship between these cultural realities and western concepts. As such, their attitude to science will increase and they will invariably show more attitude to science.

Research Question 5

What is the interactive effects of gender and instructional approach on student's attitude to science ?.

Summary of result presented in table 5 of chapter four reveal that there is no interaction between gender and teaching approach on students attitude to science. Summary of result in table 5 of chapter four indicate that ethnoscience based package is superior to the conventional package at the two levels of gender in fostering attitude.

Treatment interaction generally implies that different learners with different characteristics may profit more from one type of instruction than from another and that therefore it may be possible to find the best match of learner's characteristics and instructional approach in order to maximize learning outcomes or whichever dependent variable that is involved (Bratch 1970).

Although the goal of research in treatment interaction is to find significant disordinal interaction between alternative treatments and personal variables, it must be emphasized here that any approach which yields a superior no-interaction is cost effective and better in all ramifications. With this in mind, one may begin to appreciate the worth of the ethnoscience based package both in its superiority over the conventional package and its ability to accommodate both males and females in fostering attitude to science.

Hypotheses

HO_1 : *There will be no significant difference in the mean attitude scores of students taught science using the ethnoscience-based package and those taught science using the conventional package.*

Summary of result in table 6 shows that the f-cal is 228 while the F-critical value is 3.84 at an alpha level of 0.05. The decision rule is to reject the null hypothesis whenever the calculated value exceeds the critical value at a given alpha level. Since the calculated value exceeded the critical value the researcher rejected the null hypothesis and

concluded that there is a significant difference in the mean attitude scores of students taught science using the ethnoscience-based instructional package and those taught science using the conventional package.

Ethnoscience-based instructional package is a culture based package. The efficacy of a culture based science instruction in fostering attitude to science has long been anticipated (Fafunwa, 1983; Bronowski, 1990; Douglas, 1991). Fafunwa (1983) observed that science taught in Africa does not consider the child's initial background and as such is strange and uninteresting to the learners. He advocated that elements of the child's culture be infused into the science curriculum so as to bridge the gap between the learner's culture and the new field of knowledge. This, according to Fafunwa (1983), will improve attitude and achievement in modern science. The findings of this study therefore agrees with the speculations of Fafunwa. Result of research question 5 presented in table 3 of chapter four earlier revealed that ethnoscience-based package is superior to the conventional package in fostering attitude to science. A similar result was also obtained by Albert (1974) who assessed the effects of ethnoscience based instruction on academic achievement and attitude toward science. The result of the study revealed that ethnoscience instruction is superior in improving attitude in science. Since ethnoscience helps to reflect the intellectual tradition of the people, it should be expected that it will increase attitude to science. This is so because during science instruction which involves elements of the child's culture, and immediate environment, the students will participate more effectively and show higher attitude.

HO_2 : *There will be no significant difference in the mean attitude scores of male and females taught science using the ethnoscience based instructional package.*

Result of data analysis (see table 6 of chapter four) reveal that the f-calculated value is 3.011 while the f-critical value at an alpha of 0.05 is 3.84. Since the calculated

value is less than the critical value at the given alpha level, the researcher upholds the null hypothesis and concludes that there is no significant difference in the mean attitude scores of male and females taught science using the ethnoscience based instructional package. Result of research question four shown in table 4 reveal that females show higher attitude than males when taught with the ethnoscience based package. Although females had higher attitude than male, the analysis of co-variance shown in Table 6 has revealed that the difference is not significant at the given alpha level.

Although Davidson (1987) and Hills (1984) earlier noted that culture based science instruction offers a better opportunity for girls, it should also be appreciated that in the current society, girls are no more given the type of treatment they used to receive during the pre-colonial era. Although some cultural knowledge still remain esoteric, the supernatural re-enforcement in such practices are not quite strong as it used to be. As such the gap between boys and girls may not be as wide as it used to be. As already expected and anticipated, following the explanations of Hills (1984), Davidson (1987) and Spindler (1983), females showed higher attitude than males but contrary to their anticipation, the difference is not significant.

HO_3: *The interactive effects of gender and instructional approach on students attitude to science will not be significant.*

The result of the ANCOVA test of interaction presented in Table 6 reveal that for the two way interaction, the F-calculated value is 3.313 while the F-critical value is 3.84. Following the normal decision rule the researcher upheld the null hypothesis and concluded that there is no significant interaction, between gender and instructional approach on students' attitude to science. Summary of result in Table 5 revealed earlier that there is no significant interaction between gender and instructional approach on students' attitude to science. The data further revealed that the ethnoscience-based

approach is superior to the conventional approach for both males and females. The findings of the study contradicts the earlier assumptions of Jensen (1982) that no single instructional process provides optimal learning for all the students. That given a set of objectives, some students will be more successful with an alternative instructional program. The ethnoscience package has shown its outstanding quality by providing optimal results in terms of attitude for all the students.

Conclusion

From the results obtained in the investigation into the effects of ethnoscience base instructional package on students' conception of scientific phenomena and attitude to science, the researcher drew the following conclusions:

1. The ethnoscience based instructional package facilitate conceptual drift from ethno-conceptual types to modern scientific conceptual types ie the ethnoscience based package enhance modern science concept formation in learners. The conventional package is static with respect to concept formation.

2. The ethnoscience based instructional package has no pronounced differential impact on concept formation among male and female students. The conceptual drift is almost uniform for both male and females taught science using the ethnoscience based package.

3. The ethnoscience-based instructional package is more effective than the conventional package in fostering attitude to science. The difference between the mean attitude for students in the ethnoscience group and conventional group is statistically very significant, and in favour of the ethnoscience-based group.

4. Although with the ethnoscience based instructional package females show higher attitude than males, the difference in the mean attitudes of males and females taught science using the ethnoscience based instructional package is not statistically significant.

5. There is no significant interaction between gender and instructional approach on students' attitude to science. For both males and females, the ethnoscience based package is superior to the conventional package in fostering attitude to science.

Implications of the Study

The findings of this study has some implications for science education and development in Africa. The implications of this study are discussed with respect to the following

1. Sustainable Development in Science
2. Capacity Building

Sustainable Development In Science

This study offers an African child an opportunity to learn science from his cultural perspective and also to appreciate science better. In addition it provides a more effective way of systematizing data in a more objective and experiential way which permits better understanding of science and its practical basis. The findings of this study calls for an urgent curriculum review meant at providing a virile curriculum package capable of fostering a new innovation in science in Africa. This study calls for a revolution in curriculum innovation which will incorporate in our science curriculum the basic indigenous scientific concepts, approaches and paradigms necessary for effective appreciation of scientific realities - approaches that are free from western hegemony and

imperialism. The Africans with such a package will be freed from scientific and technological slavery. They will begin to explore their environment more effectively and consequently grow in scientific practices. For a sustainable development in science, the Africans need a culture relevant approach which this study has offered.

Capacity Building

This study was channelled toward capacity building in the sense that it aimed at providing a package meant to train youths in science. As such the package, when fully adopted in our educational system, will help to strengthen the manpower necessary for scientific growth in Africa.

Recommendations

Based on the findings of the study, the researcher made the following recommendations:

(a) Ethnoscience based science instruction should be adopted in our school system. The current science curriculum should be reviewed in terms of basic instructional approaches to incorporate basic ethnoscientific materials, concepts and paradigms in a systematic and well articulated fashion so that science instruction will improve in our school system.

(b) Teachers should be trained on the use of the package. Although the package is a liberal package, teachers need to be trained through workshops and seminars on the use of the package.

(c) The conventional instructional approach should be de-emphasized in our school system. This study has revealed its inadequacy in fostering conception and interest in science.

Limitations of the Study

The generalizations made with respect to this study are, however, subject to the following limitations:

(a) Since different teachers were used for the six schools, it may be assumed that they may not be of equal attributes in terms of cognitive and affective functioning. This may invariably introduce a little error into the study.

(b) Some students dropped before the end of the study while some did not participate in the post-test as a result of personal factors. There are some cases of students who had pre-test but no post-test scores. This reduced the sample size a little.

(c) In the experimental group, few students were not very willing to expose their cultural concepts during the science instruction, thereby making it difficult for the teacher to assist them in resolving their conceptual conflicts.

Suggestions for further Research

Based on the findings and limitations of this research, the following topics are suggested for further research.

(a) Effects of Ethnoscience based instructional package on students' cognitive achievements in science.

(b) Factors that influence science concept formation among secondary school students.

(c) Effects of Ethno-mathematical games on problem solving in junior secondary mathematics.

Summary of the Study

This study evaluated an ethnoscience-based instructional programme. The study

assessed the effects of an ethnoscience-based instructional package on studenets conception of scientific phenomena and attitude to sceince. The study employed a non-equivalent control group quasi-experimental design. The sample for the study comprised of 243 (two hundred and forty three) JS III students drawn from six secondary schools within the former Nsukka Education Zone (now Obollo-Afor and Nsukka Education zones) of Enugu State. Out of the six secondary schools, three (one male, one female and one coeducational) were assigned to the treatment group while the remaining three were assigned to the control group. The treatment group was taught science using the ethnoscience-based package while the control group was taught science using the conventional package. Data on conception and attitude were collected using a Conception of Scientific Phenomenon Test and Science Interst Scale respectively. Data on conception of scientific phenomenon were analyzed qualitatively using categorizing and typologies while data on attitude to science were analyzed quantitatively using mean, standard deviation and analysisi of co-variance. The study revealed that ethnoscience-based package is superior to the conventional package in fostering attitude to science and also in ensuring conceptual drift to modern scientific concepts, that the ethnoscience-based package has no differential impact on concept formation among males and females and that there is no significant interaction betwen gender and instructional methods on attitude to science. The researcher recommended that ethnoscience-based package be adopted in our school system and that teachers be trained on the effective use of the package.

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APPENDICES

APPENDIX I

ETHNOSCIENCE BASED INSTRUCTIONAL PACKAGE IN INTEGRATED SCIENCE (For the Treatment group).

S/N	TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES
1.	FOOD STORAGE	The Child should be able to: (1) recognise that the breakdown of food is both a physical change and an enzyme action (chemical change); (2) recognise what happens to absorbed food; (3) recognise the fate of excess food.	1. Action of enzymes on food. 2. What happens to absorbed food.	* The teacher through appropriate questioning, explores the students' cultural and popular beliefs about digestion and usage of digested food in man. The teacher provides the opportunity for students to discuss the various myths and indigenous views associated with food digestion. * The teacher notes down the concepts students have acquired culturally with respect to food digestion. * The teacher now resolves which ever misconception that was noted without outrightly dismissing their conceptions, rather he resolves it by creating a link between the children's initial ideas and the new concept he has come to introduce * Gradually, he introduces the Western Scientific concept of enzymes and its relationship with the children's initial concept. * The teacher demonstrates the effects of Ptyalin on cooked yam.

2.	HEALTH	The child should: (1) Know the causes of common ill health (2) Know and observe the rules of keeping fit.	(1) Health and its maintenance (2) Need of health in growth. (3) Keeping fit through good exercise, good diet and good hygiene. (4) Drug abuse	* Through questioning, students are made to discuss their cultural concepts of diseases and good health, explore the varying indigenous concepts, myths, folklores, paradigms surrounding sickness and good health and their categorizations. * Every member of the class is given the opportunity to participate in the folk categorization of sickness and their causes and the various practices in promotion of good health which are twined in rituals and taboos. * The teacher resolves identified areas of conflict and marries the Western approach with their cultural views.
3.	CONTINUITY OF THE FAMILY	The child should be able to: (1) Name members of their nuclear and extended family (2) Prepare a family tree from the information in (1) (3) Identify physical resemblances (4) Recognise dominant traits (5) Show the trends of appearance of dominant traits.	(1) Identification of members of the nuclear family & extended family (2) Identification of physical resemblance and differences (3) Identification of dominant / recessive traits for three successive generations.	* The teacher introduces the cultural concept of reproduction, ceremonies, myths, rituals and practices associated with reproduction through explanatory questioning. *The teacher involves the students in the use of folklores, story telling and discussion of rituals and beliefs about inheritance. The teacher allows the students to unravel their personal convictions about inheritance. The issue relating to the dead and living and their implications in inheritance will be trashed in the class. * Through a detailed and analytic explanations, illustrations and mapping of traits, the teacher merges the indigenous conceptions with the conventional standards. The teacher clarifies whichever conflict that may arise through appropriate examples of hybridization in living organisms.

4.	MAN IN SPACE	The child should be able to: (1) recognise that the moon has no light of its own, the sun being responsible for moonlight. (2) explain the concept of gravitational pull.	(1) Space travel (2) Gravitational Pull	* The teacher introduces, through questioning, the cross cultural perception of gravity and gravitational forces. The students participate in folk categorization of phases of the moon and folk knowledge of the moon. * Students further identifies other cultural perceptions of gravity through folklores, myths and rituals. *The teacher analyzes the various cultural ideas and clarifies the students on the conventional aspects through proved experiments on gravity and weight of objects.
5.	CONTROL LING THE WEATHE R	The child should be able to: (1) List the variables involved in the production of weather. (2) Operationally define humidity precipitation, haze and wind direction.	(1) Simple conditions of weather - temperature, humidity, barometric pressure, kinds of cloud, precipitation, haze, visibility, storms, lightning, and thunder Weather maps -wind direction, Isobars etc.	* The teacher introduces, through exploratory questioning, pupil's cultural understanding of weather conditions, indigenous models for determining temperature, humidity and wind direction and the utilization of these variables in prediction of rain. * The teacher then relates the folk categorizations to conventional standard. * The teacher further introduces, through questioning, the cultural practices, rituals, myths and ceremonies relating to rainfall. * The scientific relevance of these cultural practices will be explored. * Students participate in cultural zoning and its scientific relevance-weather. mapping in relation to types of cloths, shelter, animals reared etc. and the ecological implications of the classifications.

APPENDIX II

CONVENTIONAL INSTRUCTIONAL MODULE IN INTEGRATED SCIENCE
(For Control Group)

S/N	TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES
1.	FOOD STORAGE	The child should be able to: (1) recognise that the breakdown of food is both a physical change and an enzyme action (chemical change) (2) recognise what happens to absorbed food. (3) recognise the fate of excess food.	(1) Action of enzymes on food (2) What happens to absorbed food.	* Let the children chew cooked yam in their mouth for a while, what happens? * Discuss where glycogen is stored: so also fats and oil. * Effects of excess protein.
2.	HEALTH	The child should: (1) Know the causes of common ill health. (2) Know and observe simple rules of keeping fit.	(1) Health and its maintenance (2) Need of health in growth (3) Keeping fit through good exercise, good diet, good hygiene. (4) Drug abuse.	* Let children mention/describe common diseases. Help them discover the causes and what can be done about them. * Let them examine how ill health can retard growth physically and mentally. * Role of exercise and good food. Let them undertake various projects on hygiene of home and school compound. Let the result be tabulated and discussed.

3.	CONTINUITY OF THE FAMILY	The child should be able to: (1) Name members of their nuclear and extended family. (2) Prepare a family tree from the information in (1) (3) Identify physical resemblances (4) Recognise dominant traits. (5) Show the trend of appearance of dominant traits.	(1) Identification of members of nuclear family & extended family (2) Identification of physical resemblances and differences. (3) Identification of dominant/ recessive traits for three successive generations.	* Draw heavily on the experience of the pupils on this topic. Instruct them to collect information for performance objectives (1) and (2). During classroom discussion, explain the meaning of dominant and recessive traits, illustrate with examples brought from home. Point out trends in a particular family tree.
4.	MAN IN SPACE	The child should be able to: (1) recognise that moon has no light of its own, the sun being responsible for moonlight. (2) explain the concept of gravitational pull.	(1) Space travel. (2) Gravitational pull.	Demonstrate rocket (jet) propulsion with a balloon.
5.	CONTROLLING THE WEATHER	The child should be able to: (1) List the variables involved in the production of weather. (2) Operationally define humidity, precipitation, haze, and wind direction.	(1) Simple weather conditions- temperature, humidity, barometric pressure, kinds of cloud, precipitation, haze, visibility, storms, lightning, and thunder. (2) weather maps- wind direction, Isobars etc.	(1) Keep a record of temperature variations during the day and make a graph showing the changes; (2) Find the humidity, air pressure and wind direction for the day.

APPENDIX III

CONCEPTION OF SCIENTIFIC PHENOMENON TEST (CSPT)

INSTRUCTION : This test is designed to elicit your views about some natural phenomena (events) and the reason for such views. Please indicate your honest view by choosing from the alternative letter A _ D. Follow your choice with a brief but clearly stated reason for the choice you made. What is important is the reason you give and not necessarily the choice of answer. So your choice of answer must be backed up with your own reason for the choice. If you do not have any idea or notion about the question or phenomenon, indicate by ticking (_/) in the box labelled (NO IDEA/NOTION). In that case you need not give any reason.

PERSONAL DATA

SCHOOL :

CLASS :

NUMBER :

(1) Food in the stomach of human being is digested by
(a)Worm (b) Enzymes
(c) Something which God placed in the stomach (d) Blood.

☐ No idea/notion.

Briefly explain your answer in the space below

(2) Which of the following is most true of a thunderstorm
(a) It results from sudden expansion and contraction of charged air during rainfall.
(b) It results from cooling of air during rainfall.
(c) It is an angry voice of the rain gods.
(d) It is a violent sound induced by rain makers.

☐ No idea/notion.

Briefly explain your answer in the space below

(3) Gravitational pull can best be defined as :
(a) The force exerted by the gods on the earth.
(b) The force pulling an object to the centre of the earth.
(c) Unexplainable divine / spiritual force upon the earth.
(d) The pull of heavy objects by the earth.

☐ No idea/notion.

Briefly explain your answer in the space below

(4) Which of the following causes lightning during rainfall ?
(a) Spells cast by rain makers.
(b) Sudden exposure of sparkling heavenly bodies.
(c) Divine signals of rain by rain gods.
(d) Spark from electrically charged cloud.

☐ No idea

Briefly explain your answer in the space below

(5) Which of the following statements is most true of heredity
(a) The reincarnation of dead ancestors best explains inheritance.
(b) Embryonic photography of nearby people during conception best explains inheritance.
(c) Transmission of characters in genes from parents to offsprings best explains inheritance.
(d) Conferment of characters on embryo by gods of creation best explains inheritance.

☐ No idea

Briefly explain your answer in the space below

(6) Which of the following is the most vital factors to be considered before entering into a marriage contract

(a) Genotype of partner (b) Consensus by the gods
(c) Perceived destiny of the partner (d) Eye colour.

☐ No idea

Briefly explain your answer in the space below

(7) When seeds of an orange of the species of lemon is planted and it bears grape fruits, it means that :

(a) The orange is not a good specie.
(b) The type of soil affected the orange
(c) Demonic forces (witches) affected the orange.
(d) The new plant is a hybrid of lemon and grape.

☐ No idea

Briefly explain your answer in the space below

(8) Which of the following is most true about the death of an individual through a lightning shock:

(a) It results from the wrath of the gods.
(b) It results from the activity of diabolic enemy.
(c) It results from passage of electric charge through the person's body.
(d) It results from un explainable supernatural force.

☐ No idea

Briefly explain your answer in the space below

(9) Which of the following explains cholera outbreak

(a) Contamination of water/food by microbes (Vibrio Cholera).
(b) Affliction of community by water maids.
(c) Natural disaster willed by God.

(d) Poor diet among villagers.

☐ No idea

Briefly explain your answer in the space below

(10) Which of the following is true of air

(a) The movement is directed by spirits

(b) Rain makers charm can control its movement

(c) It has mass

(d) It has no weight

☐ No idea

Briefly explain your answer in the space below

(11) Which of the following practices is better in preventing the spread of epidermic disease.

(a) Isolation of victims (b) Appropriate hygiene

(c) Appropriate sacrifice/atonement to gods. (d) Vaccination.

☐ No idea

Briefly explain your answer in the space below

(12) Which of the following is true of leprosy.

(a) It is controlled by leprosy gods in the evil forest.

(b) It is a bacterial disease.

(c) It is a sickness sent by Almighty God.

(d) It is caused by charm from wicked people.

☐ No idea

Briefly explain your answer in the space below

(13) Which of the following factors govern the characters transmitted from the parents to the offspring

(a) The blood of the parents
(b) The gene of the parents
(c) Ancestral gods of the parents
(d) Nature of the womb.

☐ No idea

Briefly explain your answer in the space below

(14) Which of the following statements best explains immunity to infection.

(a) It is a form of protection specially offered by gods.
(b) It may result from accumulation of resistance after infection.
(c) It may result from special concoction prepared by native doctors.
(d) All of the above.

☐ No idea

Briefly explain your answer in the space below

(15) How best can weather condition be predicted

(a) Use of natural foresights
(b) Use of pure scientific instruments.
(c) Use of inquiries from spirits governing the earth.
(d) All of the above.

☐ No idea

Briefly explain your answer in the space below

(16) Which of the following is necessary in the stomach

(a) Water (b) Enzymes

(c) Worm (d) All of the above

☐ No idea

Briefly explain your answer in the space below

(17) Fertilization takes place inside the body of a woman. The most appropriate explanation for this is that

(a) The sperm of the man has united with the egg of the woman.

(b) The God of creation has implanted a new child inside a woman.

(c) Spirits of previously dead individual has gone into the woman for another re-birth.

(d) The blood of the man has mixed with the blood of the woman.

☐ No idea

Briefly explain your answer in the space below

(18) Which of the following is produced on electric discharge through air in lightning flashes

(a) Ozone (b) Charm from rainmakers

(c) Carbonic acid (d) Demonic gases

☐ No idea

Briefly explain your answer in the space below

(19) Rain gauge is used to measure

(a) Amount of rain fall

(b) Extent of rain maker's strength.

(c) Strength of the rain gods
(d) Amount of spell cast during the rain.

☐ No idea

Briefly explain your answer in the space below

(20) The most appropriate place where sick people should go for treatment is to the
(a) Idols (to sacrifice and seek help form spirits)
(b) Church (to pray to Almighty God)
(c) Hospitals (for appropriate medical care)
(d) Native doctor (provide a protective charm)

☐ No idea

Briefly explain your answer in the space below

APPENDIX IV

CONCEPTUAL TYPES FOR ITEMS OF THE CONCEPTION TEST

ITEMS	OPTIONS	CONCEPTUAL TYPES	TYPOLOGY
1	A	Popular	D
	B	Western scientific	F
	C	Supernatural	B
	D	Popular	D
2	A	Western scientific	F
	B	Popular	D
	C	Mythology	A
	D	Mystical	C
3	A	Mythology	A
	B	Western scientific	F
	C	Supernatural	B
	D	Popular	D
4	A	Mystical	C
	B	Popular	D
	C	Mythology	A
	D	Western scientific	F
5	A	Mythology	A
	B	Popular	D
	C	Western scientific	F
	D	Supernatural	B
6	A	Western Scientific	F
	B	Mythology	A
	C	Supernatural	B
	D	Unclassified	-
7	A	Popular	D
	B	Popular	D
	C	Mythology	A
	D	Western scientific	F
8	A	Mythology	A
	B	Mystical	C
	C	Western scientific	F
	D	Supernatural	B
9	A	Western scientific	F
	B	Mythology	A
	C	Supernatural	B
	D	Popular	D
10	A	Mythology	A
	B	Mystical	C
	C	Western scientific	F
	D	Popular	D

11	A	Western scientific	F
	B	Popular	D
	C	Mythology	A
	D	Pure scientific	F
12	A	Mythology	A
	B	Western scientific	F
	C	Supernatural	B
	D	Mystical	C
13	A	Popular	D
	B	Pure scientific	F
	C	Mythology	A
	D	Popular	D
14	A	Mythology	A
	B	Western scientific	F
	C	Mystical	C
	D	Unclassified	-
15	A	Mystical	C
	B	Western scientific	F
	C	Mythology	A
	D	Unclassified	-
16	A	Western scientific	F
	B	Western scientific	F
	C	Popular	D
	D	Unclassified	-
17	A	Western scientific	F
	B	Supernatural	B
	C	Mythology	A
	D	Popular	D
18	A	Western scientific	F
	B	Mystical	C
	C	Western scientific	F
	D	Mythology	A
19	A	Western scientific	F
	B	Popular	D
	C	Mythology	A
	D	Mystical	C
20	A	Mythology	A
	B	Supernatural	B
	C	Western scientific	F
	D	Mystical	C

The classifications were based on the following descriptions of the typologies:

Mythology

A narrative tale concerns with the gods and the nature and meaning of the universe

and man. Tales which are sacred or religious in nature and are concerned with the origin or creation of some phenomenon. An expression or crystallization of central important cultural traits or principles frequently bolstered by the activities of a mystic creator being.

Mystics

Responses or behaviour which tend to stress or provide an evidence that in as much as reality is an absolute, ineffable unity which cannot be apprehended by discursive reasoning or described by language, apprehension of the real can be achieved only through a suprarational union, more or less complete, of the knower and the known.

Supernatural

Responses which pertains to that which is above or beyond nature or which transcends the natural; divine. The responses has to do with doctrines which holds that there is something in the world above the order of nature.

Popular view

Responses generally held by the majority of people, which may in actual sense lack empirical, mythological, mystical or supernatural explanations.

Western science

Responses relating to methods in discovery and organization of knowledge gained through experience; responses pertaining to empirical knowledge as contrasted with rational knowledge. Such responses subject themselves to the scientific method.

APPENDIX V

ATTITUDE TO SCIENCE SCALE (ASS)
(Adapted from Baggaley (1973))

This instrument is designed to explore your attitude to science. The researcher demands your honest response to the items. Please indicate your honest response with a tick ( ) in the appropriate column corresponding to the items of your choice. If you feel you have no response for a particular item please leave the column for the item blank.

PERSONAL DATA

SCHOOL
CLASS
NO
SEX

S/N	ITEMS	S.A	A	D	S.D
1	I am always under a terrible train when studying science.				
2	Studying science is very interesting to me.				
3	I feel a sense of insecurity when I am attempting a problem in science.				
4	I feel very unhappy whenever I miss a science lesson.				
5	I enjoy science-based activities.				
6	I am unable to think clearly when studying science.				
7	When I hear the word science, I have a feeling of joy.				
8	I do not enjoy reading science texts.				
9	I do not waste my time attending science quiz or science club.				
10	I would like to work in science institute after my schooling.				
11	I will be very happy if science is removed from the school curriculum.				
12	Participating in science practicals is enjoyable to me.				

13	I would like to spend my leisure time solving problems in science.				
14	I would like to participate in every science workshop.				
15	To work as a scientist will be very boring to me.				
16	Assignments in science interest me a lot.				
17	I enjoy asking questions and participating fully during science lessons.				
18	The basic principles in sciences interest me a lot.				
19	I usually keep myself busy with other things during science lesson.				
20	It makes me nervous to even think about having to tackle any problem in science.				

S.A = Strongly agree

A = Agree

D = Disagree

S.D = Strongly disagree

APPENDIX VI

RETEST TYPOLOGY SUMMARY FOR THE CONCEPTION TEST

	Type A		Type B		Type C		Type D		Type E		Type F	
	Test I	Test II	Test I	Test II	Test I	Test II	Test I	Test II	Test I	Test II	Test I	Test II
1	-	-	15	13	-	-	11	11	5	3	19	19
2	07	08	-	-	20	20	-	-	20	21	2	2
3	10	10	21	21	-	-	11	11	6	6	2	2
4	08	08	-	-	30	30	09	09	1	1	2	2
5	15	15	20	21	-	-	10	09	4	4	1	1
6	10	10	4	4	-	-	-	-	6	6	30	30
7	34	32	-	-	-	-	10	12	3	3	3	3
8	15	15	5	5	22	22	-	-	5	5	3	3
9	6	6	5	5	-	-	5	5	2	2	32	32
10	20	21	-	-	27	27	-	-	-	-	3	2
11	6	6	-	-	-	-	35	36	4	4	5	4
12	28	28	20	20	-	-	-	-	-	-	2	2
13	32	30	5	7	-	-	1	1	-	-	2	2
14	15	15	-	-	10	11	-	-	10	10	15	14
15	4	4	-	-	18	18	-	-	-	-	28	28
16	-	-	-	-	-	-	15	12	-	-	25	27
17	2	2	2	3	-	-	37	36	-	-	9	9
18	8	8	-	-	30	30	-	-	-	-	12	12
19	15	15	-	-	-	-	34	34	-	-	6	6
20	8	8	3	3	4	4	-	-	-	-	35	35

APPENDIX IX

A MODEL LESSON NOTE FOR TREATMENT GROUP
(Developed from the Ethnoscience Based Instructional Package)

A LESSON NOTE ON

TOPIC: CONTROLLING THE WEATHER
CONTENT: LIGHTENING AND THUNDER STORM.
CLASS: J. S. III
DURATION: 90 Minutes

INSTRUCTIONAL OBJECTIVES

At the end of the lesson the students will be able to:

(a) Define lightening
(b) Define thunder storm
(c) State the variables involved in lightening and thunderstorm.

INSTRUCTIONAL MATERIALS

1. The chalkboard.

INSTRUCTIONAL PROCEDURE

Step I: Entry Behaviour.

The teacher introduces the lesson by asking the students questions based on the last lesson. eg. List kinds of cloud, what is the difference between precipitation and haze? What is a storm?. The teacher observes areas where they are still confused and makes adequate explanation.

Step II: Meaning of Lightening

The teacher, ask students to explain their personal conception of lightening. The teacher allows the students to bare their mind as regards their personal conceptions. The teacher should, as a matter of necessity avoid any circumstance that may lead to conceptual imposition. Every student is right in his own conception, except when necessary, ie when there is need for modification and clarification which can only be provided by the teacher as a brief intervention strategy. The teacher intervention approach is not imposed but rather a re-orientation approach.

Step III: Meaning of Thunderstorm

Through elaborate questioning the teacher further involves the students in discussion of myths, folklores, rituals and practices surrounding thunderstorm. The teacher notes the conceptions held by the students before his own intervention explanations. Areas of conflicts are amicably resolved there and then.

Step IV: Variables Involved in Lightening and Thunderstorm

The teacher now asks the students to explain the variables or factors that are involved in lightening and thunderstorm and their relevance to the various practices associated with thunder and lightening. Having appreciated the areas of conflict in the students, the teacher takes appropriate step in resolving the conflicts.

Step V. Evaluation

The teacher asks the students the following question:

1. Define each of the following terms:
   (a) Lightening
   (b) Thunderstorm
2. List the variables involved in lightening and thunderstorm.

APPENDIX X

A MODEL LESSON NOTE FOR CONTROL GROUP
(Developed from the conventional package)

A LESSON NOTE ON
TOPIC: CONTROLLING THE WEATHER

CONTENT: LIGHTENING AND THUNDERSTORM
CLASS: J. S. III
DURATION: 90 Minutes

INSTRUCTIONAL OBJECTIVES

At the end of the lesson the students will be able to:
(a) Define lightening
(b) Define thunderstorm
(c) State variables involved in lightening and thunderstorm.

INSTRUCTIONAL MATERIALS

1. The chalkboard.

INSTRUCTIONAL PROCEDURE

Step I: Entry Behaviour.

The teacher introduces the lesson by asking the students questions based on the last lesson. eg. List kinds of cloud, what is the difference between precipitation and haze?. What is a storm?. The teacher observes areas where the students are still confused and makes adequate explanation.

Step II: Meaning of Lightening

The teacher asks the students to explain the meaning of lightening. The teacher also assist the students in the Western Scientific explanations of lightening with special references to charges acquired by cloud which has attracted tiny drops of water.

Step III: Meaning of Thunderstorm

The teacher further involves the students in the Western Scientific explanations of thunderstorm. The teacher explains the heating of air by sparks of the lightening which makes the air to expand and contract and how this violent expansion and contraction of the air makes the noise which we hear as thunder.

Step IV: Variables Involved in Lightening and Thunder

The teacher discusses the variables involved in lightening and thunder eg. electric charges and scientific practices surrounding such variables. The teacher list the factors involved in lightening and thunder and their role in the entire processes.

Step V: Evaluation

The teacher also the students the following questions:
1. Define each of the following terms:
   (a) Lightening
   (b) Thunderstorm
2. List the variables involved in lightening and thunderstorm.