

CHAPTER ONE

INTRODUCTION

1.1 Background to the Problem

Science serves as a veritable tool for the sustainable growth and development of a nation. Indeed the strength of a nation and the respect she commands from other nations are functions of her level of scientific and technological development. Science and Mathematics are the keys to innovation and power in today's world (Friedman, 2005). However, the increasing complexity of the world today imposes new and changing workforce requirements. This means that new workers will need ever more sophisticated skills in Science, Mathematics, Engineering and Technology which, in effect, require improved approaches to the teaching and learning of science.

It is also instructive to note that since Science and Technology aim at improving production and productivity, the standard of living of citizens in countries that develop scientifically and technologically is most likely to improve appreciably. Ahmed, Abimbola, Omosewo and Akanbi (2012) note that any nation wishing to be recognized globally must ensure 'she is sound fated in science and technology'. Development in Science and Technology however does not come about by chance but by sound and conscious effort powered by appropriate, efficient and result-oriented science education that is dynamic enough to respond to current and emerging challenges. It is therefore not surprising to see nations that have visions invest heavily in the development of Science and Technology and constantly researching into how their educational systems can produce great scientists. Countries that are in the forefront scientifically, technologically and economically are those that have shown great improvement in the teaching and learning of Science and Mathematics. This reflects in learners' achievements in both subjects. For example, the report by the National Science Foundation (2002) on the performance of American science learners in Mathematics and that of Science achievement by

the National Assessment of Educational Progress (NAEP) shows generally that performance in Mathematics and Science has improved since the late 1960s and early 1970s. A slight decline in performance was experienced in the late 1970s, which however increased again during the 1980s and early 1990s, and has remained mostly stable since that time. NAEP Mathematics achievement has been increasing among 9-, 13-, and 17-year-old students since the early 1980s, although most of these gains occurred before 1992. In terms of international comparison, Science News (2012) reveals in its report on Global Student Achievement in Mathematics, Science and Reading Literacy that countries that have highest achievement in Science and Mathematics are the world leaders in terms of growth and development, using the Trends in International Mathematics and Science Study (TIMSS) which provides the first global assessment of Mathematics and Science.

TIMSS provides data about trends over time, measuring achievement in these subjects every four years at the fourth and eighth grades since 1995. As in previous cycles, TIMSS for 2011 -- the fifth assessment -- reports achievement at four international benchmarks that describe what students know and can do in Mathematics and Science, and can be used to help interpret achievement scores. In Mathematics at the fourth grade, Singapore, South Korea, and Hong Kong were top performers, followed by Chinese Taipei and Japan. Northern Ireland, the Flemish Community of Belgium, Finland, England, and the Russian Federation also performed very well. In addition, the US state of North Carolina also had high achievement, though lower than the East Asian countries. In Mathematics at the eighth grade, Korea, Singapore, and Chinese Taipei led the world in achievement, followed by Hong Kong and Japan. There was a substantial gap in achievement between these five East Asian countries and the next highest performing countries, including the Russian Federation, Israel, Finland, the United States, and England. For example, the gap in average achievement between Korea and England is more than 100 points. In addition, the US states of Massachusetts and Minnesota also had high achievements.

Korea and Singapore were the top performers in fourth-grade science, followed by Finland, Japan, the Russian Federation, Chinese Taipei and the United States. The US state of Florida also had high achievement, though not as high as the top seven. Singapore was the highest achiever in science at the eighth grade, followed by Chinese Taipei, Korea and Japan. Finland, Slovenia, the Russian Federation, Hong Kong, and England also performed well. In addition, Massachusetts had achievement higher than all countries except Singapore. The top-performing countries in fourth grade reading were Hong Kong, the Russian Federation, Finland and Singapore. Northern Ireland, the United States, Denmark, Croatia, and Chinese Taipei also had higher achievement than the majority of other participants. In addition, Florida and the Canadian province of Ontario were among the highest achieving participants.

In 2011, TIMSS assessed nearly 900,000 students worldwide from 63 countries and 14 benchmarking participants (TIMSS, 2012). The import of this analysis is to establish the fact that achievements in Science and Mathematics are precursors to growth and development. There is no doubt that the top performers identified above lead other countries scientifically, technologically and economically. Any country aiming for respect and global recognition must therefore develop more effective instructional approaches for the teaching and learning of Science and Mathematics.

In analysing achievement in science in a country like Nigeria, a holistic assessment can be done using the Basic Science platform. This is probably why Duada and Udofia (2010) state that Basic Science is actually an advanced integration of science. It integrates Physics, Chemistry, Biology and Earth Science. In terms of efforts, level of investment, educational programmes and policy formulation, Nigeria - like other developing and less developed countries - has not been resting on her oars. It would be recalled that in 1968, under the Comparative Educational Study and Adaptation Centre (CESAC), Aiyetoro Basic Science Programme for lower forms (one and two) of the secondary school were instituted. This centre later became the

Nigerian Educational Research and Development Council (NERDC). Attempts were made to teach the core science subjects (Physics, Chemistry, Biology, Geography, Health Science and Agricultural Science) as one entity.

Various conferences on science teaching and learning, such as those held in Droubja (Bulgaria) in 1968, Maryland (USA) in 1973 and Netherland in 1978, also recommended this integrated approach. These conferences, organised by UNESCO were fully supported and monitored by Science Teachers Association of Nigeria. (STAN). This is the antecedent of Integrated Science which was then introduced into the Nigerian Educational curricula. Integrated Science was meant to be taught for the first eight years of formal education. Afuwape and Olatoye (2004) report that UNESCO-UNICEF, in 1971, defined Integrated Science as an approach to teaching and learning of science in which concepts and principles are presented so as to express the fundamental unity of scientific thought and avoid pre-mature or undue stress on the distinctions between the various scientific fields. Integrated science was science presented to the child such that the child gained the concept of the fundamental unity of science, the commonality of approach to problems of scientific nature and an understanding of the role and function of science in everyday life and the world in which they live (FRN, 1984). A curriculum was therefore developed for this purpose.

To achieve the set goals, a Nigerian Integrated Science Project was commissioned. The fundamental aim of Nigerian Integrated Science Project, which is a process-oriented curriculum, was to develop science process skills in students. Though the curriculum specifies, hands-on process and skill acquisition, most children were not exposed to these real situations in the schools. Scientific, vocational and technological aspects of education were not effectively implemented. Hence, curriculum reviews to make it relevant to national development in line with the global and national demand of this era became imperative. The Federal Government of Nigeria informed by the need to attain the Millennium Development Goals (MDGS) by the year

2015 together with the need to meet the critical targets of the National Economic Empowerment and Development Strategies (NEEDS) - value re-orientation, poverty eradication, job creation, wealth generation and using education to empower the people - decided to introduce the 9 years of Basic Education and it became obvious that the existing curriculum for JSS should be reviewed, re-structured and realigned to fit into a 9 – year of Basic Education.

The National Council on Education (NCE), at its meeting in December 2005, then directed the Nigerian Educational Research and Development Council (NERDC) to carry out this assignment. The NCE also approved the new curriculum as Basic Education Curricula. Consequently, a high level policy committee on curriculum development met and produced the guidelines for the curricula re-structuring (Duada and Udofia, 2010). The Nigerian Educational Research and Development Council (NERDC) therefore organized a series of workshops between January and March 2006 in which eggheads from various fields and works of life worked assiduously to restructure the curricula. These curricula came into use with effect from September 2007. In the restructuring, Basic Science replaced Integrated Science. In general, the goals of the curricula reform were to reflect depth, appropriateness and inter-relatedness of the curricula contents. Emerging issues which covered value orientation, peace and dialogue including human rights education, family life, HIV/AIDS education, entrepreneurial skills etc. were fused into the 9 year of Basic Education Curricula. Additionally the curricula planners agreed that major issues shaping National and Global Development such as globalization, information and communication technology were essential inclusions in the Basic Education Curricula. Hence the following themes were infused into the Integrated Science curriculum to form the Basic Science curriculum:

- Environmental Education
- Drug Abuse Education
- Population and Family Life Education

- Sexually Transmitted Infections (STI) including HIV/AIDS (FRN, 2006).

Duada and Udofia, (2010) maintain that one of the cardinal precautions in the production of the Basic Science curriculum is to ensure continuity. This is why some relevant themes in the Integrated Science are still maintained in the Basic Science curriculum. As stated earlier, Integrated Science was science presented to the child such that, the child gains; the concept of the fundamental unity of a science, the commonality of approach to problem of a scientific nature and an understanding of the role and function of science in everyday life, and the world in which he/she lives. (FGN, 1984). Basic science on the other hand is the basic training in scientific skills requirement for human survival, sustainable development and societal transformation. Basic Science combines science and technology. It attempts to provide a holistic presentation of science and technology with the theme 'You and Technology'. This was designed to expose students to developing science and technological skills, which will assist them to make informed decisions, develop survival strategies and learn to contribute and live quantitatively in the global community.

The issue of Basic Science cannot be addressed without reference to the Universal Basic Education (UBE).which was launched in 1999 with a full legal backing by the Compulsory Free Universal Basic Education Act of 2004. The Universal Basic Education (UBE) covers the Primary school and the first three years of the Secondary School usually known as the Junior Secondary School. The word 'Basic' in UBE informs the term 'Basic' for all courses taught under the basic education programme. Science became Basic Science. The 9-Year Basic Education Curriculum is divided into three basic levels:

1. Lower Basic Level- Primaries 1-3
2. Middle Basic Level- Primaries 4-6
3. Upper Basic Level- JSS 1-3

The Curriculum as developed by the Nigeria Educational Research and Development Council (NERDC) from the primary and junior secondary curricula enumerated the objectives of the new Basic Education Curriculum in Science and Technology as they apply to the learners as follows:

- a) To develop interest in science and technology;
- b) To apply their basic knowledge and skills in science and technology to meet societal needs;
- c) To take advantage of the numerous career opportunities offered by the study of science and technology and
- d) To become prepared for further studies in science and technology.

In order to achieve the above objectives, Danmole_(2011) asserts that the use of different teaching methods and strategies to ensure students' understanding of topics becomes imperative. This assertion informed the use of a number of innovative methods and strategies in teaching Basic Science and by extension other science subjects in general. Yet the results have been anything but impressive. While they have been proved to have worked somewhere else, they do not seem to have worked among science learners in Nigeria. Years after the introduction of Basic Science, what is the level of achievement of the science learner? An analysis of the Junior Secondary School Certificate Examination (JSSCE) results as shown below is apt.

Table 1.1 and Figure 1.1 below show an unstable performance pattern. Within the 10-year analysis, performance in three years (2006, 2010 and 2011) was below 50% in terms of credit passes and above. The performance was just above 50% in six years (2000, 2001, 2002, 2003, 2004 and 2007). It is only in 2005 that the performance rose far above 50% to 64.90%. But it was like a flash in the pan as performance fell considerably by 17% the following year (2006) to 47.91%. Another worrisome and noticeable trend is that in more recent years, performance has been below 50 %.(2010 and 2011).

Table 1.1: Analysis of JSSCE Integrated Science/ Basic Science Result, Nigeria

Year	Number of Candidates Registered	Number with Credit (A-C)	%	Number without Credit (P-F)	%
2000	12719	7324	57.58	5395	42.42
2001	12984	7286	56.11	5698	43.90
2002	14725	7597	51.60	7128	48.40
2003	16916	9013	53.30	7903	46.72
2004	17613	9492	53.87	8125	46.13
2005	19362	12561	64.90	6801	35.13
2006	18913	9062	47.91	9851	52.10
2007	20614	11585	56.20	9029	43.80
2010	15803	6639	42.01	9164	57.99
2011	16429	7693	46.83	8736	53.17

Source: Federal Ministry of Education, Research Statistics and Planning Section, 2011
[The examination was not conducted in 2008 and 2009]

To show clearly the pattern of changes in the result, Figure 1.1 is presented below. It shows graphically the falling and rising pattern of the result. It is a clear indication of the level of instability in science achievement of learners. This is definitely unacceptable for a nation aspiring for greatness in science and technology.

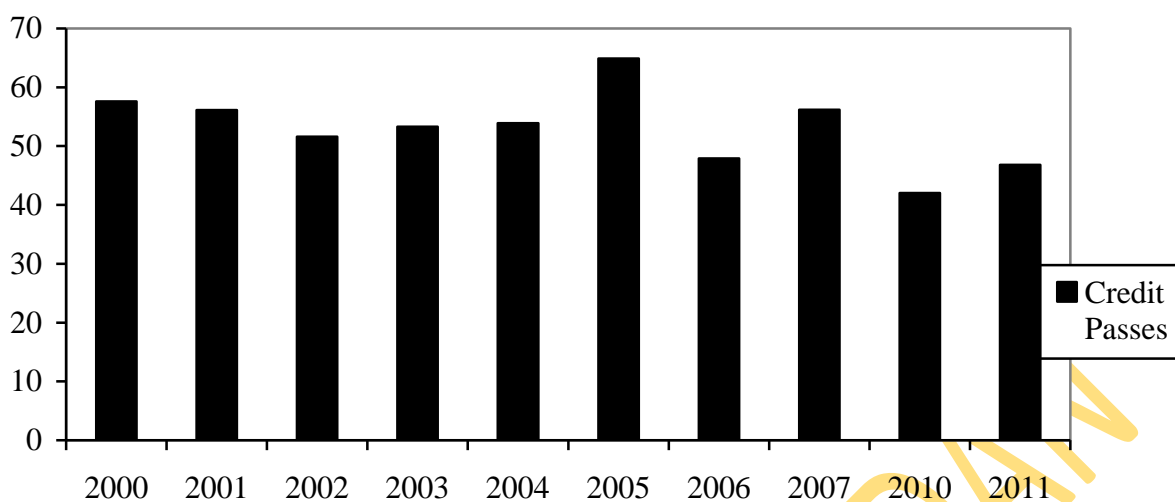


Fig 1.1 JSSCE Credit Passes In Basic Science (2000-2011)

This unacceptable general situation of science achievement in Nigeria has been a source of concern to scholars in the area of science education. A number of reasons have been adduced for this and various solutions are being proffered. Ajayi (2005) identifies the shortage of qualified teachers who are associated with high quality instruction. Other researchers, such as Ogundare (2008), attribute the low performance to inadequate provision of materials and instructional resources that could facilitate science teaching and learning. Erinoshon (2004) pins down the reason for low achievement in science to poor understanding of scientific concepts by students. Osuafor (2008) maintains that the failure of teachers to put into use research findings and recommendations is responsible for low science achievement. Ibraheem and Oladele (2010) however maintain that low achievement in science is caused by the use of inappropriate, non-effective teaching methodology by teachers.

Some scholars also link poor achievement in Basic Science to negative attitude of learners to the subject because of wrong perception. Adodo and Gbore (2012) note the negative attitude of Nigerian students to Basic Science and observe that very few students love studying the subject and those who study it are mostly those who want to use it as a “job ticket”. Some other researchers believe that the subject is made up of “hard” science subjects such as Physics,

Chemistry, Biology and Agricultural Science. Other reasons identified include the fact that teachers are unable to satisfy the students' aspirations or goals and teachers do not often provide the career incentives and explain career opportunities for students to appreciate the role of the scientist. This has often led to variations in goals between learners, teachers, parents and industries. Adodo and Gbore (2012) also maintain that instructional methods often used have no bearing on the students' practical life.

Hiwatig (2008) narrows the reason for poor achievement in science to lack of regard for the cultural belief of learners which greatly influence the attitude. He therefore recommends the use of ethno-scientific teaching approach for classroom instruction in science. It is therefore important that an approach that is practical and relates science concepts to the day-to-day life of the learners be developed. An instructional approach of this nature may therefore serve as the elixir needed to inject life into the attitudinal disposition of science learners.

Of greater concern, however, is the problem of underachievement of learners in science in Africa and other parts of the world where daily activities are still greatly influenced by cultural beliefs. Research findings suggest that learning of science among students in traditional settings have been made difficult by the conflicts between Western modern science and cultural beliefs. In so many different cultural settings, educators have been faced with the problem of teaching pupils Western science without the assimilation of the concepts (Jegade, 1995; Kawagley, 1995; Lee, 1997; Lowe, 1995; MacIvor, 1995; Nelson-Barber and Estrin, 1995; O'Loughlin, 1992; Pomeroy, 1994). Ogonnaya (2011) while analysing the situation in Nigeria affirms that the neglect of the diverse cultural activities and beliefs of students and the failure of teachers to consider varied cultural resources of the students in teaching biology (and other sciences) remains one of the major reasons for students' alienation from sciences. Earlier studies in Nigeria and Ghana (Bajah 1981, Jegede & Okebukola 1991, Akpan & Anamuah-Mensah, 1992 and Wasagu, 1999) have shown that students' cultural beliefs and ways of learning are hardly

affected by their knowledge in science, even when studying at undergraduate level. Jegede and Aikenhead (2005) maintain that for many pupils worldwide, conventional school science seems highly disconnected from practical ends. "Science learned in schools is learned as science in school, not as science on the farm or in the health clinic or garage" (Medvitz, 1985). Aisiku (2007) also adduces the reason for underachievement of learners in science to the disjoint between what is learnt in the science class and everyday life of typical learners in traditional settings.

The concern shown by scholars is informed not only by the need to improve learning outcomes of this set of learners but also because of the ever increasing importance of science and technology in today's world as earlier explained. It is disheartening to note that no African country is listed among the thirty most technologically advanced countries in the world (EIU, 2007). Only two African countries made the list in which 65 countries were ranked. South Africa is 35th while Nigeria is 60th. This position is completely unacceptable. For how long will African people and others countries that are still largely influenced by their cultural background continue to play second fiddle to others in the world of science?

And as science has become ever more deeply embedded in our everyday life, how ordinary people perceive science has therefore, attracted growing attention not only from the scientific community, but also from social scientists (Bak, 2001). Incidentally the aims of the major worldwide reform in science education, initiated in America after the passage of Haley's comet in 1986, include: science for all and inclusion of a broader view of science, teaching for understanding and application of science knowledge and processes and 'Less is better' (Udeani, 2007).

These goals, especially science for all and inclusion of a broader view of science, accentuate the need by scholars for a consideration of learners' cultural background in the teaching and learning of science. To be able to do this, the understanding of how learners deal

with cognitive conflicts between everyday life world and the world of school science is required. Everyday life refers to the learners' cultural environment comprising social attitudes, beliefs, principles and conventions developed over a long period of time and a range of experiences. Students come to school with these experiences, serving as prior knowledge, which Pfundt and Duit (1991) maintain are highly resistant to change and strongly influence learning and may lead to unintended interpretation of concepts. These interpretations are collectively known as alternative conceptions. This is why Jegede and Aikenhead (1999) maintain that for many pupils worldwide, conventional school science seems highly disconnected from practical ends. "Science learned in schools is learned as science in school, not as science on the farm or in the health clinic or garage" (Medvitz, 1985, p. 15). In discussing the influence of cultural background in learning science, Tobin (1990) asserts that learning science involves negotiating meaning, comparing what is known (prior knowledge) to new experience and resolving discrepancies between what is known and what seems to be implied by new experiences.

When prior knowledge relates to cultural environment or background, some scholars find it more convenient to refer to it as Traditional Ecological Knowledge (Snively and Corsiglia, 2000). The ambiguous nature of terms like traditional, indigenous, ecological, alternative conceptions however poses a problem. An attempt to avoid these terms and issues surrounding them made some scholars hold on to the use of the term Ethnoscience. Ogunleye (2007) states that when scientists occasionally took note of indigenous knowledge of nature, that knowledge is distinctively labelled Ethnoscience and never simply science. He further maintains that to make meaning out of their experiences in science classrooms, students need to negotiate a cultural transition from their life world into the world of school science. He concludes that science education must be culture sensitive for it to serve the emerging global community. Baimba (1993) maintains that culture is not an accidental collection of customs and habits. It is transmitted from generation to generation in form of hidden curricula, even if it was not taught in

formal school education. He concludes that the disparity between traditional and scientific cultures has not engendered positive outcomes from studying science in many non-western societies. He advises that instead of superimposing value that are hardly ever assimilated by traditional children, science education might best serve as a medium for bridging the gap between traditional and scientific outlooks of nature and knowledge. He stresses that cultural consideration in science curriculum innovations in non-Western societies is a must.

Until the recent past, little attempt had been made by researchers at tracing the connection between ethnoscience and science education. However, attention is now gradually shifting to the science exposure of students who live in communities where traditional practices guide and influence daily activities and actions. The import of this in the current discussion is expressed by George (2001) who explains “science for all” as science that is meaningful and useful in daily life. Science for all or science for daily living takes on new meaning when indigenous knowledge of learners is considered. To develop school science programmes that are intended, not for a select few, but for all students, cognizance must be taken of the indigenous knowledge embedded in the culture of the users of such programmes.

The implementation of the ethno-scientific teaching approach was therefore based on the recommendations for teaching science by the CCIP (2002) and the Science for All movement (UNESCO, 1991) which are that: (1) the content, language, symbols, designs, and purpose of the curriculum should be linked to day-to-day experiences and goals of the children; (2) theory should be linked to practice, human purpose, the quality of life, and in-school experience to out-of-school experience; and (3) teaching and learning should begin from the beliefs, interests, and learning skills that students bring to the classroom and should help each of them extend and revise their ability and understanding (Hiwatig, 2008).

Based on the above, many scholars suggest the acceptance of the consideration of cultural background as necessary in planning science instructions. In essence, “science learning must

provide a platform that allows learners to achieve a rich understanding of a scientific topic by successfully integrating accurate scientific knowledge with their own personal knowledge of the world” (Kyle, 1989). Aisiku (2007) while noting the pedagogical imperatives of learners’ cultural background maintains that teachers must acknowledge and respect the dignity and worth of students’ home and cultural environments. Key (2009) also states that what is sought and needed in science classrooms is a model that integrates the learning of the traditional science with the cultures within the classroom. She maintains that culturally inclusive model demonstrates that the equity pedagogy and the content integration dimensions are not mutually exclusive. Culturally inclusive science integrates the learner’s culture into the academic and social context of the science classroom to aid and support science learning (Baptiste & Key, 1996). Abonyi (1999) notes that current instructional approaches in science education which did not take into consideration prior cultural beliefs seemed to have contributed to poor concept formation and students interest in science.

Empirical evidences also support the assertions of scholars enunciated above. For instance, Wasagu (1999) reports a strong relationship between cultural beliefs and scientific achievements. A number of scholars have also identified cultural beliefs as a major cause of under-achievement in science, technology and mathematics education. Ivowi (1992) supports this assertion in respect of Nigeria by noting that the conflict between cultural beliefs and science is one of the major causes of poor performance in science, technology and mathematics education in Nigeria. Okeke and Njelita (2002) are more emphatic when they conclude that conflict between cultural beliefs and school science is one of the major causes of poor conception of scientific phenomena and interest in science. These assertions have great implications on teaching and learning of science in Nigeria with her one hundred and seventy two ethnic groups, each having its own different belief and cultural practices that marks it out as a unique entity (Modo, 2002). There were, therefore, speculations that the introduction of

ethnoscience concepts, theories and paradigms into the science curriculum and instruction may bridge the gulf between the culture of the learner and modern science (Fafunwa, 1983)

The question that however arises is whether science as taught today is completely lacking in cultural orientation? In answering the question, Coburn (1991) posits that science as currently taught reflects western history and western foundational beliefs or world views. Lawton (1984) earlier concluded that modern science was based on the culture of Western Europe and Northern America collectively known as “Western culture”. This is why Ogunniyi (1990) is of the view that non-western modes of thought and scientific mode of thinking were diametrically opposite to each other on ‘a linear theory of social change’.

The initial efforts at solving this problem seem misdirected. For example, Fafunwa, Macauley and Sokoya (1989) recommend the mother tongue approach based on the success of a programme in which students were taught science using the local language. He is, however, criticized for transmitting western science concepts in local language (Abonyi, 1999). Achimugu (1995), in his own case recommends the use of improved local instructional materials. He is said to have succeeded only in improvising western instructional materials. The two recommendations have not removed the ‘western’ in them (Abonyi, 1999). Various conferences such as those held in Addis Ababa in 1961, Tananarive in 1962, and Lagos in 1964 have also made failed attempts at integrating indigenous elements into science curriculum (Eshiet, 1991).

The studies reviewed so far have focused on identification of cultural beliefs hindering achievements in science, effect of neglecting the diverse cultural activities and beliefs of students in science and conflicts between modern science and cultural beliefs. However, studies on how the knowledge of these beliefs could be used to improve the learning of science are scanty. There is therefore the need for a new approach in this direction.

Such approach must meet some criteria. George (2001) in her work on culture and science education states that a workable approach to science education that incorporates indigenous knowledge must be able to:

- draw upon cultural experience and everyday life.
- access different ways of thinking about scientific concepts.
- bridge the gap between the traditional and the conventional.

She maintains that, to many students, science and culture have links. She asserts that for students in traditional settings, daily living is guided at least to some extent by a knowledge system that is different from conventional science as taught in schools. This knowledge is typically passed down orally from one generation to the next according to her. She states further that to be able to do this, scholars are currently faced with the challenges of identifying, analysing and documenting traditional knowledge and structuring it for use in the classroom. Supporting this view, Ogonnaya (2011) states that both local and national research should be carried out comprehensively to identify and document such concepts and processes in the cultural activities of all the tribes and communities in Nigeria. For the achievement of this task, the development of a database of science-related cultural beliefs and expressions, which often reflect in various activities of the people especially their common sayings, should be appealing to a versatile researcher.

An Ethnoscience database useful in a classroom setting will therefore be desirable. Such a database would be a ready source of science related common verbal expressions (prevailing in the learner's society) for implementing ethnoscience instructions. What would be the effects of such a culture-based instructional design on students' cognitive achievement in science? This question is appropriate because some scholars have identified the use of instructional methods that did not take into consideration the indigenous knowledge of learners as a major cause of under achievement in science (Okebukola, 1991 and Jegede, 1999). This seems to lead to

conflict between modern science and cultural beliefs. To Okeke and Njelita (2002), this conflict is a major cause of poor conception of scientific phenomena and interest in science. Ethnoscience instruction would therefore shed more light on various issues raised in respect of cultural beliefs and modern science. A necessity for this is a database which would be easily accessible if it is made available through a simple search and retrieve computer programme as done in this study.

A number of variables have been suggested as capable of affecting students' attitude towards science. Some of these are beliefs and values about an object or situation. Young and Horton (1992) are of the opinion that emotion tied to object influences knowledge assimilation as well as behaviour. Interestingly, Rokeach (1968, p.4) had earlier in his book linked beliefs and attitudes together in his definition of beliefs. He explains beliefs to mean "... a relatively enduring organization of attitude around an object which will predispose man to respond in some preferential manner". The effects of ethnoscientific beliefs on attitude will therefore provide an empirical evidence for whatever link (if any) that exists between beliefs and attitude.

Studies on the effect of school location on cognitive achievement in science indicate conflicting results. Akintunde (2004) who worked on environmental education concepts concludes that students in urban centres had better cognitive performance than those in rural centres but Kannapol and Deyoung (1999) express contrary opinion. Fehintola (2003) however asserts that there is no significant difference in the academic achievement of female students in terms of school location. Because it is popularly believed that culture is richer in the rural areas than urban areas, what effects would school environment in terms of location have on students' cognitive achievement, attitude to science and conception of scientific phenomena in respect of this study?

Parent Educational Status (PES) is a measure of the level of education of parents. While Lee, Bryk and Smith (1993) maintain that Socio-Economic Status (SES) is one of the best

predictors of students achievement, Sirin (2005) concludes that Parent Educational Status is considered one of the most stable aspects of Socio-Economic Status (SES) because it is typically established at an early age and tends to remain the same over time. Various studies attest to the fact that the family plays a meaningful role in a child's academic performance and development (Tucker, Harris, Brady, & Herman, 1996).

Parent educational status has also been identified as an important factor affecting student achievement (Dryfoos, 1990). The study carried out by Rhea and Otto (2001) shows that the mothers' level of education and family incomes influence adolescent educational outcome expectancy beliefs. Rumberger (1995) explains that students' "family background is widely recognized as the most significant important contributor to success in schools" (p 587). This assertion is supported by the findings of earlier researchers who argued that the home has a major influence on students' school success (Swick & Duff, 1978) and that it is the quality of relationships within students' home environments that has an important effect on school performance (Selden, 1990; Caldas, 1993). More educated parents are assumed to create environments that facilitate learning (Williams, 1980; Teachman, 1987). Other research evidences show that learners with high-PES exhibit higher average levels of achievement than those with low-PES (Jabor, Machtmes, Kungu, Buntat & Nordin, 2011). Chen (2009) concludes that parents' education has been found to be a key determinant of student achievement. The studies examined show that there is the need for further studies on the effect of this variable on science learners especially those in the traditional setting. What then would be the effect of Parent Educational Status (PES) on learning outcomes using Ethnoscience-based instructional method?

1.2 Statement of the Problem

Various studies have established poor cognitive achievement of learners in sciences especially among learners in traditional settings. Equally established are learners' poor attitude to science and poor conception of scientific phenomena. Directly linked to these poor learning outcomes are the cultural clashes that exist between students' life-world and world of modern science. These clashes are influenced by cultural beliefs embedded in prior knowledge which itself remains a contentious issue in education, not on whether it influences learning or not since there is wide spread agreement on its influence but much debate exists about how to use this fact to improve learning. This knowledge including its cultural beliefs component presents a great challenge to science educators especially at this period when the global thrust is towards science for all students. Scholars believe that this factor is one of the factors that account for underachievement in science and alienation of students from science in Nigeria and other countries where differences exist between learners' everyday life world and the world of science. Solutions to this problem will help learners make meaning out of their experiences in science classrooms by making it easy for them to negotiate a cultural transition from their life-world into the world of school science.

This 4-stage study therefore developed an Ethnoscience database, designed a storage and retrieval system for it, produced a framework of its incorporation into a classroom setting and conducted a field test of the data on teaching and learning of selected Basic Science concepts. Classification of its items was equally carried out, both in terms of broad classification of science concepts and compatibility with the understanding of related modern science concepts. Its impacts on cognitive achievement in and attitude to science were investigated. Also investigated was its impact on conception of scientific phenomena. The moderating effects of school location and parent educational status on these learning outcomes were also determined.

1.3 Research Questions

1. To what level is the Ethnoscience Database standardized?
2. What are the collected sciences-related *Yorùbá* common sayings in terms of science classification?
3. How compatible are the collected science related *Yorùbá* common sayings with modern science concepts?

1.4 Hypotheses

At the field-testing stage, the following null hypotheses were tested at 0.05 level of significance.

Ho1: There is no significant main effect of treatment on students'

- a) cognitive achievement in science.
- b) attitude to science.
- c) conception of scientific phenomena.

Ho2: There is no significant main effect of school location on students'

- a) cognitive achievement in science.
- b) attitude to science.
- c) conception of scientific phenomena.

Ho3: There is no significant main effect of parent educational status on students'

- a) cognitive achievement in science.
- b) attitude to science.
- c) conception of scientific phenomena.

Ho4: There is no significant interaction effect of treatment and school location on students'

- a) cognitive achievement in science.
- b) attitude to science.

- c) conception of scientific phenomena.

Ho5: There is no significant interaction effect of treatment and parent educational status on students'

- a) cognitive achievement in science.
- b) attitude to science.
- c) conception of scientific phenomena.

Ho6: There is no significant interaction effect of school location and parent educational status on students'

- a) cognitive achievement in science.
- b) attitude to science.
- c) conception of scientific phenomena.

Ho7: There is no significant interaction effect of treatment, school location and parent educational status on students'

- a) cognitive achievement in science.
- b) attitude to science.
- c) conception of scientific phenomena.

1.5 Significance of the Study

The desire to develop a viable instructional method that would provide the much needed solution to the identified problem of underachievement in science by learners from traditional background in which day-to-day activities are still influenced by cultural beliefs and activities informed the need for this study. Previous studies concluded that cultural belief is a factor hindering achievements in science and identified the effects of neglecting the diverse cultural activities and beliefs of students in science. The studies equally identified constant conflicts

between modern science and cultural beliefs. The need for a study on how this knowledge can be used to improve learning of science therefore becomes imperative.

Curriculum designers, teachers and students would find the database, framework for its incorporation into the classroom setting and results from the field test very useful and this would chart a path for further research in ethnoscience in science education. The findings offered the much needed solutions required to resolve the cognitive and attitudinal conflicts introduced in the mind of beginners in science as a result of differences between their cultural background and the new field of knowledge (modern science). It also provided a bridge through which science learners of the traditional setting can cross to the world of modern science and a platform for mutual comparison which facilitates conceptual change.

Finally the study has unravelled the interactions effects of treatment and school location on students' attitude to science and students' conception of scientific phenomena and thus made significant contributions towards improving students' learning outcomes in science.

1.6 Scope and Delimitation

The first stage of the study in which common *Yorùbá* sayings were gathered was restricted to *Yorùbá* land (Southwestern Nigeria). Data were collected from three states (Ogun, Oyo and Ekiti) that were selected out of the six states within this regional zone through stratified random sampling technique.

The field testing stage was restricted to Junior Secondary School 1 students in Ibadan city. Stratified random sampling technique was used in selecting four coeducational schools that were used in the study (two schools each from both urban and rural centres). The study was also limited to Basic Science since it is a foundation for other science subjects.

In terms of content coverage, the researcher selected contents from the Basic Science curriculum of the Federal Ministry of Education for J.S.S.1. The content covered the four themes of:

1. You and Energy
2. You and Science
3. Living and Non-Living Organisms
4. You and Environment

The topics treated are:-

- (a) Environmental conservation and Safety
- (b) Matter and characteristics of Living and Non- Living Things
- (c) Gravitation and Weightlessness
- (d) Gravitation and Weightlessness

1.7 Operational Definition of Terms

Attitude: It is the emotional orientation of the subject towards selected science concepts measured using Attitude Towards Science Scale (ATSS).

Cognitive Achievement: This is in terms of subjects' knowledge and comprehension of selected science concepts measured using Basic Science Cognitive Achievement Test (BSCAT).

Conception of Scientific Phenomena: This refers to the meanings attached by the learners to scientific terms or phenomena which were measured using Conception of Scientific Phenomena Assessment Sheet (CSPAS).

Ethnoscience-based Instructional Method: This is the culture-based instructional method designed for science students using data obtained from Ethnoscience Database.

Ethnoscience Database (ED): This is a collection of structured, validated and standardized information on science-related common sayings of the people of *Yorùbá* land of Nigeria organized to provide efficient retrieval in a database table using Microsoft Excel.

Modified Lecture Method: This is the instructional method in science in which the teacher with chalkboard illustrations does most of the talking and demonstrations while few questions and answers are allowed during and at the end of the presentation.

Parent Educational Status (PES): This is measured according to the highest level of education attainment of the most educated parent. It is classified into:

(a) **Low PES** which refers to subjects whose parent(s) did not attend school or attended primary school only.

(b) **Average PES** which refers to subjects whose parent(s) completed junior or senior secondary school or vocational school.

(c) **High PES** refers to subjects whose parent(s) completed NCE, ND, HND programme or had a university degree.

School Location: It refers to where the schools for the study are situated. They are grouped into:

(a) **Urban:** A city with a population of more than 200,000 and many social amenities such as electricity, tarred road, tap water, tertiary institutions and hospitals.

(b) **Rural:** Very small community with a population of less than 20,000 people without tap water, tertiary institutions and hospitals.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviews literature related to the study under the following sub-headings:

- 2.1 Theoretical Framework
 - 2.1.1 The Border Crossing Theory
 - 2.1.2 Vygotsky's Socio-Cultural Theory
 - 2.1.3 Collateral Learning Theory
 - 2.1.4 Conceptual Change Model
- 2.2 Conceptual Framework
 - 2.2.1 Concept of Ethnoscience
 - 2.2.2 Scope of Ethnoscience
 - 2.2.3 Rationale for Ethnoscience.
- 2.3 Empirical Studies
 - 2.3.1 Instructional Methods of Teaching Science.
 - 2.3.2 Students' Cognitive Achievement in Science
 - 2.3.3 Students' Attitude to Science
 - 2.3.4 Conception of Scientific Phenomena
 - 2.3.5 Ethnoscience-based Instruction and Students' Learning Outcomes
 - 2.3.5.1 Ethnoscience-based Instruction and Students' Achievement
 - 2.3.5.2 Ethnoscience-based Instruction and Students' Attitude to Science
 - 2.3.5.3 Ethnoscience-based Instruction and Students' Conception of Scientific Phenomena
 - 2.3.6 School Location and Students' Learning Outcomes
 - 2.3.7 Parent Educational Status and Students' Learning Outcomes
- 2.4 Appraisal of Study
- 2.5 The Present Study

2.1 Theoretical Framework

Educators often expend so much energy on the ideas they want their audience to have. Researches however show that learners' prior knowledge often confounds educators' best efforts at delivering ideas accurately. Findings show that learning proceeds primarily from prior knowledge, and only secondarily from the presented materials. Prior knowledge can be at odds with the presented material, and consequently, learners will distort presented material. Neglect of prior knowledge therefore can result in the audience learning something opposed to the educator's intentions, no matter how well those intentions are executed. To help people make the most of a new experience, educators need to understand how prior knowledge affects learning. Many researchers have focused on the central tension that dominates the debate about prior knowledge. This tension is between celebrating learners' constructive capabilities and bemoaning the inadequacy of their understanding. On one hand, educators rally to the slogan of constructivism: "create experiences that engage students in actively making sense of concepts for themselves." On the other hand, research tends to characterize prior knowledge as conflicting with the learning process, and thus tries to suppress, eradicate, or overcome its influence. One factor that largely influences prior knowledge is culture.

Culture as suggested by Phelan, Davidson and Cao (1991) conceptualises culture as the norms, values, beliefs, expectations, and conventional actions of a group. Neito (1999) offers a more elaborate definition of culture as "the ever-changing values, traditions, social and political relationships, and worldview created, shared and transformed by a group of people bound together by a number of factors that can include a common history, geographical location, language, social class, and religion". These definitions imply that culture differ between different social groups. Equally, in any culture there are likely to be many subcultures, either mutually exclusive or overlapping (which are also possible at the level of cultures); one of these subcultures is the subculture of science (Aikenhead, 1996). Consequently, Phelan et al (1991)

identify students' subcultures of family, school and peer worlds, the interrelationships between them, and, in particular, how meanings and understandings combine to affect students' engagement with learning. They examine students' perceptions of the boundaries between worlds and adaptation strategies they employ as they move from one context to another. They suggest that boundaries or borders refer to real or perceived lines or barriers between the subcultures and identified four patterns of students being able to move between subcultures. In the light of this, Aikenhead and Jegede (1999) use the metaphor of international travel to demonstrate cultural borders and border crossings, and they use the spectrum of four types of border crossings: smooth, managed, hazardous and impossible.

An approach that would however be helpful is the need for educators to understand the content of and how culture and prior knowledge affect learning to help people make the most of a new experience. Studies in respect of prior knowledge have however forced a theoretical shift to viewing learning as "conceptual change." (Strike and Posner, 1985). Prior knowledge is a concoction of different types of experiences which have to be disentangled. Many researchers have isolated cultural beliefs or cultural background as a major source of prior knowledge. In spite of the assertions above, the two scientific traditions that dominated research on cognition and learning in the twentieth century - behaviorism and cognitivism - did not give culture an important place in learning.

For behaviorism, culture is considered as being "too mentalistic a concept to be incorporated into the understanding of how people learn" (The International Encyclopedia of Education, 1995). In cognitivism, little or no attention is given to the impact of the social environment on cognitive processes. It is more interested in idealistic and rationalistic perspectives (Saljo, 1995). But today, researchers now know better. It is therefore not surprising that discussions on the possible connection between culture and science education started just a few years back. The scenario is now changing and attention is being paid to cultural impact on

science teaching and learning, especially as they relate to students in communities in which daily actions are guided by traditional practices and beliefs which have been passed down from one generation to the next.

A research work of this nature would be based on a number of theoretical constructs since a single theory cannot clearly capture the essence of the work. This study is therefore premised on the following theories:

2.1.1 The Border Crossing Theory

This theory proposed by Aikenhead (1996) views students' experiences with school science as a form of "crossing borders". It explains that learning school science requires some students to cross boundaries between the cultural context of their home, family and society and the cultural context of school science.

Aikenhead identified four types of border crossing, namely;

- i. **Smooth border crossing:** This occurs when students' world view is in congruent with school science.
- ii. **Managed border crossing:** This occurs when students' worldview is different from the science worldview; hence such transition is regarded as managed.
- iii. **Hazardous border crossing:** This occurs when students' worldview and their science worldview are somehow diffused with each other leading to a hazardous transition.
- iv. **Impossible border crossing:** This occurs when students' worldview and their science worldview are incompatible with each other.

George (2001) describes the mechanism by which this crossing over (back and forth) might take place as "bridging the gap". She maintains that this way of thinking is different from

the way school science has been presented i.e. as a totally neutral subject without culture-related difficulties.

Ethnoscience Instructional Method while identifying with this theory broadly classifies the relationship between these two science views into compatible, modifiable and contradictory.

2.1.2 Vygotsky's Socio-Cultural Theory

Perhaps, the most serious attempt at integrating culture into the understanding of human psychological functioning is the one formulated within this school of psychology founded by Lev Vygotsky (1896-1934). He developed a theoretical framework that combines history, social institutions, cultural artefacts, cultural meanings, cultural signs (such as languages), activities, interpersonal interactions and cognition. Vygotsky's work brought new life into investigation into culture and cognition.

Vygotsky's Socio-Cultural theory of human learning describes learning as a social process and the origination of human intelligence in society or culture. He believed that everything is learnt at two levels. First through interaction with others and then integrated into the individual's mental structure. He focuses primarily on what he calls the higher mental functions (e.g. thinking, reasoning, problem solving and voluntary attention), which he sees as characteristic of mental life of humans and as heavily influenced by socio-cultural factors. To Vygotsky, the society influences the development of higher mental functions both through its history and immediate interpersonal environments (Vygotsky, 1978).

He believes society influences psychological development through face-to-face interactions. He asserts that higher mental functions have their origins in the child's cultural interactions. Every function in the child's cultural development appears twice; first, on the social level and later, on the individual level i.e. first between people [inter-psychological] and then inside the child [intra-psychological] (Jacob, 1995). Within this framework, culture is a very

significant concept because the world is mediated to individuals through participation in cultural activities. Perception is influenced by cultural beliefs. Children experience the world as it is mediated to them in their interactions with adults and more knowledgeable members of the culture. Human beings live in a mediated reality and their conventionalized mode of construing events and objects are stored in culture, especially language. Lucia (1976) carried out a research work during the early 1930s in two Soviet Central Asian Republics (Uzbekistan and Kirghizia) on the impact of culture on cognition.

The work tested Vygotsky's theoretical claims on mediation and dependence of psychological functions on culture. It was a study of the psychological consequences of a social experiment involving the collectivization of agriculture on the modernization of production and the introduction of literacy in the remote areas of USSR. It set out to answer the simple question "Would people who had no contact with modern society, change the way they perceived and construed reality when they became literate and when they were given new and more 'theoretical' responsibilities in the modern production processes?" The result showed significant shift in cognition. Lucia's work was however heavily criticized for the use of terms such as "backward" about traditional societies and value laden terms such as "literate." It was a clearly biased and ethnocentric approach. No attempt was actually made to study the indigenous forms of thinking to learn in what respects they might represent social values or conceptual systems containing their distinct ideas and norms. Lucia's work shows the typical problem of evolutionism and ethnocentrism tendency expressed in cross- culture research.

From a broader perspective of constructivism, social constructivism characterises the nature of knowledge to include the following: (1) knowledge is not a passive commodity to be transferred from a teacher to learners, (2) pupils cannot and should not be made to absorb knowledge in a spongy fashion, (3) knowledge cannot exist separate from the knower, (4) learning is a social process mediated by the learner's environment, and (5) the prior or

indigenous knowledge of the learner is of significance in accomplishing the construction of meaning in a new situation. All learning is mediated by culture and takes place in a social context. The role of the social context is to scaffold the learner, and provide hints and help that foster co-construction of knowledge while interacting with other members of the society (Linn & Burbules, 1993).

Therefore the attempt at using Ethnoscience instructional method is to give recognition to the effect of culture on learning outcomes.

2.1.3 Collateral Learning Theory

This theory proposed by Jegede (1995) attempts to explain why many pupils, non-Western and Western, experience culturally related cognitive dissonance in their science classes. It explains that effective cultural border crossing is indeed a complex event. It states that collateral learning generally involves two or more conflicting schemata held simultaneously in long-term memory. Jegede (1995, 1996, and 1997) recognises variations in the degree to which the conflicting ideas interact with each other and the degree to which conflicts are resolved. The theory therefore postulates a spectrum of cognitive experiences (parallel, simultaneous, dependent, and secured collateral learning) to explain cultural border crossings. These four types of collateral learning are not separate categories but points along a spectrum depicting degrees of interaction/resolution.

The implication is that the different forms of collateral learning are in form of a continuum with the two extremes being parallel and secured learning. At the first extreme, the conflicting schemata do not interact at all. At the other extreme, referred to as the secured collateral learning the schemata are compatible. Here, conflicting schemata consciously interact and the conflict is resolved in some manner. This is secured collateral learning. The person will have developed a satisfactory reason for holding on to both schemata even though the schemata

may appear to conflict, or else the person will have achieved a convergence toward commonality by one schema reinforcing the other, resulting in a new conception in long-term memory. There are various ways to resolve conflicts and to achieve secured collateral learning. There are varying degrees of conflict and compatibility between the two. Pupils will access one schema or the other depending upon the context. An example is given by Solomon (1983) who notes that pupils will use a scientific concept of energy only in school, never in their everyday world where common sense concepts of energy prevail. This segregation of school science content within the minds of pupils is called "cognitive apartheid" by Cobern (1996).

Between these two extremes of parallel and secured collateral learning, there are varying degrees and types of interaction between conflicting schemata resulting in various forms of conflict resolution. In this context, Jegede designates points in between the two extremes. One of which is called dependent collateral learning. For many pupils, learning science in order to imbibe its culture meaningfully, often involves cognitive conflicts of some kind. Therefore, meaningful learning often results in parallel, dependent, or secured collateral learning. The theory further explains that simultaneous collateral learning ensues when ideas from two world views about a particular concept is learned at the same time.

Depending on the knowledge base of the learner, a number of interacting elements such as current problem state, problem solving techniques, and differences or similarities between the ideas from two different world views are simultaneously assessed. For a learner who needs to move into the culture of science, he or she requires an effective use of collateral learning with a heavy reliance on successful cultural border crossings into school science. Ethnoscience Instructional Method makes cultural border crossings easier through the identification of cultural beliefs, verbal expressions and assertions that are related to the science concept to be learned by the student. Those that are compatible fall into the category of secured collateral learning while

those that are modifiable fall between dependent and simultaneous collateral learning. Those that are contradictory belong to parallel collateral learning.

2.1.4 Conceptual Change Model

When you ask an average *Yorùbá* boy or girl of South-Western Nigeria what his or her understanding of lightning and thunder is, he is likely to relate it to *Şango*, the mythical god of thunder. He is convinced that his ideas are correct and will do all he can to defend them. His constructed knowledge, not scientifically accepted, is called "naive knowledge" or "prior conceptions." This is the typical dilemma faced by learners especially those from a traditional background. Vosniadou (2002) asserts that children begin the knowledge acquisition process by organizing their sensory experiences under the influence of everyday culture and language into arrow, but coherent, explanatory frameworks that may not be the same as currently accepted science.

Chi & Roscoe (2002) maintains that students' constructed knowledge typically has two properties: it can be incorrect, and it can often impede learning of conventionally accepted knowledge. They differentiate naive knowledge into two forms:

- (a) Preconceptions that can be easily and readily revised through instruction.
- (b) Misconceptions that is robust and highly resistant to change, even when not supported by observations.

The above observations readily set the stage for Conceptual change model. The conceptual change learning model can be said to have built on fundamental concepts of constructivism which has become a familiar view of learning among science educators. These concepts include assimilation from Piaget's work which denotes the fitting of new experiences into existing mental schemes and accommodation which Geelan (2000) describes as the changing of mental schemes that are unable to explain one's new experiences. Other theorists

consequently came up with a theory that explains and describes the "substantive dimensions of the process by which people's central, organizing concepts change from one set of concepts to another set, incompatible with the first" (Posner, Strike, Hewson, & Gertzog, 1982) - The "conceptual change" learning model. The central commitment of this model is that learning is a rational activity that can be defined as coming to comprehend and accept ideas because they are seen as intelligible and rational. This is described by Suping (2003) as the "ahaa" experience which is of utmost importance in learning.

What exactly is conceptual change?

Davis (2001) defines conceptual change as learning that changes an existing conception (i.e. belief, idea, or way of thinking). He states further that this change brings a shift in or restructuring of existing knowledge and beliefs. This is what distinguishes conceptual change from other types of learning. Learning for conceptual change is therefore not mere accumulation of new facts or learning a new skill. In conceptual change, an existing conception is fundamentally changed or even replaced, and becomes the conceptual framework that students use to solve problems, explain phenomena, and function in their world.

Posner, Strike, Hewson, and Gertzog who are frontline advocates of conceptual change model used Thomas Kuhn's idea of paradigms and Imre Lakatos's notion of theoretical hard core ideas to formulate this model of learning. Paradigms and theoretical hard core ideas are characterized as the "background of central commitments which organize research". For students, concoctions of experiences - physical, mental, and cultural beliefs - constitute highly personal conceptual ecologies that increase in complexity with age (Posner et al, 1982). Apart from Posner and his colleagues, some other theorists in an attempt at clarifying the concept of conceptual change actually offered competing views of the central process. Davis (2001) lists these views:

* To Vosniadou (2002), conceptual change is a process that enables students to synthesize models in their minds, beginning with their existing explanatory frameworks. This is conceived to be a gradual process that can result in a progression of mental models. Mortimer (1995) argues for what he calls a conceptual profile change because "it is possible to use different ways of thinking in different domains" and "the process of construction of meaning does not always happen through an accommodation of previous conceptual frameworks in the face of new events or objects, but may sometimes happen independently of previous conceptions" Though their arguments differ, the views of Mortimer and Vosniadou are related and acknowledge the importance of prior knowledge to learning.

* Chi and Roscoe (2002) conceive of conceptual change as repair of misconceptions. Starting with naive conceptions, students must identify their faulty conceptions and repair them. In this view, misconceptions are miscategorizations of concepts, so conceptual change is the reassignment of concepts to correct categories.

*Conceptual change to DiSessa (2002) is the reorganization of diverse kinds of knowledge into complex systems in students' minds. In this view, conceptual change is really about cognitively organizing fragmented naive knowledge.

*Ivarsson, Schoultz, and Saljo (2002) take a more radical stance in that they think naive conceptions do not serve a purpose in conceptual change because conceptual change is the appropriation of intellectual tools. In this view, conceptual change results from changes in the way that students use the tools in various contexts, and the change actually occurs at the societal level.

This study is a trail blazer on how science educators should respond to these four competing views of conceptual change.

2.2 Conceptual Framework

2.2.1 Concept of Ethnoscience

Scholars have variously defined ethnoscience. But each of the definition points to the fact that it relates to knowledge indigenous to a culture. Abonyi (2002a) defines it as the “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”. This means that branches of ethnoscience would include ethnochemistry, ethnophysics, ethnoagriculture and so on. Ogunbunmi and Olaitan (1988) define ethnoscience as 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. This definition is a general one. Others have actually defined it from specific angles. For instance, Hunter and Whiter (1990) look at it from taxonomies’ point of view. They assert that the chief concern of ethnoscience is the enumeration of what have been called the “folk taxonomies” which are modes of analysis whose main purpose is the description of particular types of hierarchical relationship between members of a given set of elements.

A new dimension was earlier added to the conception of the meaning of ethnoscience by Ezeagbasili (1977), who views ethnoscience from a purely African perspective. He uses African science as a synonym for ethnoscience and defines it as an African account of nature and how it works. He asserts that the testing ground of all science (Ethno or Conventional) is utility. This utility can therefore be measured in terms of the extent to which this indigenous knowledge provides a medium for further accumulation of science and technical knowledge within the immediate society. It should therefore, be consistent with the essentials of her people’s common sense.

Ethnoscience can also be defined as the natives’ knowledge of and beliefs about natural entities and phenomena and the meanings they attach to them.

2.2.2 Scope of Ethnoscience

The scope of ethnoscience is wide and actually touches every aspect of nature and life. Some of these include ethnomedical practices (Foster and Anderson, 1992), ethnophysics (Ogunbunmi and Olaitan, 1988, folk classification system or ethnotaxonomy (Foster and Anderson 1993) and ethnobiology (Turner, 1988).

Studies abound in all these areas. Ethnomedicine involves the study of indigenous healing practices and of beliefs, attitudes and strategies regarding health and diseases (Ohaeri, 1988). In Yorùbá land (South-western, Nigeria) for example, despite the fact that many claim to profess Islam and Christianity, 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 (Maclean, 1986).

Interestingly, Ethnoscience also reflects in colour perception, which is largely a function of language. For example, the Yorùbá perception of white is the colour of raw cotton (*O funfun biẹgbon owu*), while a Briton would perceive white colour in terms of snow (As white as snow). Yet the colour of raw cotton and snow are not exactly the same.

2.2.3 Rationale for Ethnoscience.

In asserting the rationale for ethnoscience, Whorf (1989) formulated the 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 way be calibrated. Essentially culture is the ways by which people categorize their physical and biological world. Abonyi (1999) explains that since ethnoscience deals with knowledge indigenous to a culture, it therefore serves as a basis for the construction of reality by linking culture to advanced scientific knowledge. He further asserted that it acts as an intermediate situation between fantasy and exact

knowledge or between drama and technology, by sniffing a quarry in the cave where dogs cannot penetrate so that their baying and pointing may finally call the hunter to the spot.

Lloyd (1992) in his own case bases the rationale for ethnoscience on the premise that it helps to clear the notion that science is what modern scientists believe in and the methodology with which they operate. Adams (1983) points out that when one adopts uncritically the science and paradigms of another people's culture, it means that one adopts their consciousness and also limits the arena of one's own awareness.

Abonyi (1999) summarizes Adams thought by saying children who are taught scientific principles using the western method and applying strictly concepts and paradigms that are completely alien to the students are bound to experience mental disequilibrium.

Studies in ethnoscience therefore bring to the fore the intellectual and scientific treasures embedded in various culture and serve as a guide to their scientists on what to address based on societal needs.

2.3. Empirical Studies

2.3.1 Instructional Methods of Teaching Science.

Science education is being continuously enriched with methods, strategies and techniques developed to improve the learning and teaching of various scientific concepts in schools. Various changes in science curricula and constant developments in educational technology make the teaching of science more challenging. There are many instructional methods used in a conventional science classroom. These methods include: Lecture method, Demonstration method, Fieldtrip, Discussion method etc (Okebukola, 2002). Some of these methods have however been described as being teacher centred in approach. Other researchers such as Von (2002) and West (2002) have similarly concluded that poor teaching methods have greatly contributed to under achievement in science. This probably informed the opinion of Ajelabi

(1998) that teaching methods adopted by teachers is important. He emphasizes the need to introduce, adopt and adapt latest instructional techniques capable of improving achievement in science. This is the main aim of Ethnoscience Instructional Method.

2.3.1 Instructional Methods of Teaching Science.

2.3.1.1 Conventional Method of Teaching Science

This is the use of traditional or lecture method in the teaching of science. This method involves the use of some forms of demonstration by the teacher. It involves displaying something before the student (Akinlaye, 2000). The teacher stands before the students to perform an experiment.

The main function of the method is to verify facts and principles already learnt and reinforce students' understanding of concept taught. The combination of lecture and demonstration methods ensures the following instructional effects on students:

- (i) It helps to stimulate the interest of students.
- (ii) It allows pupils to observe how a scientist thinks and proceeds.
- (iii) It leads to easy coverage of the syllabus.

(Erinosho 2000 and Stollberg 1995).

The method has however been criticized for not allowing pupils to develop manipulative skills. It does not allow pupils to satisfy their psychological demand for carrying out activities on their own. Stollberg (1995) noted that sight alone cannot provide most of the scientific information that pupils need.

2.3.1.2 Ethnoscience Instruction

The implementation of the ethno-scientific instructional approach was based on the recommendations for teaching science and the Science for All movement (UNESCO, 1990).

These are:

- (1) The content, language, symbols, designs, and purpose of the curriculum should be linked to day-to-day experiences and goals of the children.
- (2) Theory should be linked to practice, human purpose, the quality of life, and in-school experience to out-of-school experience and
- (3) Teaching and learning should begin from the beliefs, interests, and learning skills that students bring to the classroom and should help each of them extend and revise their ability and understanding.

Again in 1999, UNESCO sponsored Science for the 21st Century conference held in Budapest came up with two statements; the 'Declaration of Science and the use of scientific knowledge' and 'Science agenda: Framework for action'. In the Declaration of science and the use of scientific knowledge, it is stated that:

...traditional and local knowledge systems are dynamic expressions of perceiving and understanding what the world can make and historically have made, a valuable contribution to science and technology, and that there is need to preserve, protect, research and promote this cultural heritage and empirical knowledge. Science curricula should include ethics, as well as training in the history and philosophy of science and its cultural impact.

In response to this call, some scholars have argued for the importance of connecting school science education to the students' cultural background (Cajete, 1995). McKinley (2005) divides this argument into two strategies. The first is, making science relevant to the students which usually involve the teaching of culturally relevant contexts. This direction is referred to as

integration of indigenous knowledge into school science, which is unidirectional, reflecting indigenous knowledge as small, less useful, grounded and is tantamount to assimilation. The second strategy directs towards improving indigenous students learning through more appropriate teaching approaches and models which he refers to as culturally responsive teaching or culturally based pedagogy.

2.3.2 Students' Cognitive Achievement in Science

A number of studies on cognitive achievement in science have been carried out and the causes of varying levels of achievement in schools have frequently been the subject of investigation. Many indices however show low cognitive performance of learners in science. The Coleman (1966) report, which states that the best predictor of student achievement is the socioeconomic status of the parents led to a flurry of investigations on student achievement. Bulach et al (1995) investigated the relationships existing between student achievement and possible predictor variables. They conclude that teachers' instructional strategy, students' socioeconomic status, school climate, parent, and community involvement are major factors affecting students' cognitive achievement.

Akinjitan (2002) also identified some of the factors responsible for this poor performance to be the use of poor instructional strategy, inadequate teaching facilities, shortage of professionally qualified science teachers among others. Young and Fraser (1993) also conclude that several factors affect students' science and physics achievement. Some of the other factors mentioned in other studies are students' gender, age, cognitive development, previous knowledge, mathematics achievement, attitude, socio-economic status and achievement expectations.

Socio-Economic Status (SES) as used through this study refers to the level of students' socioeconomic background as assessed by their parents' occupation, educational level, family

income, family size and some other variables. The result of Young and Fraser study indicates significant positive and large effect of students' socioeconomic status on their science achievement. Young (1995) points out the same result in another study: Students from higher socioeconomic background tend to outperform those students from poorer homes. In that study, what is meant by the SES is assessed by parents' occupations, mother's educational level, number of books in home, and family size. UNESCO (2010) also identified various other factors associated with cognitive achievement factors which may be classified in two groups. The first group is made of variables related to school equipment and processes while the second consists of characteristics of the students that affect learning. Students' characteristics are closely linked to learning.

Findings from the study show that grade repetition, socioeconomic and cultural status, gender, child labour, preschool attendance, and being a member of an indigenous group are elements that shape student academic performance. The social, economic and cultural status of students is the variable that most influences learning performance. Students who come from families with less access to material and cultural goods, and whose parents have less schooling, tend to attain lower levels of academic achievement than their peers from families with greater access to materials and cultural goods and whose parents have more schooling opportunities. This study is interested in the cultural influence on cognitive achievement and how the use of appropriate instructional methods can bring about desired result as recommended by Okebukola (1991).

2.3.3 Students' Attitude to Science

Many studies on attitude have shown that a person's attitudes are learned, as opposed to being inherited. Different factors have been identified as influencing a person's attitude, including previous experiences and social influences. Attitude towards science can be defined as,

“favorable or unfavorable feelings about science as a school subject,” (Morrell & Lederman, 1998). Oliver and Simpson (1988) also define attitude to science as the degree to which a student likes science. Salta and Tzougraki (2004) summarize attitude as a tendency to think, feel, and act positively or negatively toward objects in our environment. Attitudes can be viewed as having three main components: cognitive, affective, and behavioral components (Salta & Tzougraki, 2004).

Students’ attitude to science and students’ achievement have been of great interest to researchers. Review of relevant literature depicts varying opinions and findings on the students’ attitude towards science and their performances. Olatoye (2001) found that students attitude towards science have significant direct effect on student achievement in the subject. Adesokan (2002) and Onwu (1981) asserted that in spite of the recognition given to Chemistry among the science subjects, it is evident that students still show negative attitude towards the subject thereby leading to poor performance and low enrolments. However, according to Keeves (1992) and Postlethwaite and Wiley(1991), attitudes towards science are, in general, highly favoured, indicating strong support for science and the learning of science. Siegel & Ranney (2003) establish modest positive correlations between science attitudes and science achievement. Cannon and Simpson (1985) argue that changes in student achievement motivation were similar to changes in science attitude.

A positive attitude towards science can however be developed through methods of instruction that excite students and encourage them to learn (Freedman, 1997). Adesoji (2008) establishes the fact that acceptable methods of instruction are capable of changing students’ attitude towards science. He concludes that if many students could be drawn towards science through appropriate instructional strategies, the anticipated 60:40 science students to Liberal Arts students in Nigerian Universities would be a reality. A study on what would be the effect of an ethnoscience instruction on students’ attitude to science is therefore appealing.

2.3.4 Conception of Scientific Phenomena

For a long time early scholars made wrong assumptions about how students learn. Interestingly these include some academic canons of early modern philosophy like John Locke and David Hume who were both empiricists. It was John Locke who stimulated investigation into how children learn and posited that the human mind is a *tabula rasa* (blank tablet) that merely registers what comes into it. This is now widely rejected in the light of new findings. Research has shown that people construct new knowledge based on prior experiences and understandings. It is now known that students come to school with previous ideas that deal with the natural world that are highly resistant to change and strongly influence new learning (Pfundt & Duit, 1991). Thus instead of remembering a host of accurate details, people tend to remember events by incorporating a few details within a schema for the event (Silva et al., 2006; Scoboria et al 2006).

Alternative conceptions often result when new experiences are interpreted in the light of prior experiences, and new understandings are grafted onto prior understandings. Memories in general are retrieved by first recalling the schema and then the associated details. If a concept does not fit a pre-existing schema and is not all that salient, it is likely to be forgotten or even rejected. In the words of Wenning (2008), misunderstanding, miscommunication, miseducation and even a misapplication of well-established physical principles lead to the formation of alternative conception. Wandersee, Mintzes, and Novak (1994) generated eight “emerging” research-based claims relating to alternative conceptions in science as listed by Wenning (2008). These are:

1. Learners come to formal science instruction with a diverse set of alternative conceptions concerning natural objects and events.
2. The alternative conceptions that learners bring to formal science instruction cut across age, ability, gender, and cultural boundaries.

3. Alternative conceptions are tenacious and resistant to extinction by conventional teaching strategies.
4. Alternative conceptions often parallel explanations of natural phenomena offered by previous generations of scientists and philosophers.
5. Alternative conceptions have their origins in a diverse set of personal experiences including direct observation and perception, peer culture, and language, as well as in teachers' explanations and instructional materials.
6. Teachers often subscribe to the same alternative conceptions as their students.
7. Learners' prior knowledge interacts with knowledge presented in formal instruction, resulting in a diverse variety of unintended learning outcomes.
8. Instructional approaches that facilitate conceptual change can be effective classroom tools.

It will therefore not be out of place if a study is carried out to empirically determine how effective an Ethnoscience Instructional Method will be in facilitating conceptual change.

2.3.5 Ethnoscience Instruction and Students Learning Outcomes

2.3.5.1 Ethnoscience Instruction and Students' Achievement

A number of scholars have for long anticipated the efficacy of a culture based instruction on achievement and other students' learning outcomes (Bronowski, 1990; Douglas, 1991 & Fafunwa, 1983). In specific terms, Albert (1974) assessed the effects of ethnoscience instruction on academic achievement and interest in science. The result of his study revealed that students' taught using ethnoscience instruction had higher academic achievement than those taught using the conventional method. The study which took place among American – Indians therefore recommended the use of Ethnoscience -based instruction in teaching science concepts to students.

Some researchers, among whom are Levy-Bruhl and Clare (1992) however argue that indigenous knowledge is primitive and therefore capable of generating 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. Their views are however speculations that are not backed up by empirical evidence. The present study in the area of ethnoscience instructional method will further enrich the literature on this issue.

2.3.5.2 Ethnoscience Instruction and Attitude to science.

Attitude has been defined as the effective disposition of a person or groups of persons to display an action towards an object based on the belief that such a person or groups of persons have about the object (Oguntade, 2000). Research findings revealed that attitude towards a subject greatly affects achievement (Olagunju, 1998). Attractiveness or repulsiveness to science is influenced by the learner's attitude (Ogunkola, 2002). The implication of this is that positive attitude towards science is likely to lead to persistent and better achievement (Odogwu, 2002). Indeed Osborne (2001) prove that there exists a positive correlation between students' attitude towards science and performance.

It must be stated that attitude has three components as identified by Oscamp (1977). These are the cognitive, feeling and action or behavioural components. The cognitive component is the intellectual aspect which relates to opinions, beliefs and stereotypes learners may hold about specific issues, events or personalities. The feeling component refers to the emotions connected with the person, place or object. The behavioural or action component on the other hand is the overt manifestations of all that takes place within a learner. The effect of ethnoscience instructional method on attitude towards science would therefore go a long way towards determining achievement in science.

2.3.5.3 Ethnoscience Instruction and Students' Conception of Scientific Phenomena

When new experiences are interpreted in the light of prior experiences and new understandings are grafted onto prior understandings, learners' understanding of new concepts may be quite different from the intended meaning. Corben (1991) gives an illustration:

Three men went to see Nigerian falls. One from India, one was from China and one was from America. On seeing the falls, the India as a matter of course thought of the god manifest in his grandeur of nature. The Chinese simply wished to have a little hut besides the falls where he might invite his friend and enjoy conservation. The American however on viewing the falls immediately asked himself what would be done to make the most of such an enormous amount of energy. p.34

The above explains how learners' conception of scientific phenomena is greatly influenced by their prior knowledge. The impact of ethnoscience instructional method on students' conception of scientific phenomena would therefore assist in determining achievement in science. From all the points and issues so far discussed, the need for a culture-based instructional method therefore becomes obvious.

2.3.6 School Location and Students Learning Outcomes

Studies have shown various effects of school location on learning outcomes. Urban environment is characterized by high population density, presence of tertiary educational institutions, and presence of secondary health centres whereas rural environment is characterized by low population density, sometimes primary schools and primary health centres. These differences and others bring out various effects on students learning outcomes. Numerous studies have shown positive correlation between location and students' academic achievement, (Reeves & Bylund, 2005; Lawani 2004; Orji 2004; Ndukwu 2002).

While Ogunleye (2002) and Ahofo (2002) maintains that school location has significant effect on students' academic performance, Akintunde (2004) indicates that urban students have better performance than their peri-urban counterparts in concept attainment. Kannapol and Deyoung (1999) indicates a contrary view stating that urban schools are not as they once were and rural schools had improved considerably in their attitude to science. Aina (1998) further explains that natural aesthetic values present in the rural areas such as trees, shrubs and flower beds in rural schools which beautify them create good learning atmosphere. In a recent study, Osokoya and Akuche (2012) who studied the effects of school location on students' learning outcomes in practical physics, found a significant main effect of school location on cognitive attainment in practical physics with learners in urban schools performing better than those in rural schools. A significant main effect of school location on students' performance in practical skills in practical physics was also recorded with urban students performing better than rural students. However there was no significant main effect of school location on students' attitude to practical physics.

Reeves (2005) carried out an analysis of 5-year series of math and science achievement data from the state of Kentucky to determine the effects of school location on learning in these subject areas by adopting an organizational assessment approach showing how growth models may be used to estimate achievement trends. He found out that rural location does not significantly influence the achievement trends of 5th grade math or 11th grade science, at least insofar as these trends are accurately measured by Kentucky's official tests. In the case of 5th grade math learning, the apparently significant rural gap is not real. The gap is explained by the presence of a greater percentage of low-income students in rural schools. He also found out that with respect to 11th grade science learning, the effects of location on achievement status and the actual growth rate (after the correction for deceleration) were too small and insignificant to

warrant immediate attention by policymakers. His results do not support the claim that rural students achieve less well than their non-rural peers in math and science.

With these conflicting results, Ethnoscience instruction would shed more light on the effect of location on science learning outcomes.

2.3.7 Parent Educational Status (PES) and Students' Learning Outcomes

Parents play an important role in their children's learning. Aside from being actively involved in their children's education, parents also provide a home environment that can affect learning. Parents serve as a model for learning, determine the educational resources available in the home and hold particular attitudes and values towards education. Although it is difficult to examine the home environment of each student, the educational attainment which leads to the occupation of parents serve as an indicator of the values and resources, with which parents create this environment (Education Matters, 2005). Indeed Ojo (2008) states categorically that parent education is the single most important predictor of participation in Mathematics and Science.

Parent educational status has been identified as an important factor affecting student achievement (Dryfoos, 1990). Chubb and Moe (1990) also report that parents' education and income were the most important socioeconomic variables for determining the performance of students. Campbell, Hombro and Mazzeo (1999) indicate from their study that students who reported higher parent education levels tended to have higher average scores. More educated parents are assumed to create environments that facilitate learning and involve themselves in their children's school experiences and school environments (Useem, 1992). Brian (2008) however concluded from his study that a parent's education background has no substantive effect on their children's home school academic performance but for public schools, a parent's educational level affects children's performance.

Awofala (2010) shows from his study that parent educational background has a significant effect on students' achievement in Mathematics word problem and no significant effect on

students' attitude to Mathematics word problem. Students' from high parent educational background performed better than their counterparts from low educational background. This is also the case with Ogwu (2006) who asserted based on the empirical result from their study that parent educational background is significantly and positively related to achievement. A research work using ethnoscience instructional method with PES as a moderating variable therefore looks appealing. It will confirm or support assertions already made from previous studies which have not been conclusive.

2.4 Appraisal of Literature Review

The review of literature has shown that several attempts have been made at understanding how learners deal with cognitive conflicts between everyday life world and the world of school science. It also revealed that students come to classes with a range of experiences referred to as prior knowledge (Pfundt & Duit, 1991). When this knowledge relates to cultural environment or background some scholars refer to it as Ethnoscience. This prior knowledge is said to be resistant to change and strongly influences learning which may lead to unintended interpretations of concepts. These interpretations are collectively known as alternative conceptions.

Little attempts have however been made to trace the connection between Ethnoscience and science education. The few previous attempts made in the past have however established that learning and teaching of science among students in traditional settings have been made difficult by the conflicts arising between western modern science and cultural beliefs (Bajah, 1981; Jegede & Okebukola, 1991; Akpan & Anamuah – Mensah, 1992 and Wasagu, 1999).

The initial efforts at solving these problems seem however misdirected. For example, Fafunwa (1983) recommends the mother tongue approach based on the success of a programme in which students were taught science using the local language. He was criticized for transmitting western science concepts in local language. Achimugu (1995), in his own case

recommends the use of improved local instructional materials. He is said to have succeeded only in improvising western instructional materials. The two recommendations have not removed the 'Western' in them. Various conferences have also made failed attempts at inculcating indigenous elements into science curriculum. There is therefore the need for a different approach to solving the problem.

George (2001) however recommends that a workable approach to science education that incorporates indigenous knowledge must be able to:

- draw upon cultural experience and everyday life.
- access different ways of thinking about scientific concepts.
- bridge the gap between the traditional and the conventional.

A collection of science related cultural beliefs commonly expressed verbally in day-to-day activities would be required to successfully do this which makes an Ethnoscience database that is useful in a classroom setting desirable. When structured for the classroom setting, it is to shed more light on various issues raised in respect of cultural beliefs and modern science. Empirical evidence would be provided on how other identified variables such as school location and parent educational status interact to affect cognitive achievement, attitude to science and conception of scientific phenomena.

The review shows that educators often expend so much energy on the ideas they want their audience to have but learners' prior knowledge often confounds educators' best efforts to deliver ideas accurately. To capture the essence of this work various theories were examined. They include the Border Crossing theory, Collateral Learning theory and Vygotsky's Socio-Cultural theory. Conceptual Change model was also examined.

2.5 The Present Study

Specifically, an Ethnoscience Database was developed a procedure set for its standardization. Classification of its items was equally carried out, both in terms of broad classification of science concepts and compatibility with the understanding of related modern science concepts. A storage and retrieval system was also developed. A framework for its incorporation into the classroom setting was similarly developed. Its field trial involved determining the:

- a) impact of ethnoscience instructional method on students cognitive achievement in science.
- b) impact of the method on students' attitude towards science.
- c) impact of the method on students' conception of scientific phenomenon.
- d) impact of the method based on schools' location (rural and urban).
- e) effects of the method on students with different parent educational status (Low PES, Average PES and High PES).
- f) interaction effects (if any) of the method between the variables.

Therefore the project is aimed at making research results and findings available on the impact of culture-based instructions on students' learning outcomes in science.

Data were obtained through the use of appropriate response and stimulus instruments from students. Finally the data obtained from the study have revealed the impact of the method on the identified variables.

CHAPTER THREE

METHODOLOGY

This chapter discusses the research design, variables of the study including the independent, moderator and dependent variables, the sample and sampling techniques, the instrumentation with both response and stimulus instruments and the research procedure involving the development and standardization of the database, development of a framework of its incorporation into the science classroom, the work schedule and the method of data analysis used.

3.1. Research Design:

The study was carried out in two phases. Each phase had its own research design. Descriptive survey design, with the use of unstructured personal interview of elders and community leaders, students' responses, review of previous work and personal survey, was utilized for the first phase involving the development of Ethnoscience Database (ED) [Appendix 3A]. The second phase involved the adoption of the pretest, posttest, control group quasi-experimental design. This design is shown structurally as follows:

01 X1 02

03 X2 04

Where 01 and 03 represent the pretest observations for the experimental and control groups respectively while 02 and 04 represent the posttest observations for the experimental and control groups respectively.

X1 – Experimental Treatment (Ethnoscience Instructional Method).

X2 – Modified Lecture Method.

The design also adopted a 2 x 2 x 3 factorial matrix for the purpose of analysis of the research data. The layout is presented in Table 3.1.

Table 3.1: The 2 x 2 x 3 Factorial Matrix

Treatment	School Location		Parent Educational Status
	Urban	Rural	
Ethnoscience Instructional Method			Low
			Average
			High
Modified Lecture Method			Low
			Average
			High

3.2. Variables of the Study

There are three categories of variables in the study. They include:

(a) Independent variable: This is Instructional Method at 2 levels:

- (i) Ethnoscience Instructional Method (EIM).
- (ii) Modified Lecture Method (MLM).

(b) Moderator Variables: These are:

- i) School location at two levels (Urban and Rural)
- ii) Parent Educational Status (Low, Average and High)

(c) Dependent Variables:

These are Students':

- i) Cognitive Achievement in Science
- ii) Attitude Towards Science
- iii) Conception of Scientific Phenomena

Table 3.2: Summary of Variables in the Study

Independent Variable	Moderator Variables	Dependent Variables
Instructional method at two levels: (i) Ethnoscience Instructional Method (ii) Modified Lecture Method	(i) School Location (Urban and Rural) (ii) Parent Educational Status (Low, Average and High)	Students' (i) Cognitive Achievement (ii) Attitude Towards Science (iii) Conception of Scientific Phenomena

3.3 Sample and Sampling Technique

The target population of the first phase of the work for the development of the database consisted of all the six south-western states of Nigeria made up of mainly the *Yorùbá* with common cultural background. Stratified random sampling was used to select three of the states- Oyo, Ekiti and Ogun - based on closeness and one each from those divide into two from the last state creation exercise. 31 elders and community leaders (18 males and 13 females) from peri-urban centres of cities of Ibadan, Abeokuta, and Ado-Ekiti (12, 10, and 09 respectively) were also involved in the study. They were purposively selected based on their positions in the community as traditional leaders, custodians and preservers of cultural norms and beliefs and opinion moulders. Additionally all students of two junior secondary and two senior secondary schools (all co-educational) each randomly selected from Ibadan, Abeokuta and Ado Ekiti respectively numbering 3,055 were also used for data collection in the first phase during the development of the Ethnoscience Database (ED).

The target population of the second phase of the study consisted of all Junior Secondary I students in Ibadan Municipality (Urban and Rural centres) made up of 11 local government Areas (5 in urban and 6 in rural areas). Stratified random sampling was used to select four public co-educational Junior Secondary Schools that were used. Two schools were selected from one

randomly selected local government in the urban centre of Ibadan while two schools were also selected from one randomly selected local government in the rural centre of Ibadan based on the performance of their teachers during the training programme. Two randomly selected intact classes were used in each school. This was to prevent the disruption of normal class activities noting that none of the classes had less than 90% students with *Yorùbá* cultural background. The non-*Yorùbá* students lived and daily interacted with members of the local community and were more likely to have been influenced by the society. A total of 352 JS1 students participated in this phase of the study.

3.4 Instrumentation

(A) Three response instruments were used for data collection. These are:

1. Basic Science Cognitive Achievement Test (BSCAT) (Appendix 1A)
2. Attitude Towards Science Scale (ATSS) (Appendix 2A)
3. Conception of Scientific Phenomena Assessment Sheet (CSPAS) (Appendix 3A)

(B) Four stimulus instruments were also used. These are:

1. Teachers Instructional Guide on Ethnoscience (TIGE) (Appendix 4A)
2. Ethnoscience Database (ED) (Appendix 4B)
3. Teachers Instructional Guide on Modified Lecture Method (TIGMLM) (Appendix 5)
4. Teachers Performance Evaluation Sheet (TPES) (Appendix 6):

The Teachers Instructional Guide on Ethnoscience (TIGE) was developed by the researcher while the Teachers Instructional Guide on Modified Lecture Method (TIGMLM) was drawn from the Basic Science curriculum module of the Federal Ministry of Education. They are identical in terms of contents, basic instructional objectives and mode of evaluation. The only differences are in the instructional activities and instructional materials where Ethnoscience method made use of

additional information from the database and utilized additional instructional materials that reflected local beliefs. Teachers Instructional Guide on Modified Lecture Method (TIGMLM) involves the following procedure. The teacher:

- (i) introduces the lesson by asking questions on relevant prior learning.
- (ii) presents the new concept to the learners by explaining the new topics to the learners.
- (iii) shows or demonstrates with relevant materials.
- (iv) concludes the lesson by asking learners questions on what they have been taught and later take the summary of the lesson. The teacher finally gives assignments and home works to the learners.

The Teachers Performance Evaluation Sheet (TPES) (Appendix 6) was designed by the researcher to assess the performance of the teachers after the training programme.

3.4.1 Basic Science Cognitive Achievement Test (BSCAT) [Appendix 1A]

This was used in measuring the cognitive achievement of the students in science. It is made up of two sections. Section A was used to collect the subjects' personal data. Section B is a 40-item multiple choice test with four options (A – D), one of which is the correct option. All the questions were answered in one hour. The items were generated around three levels of cognitive domain i.e. Remembering, Understanding and Thinking in accordance with the recommendation of Okpala and Onocha (1995). The items were carefully selected to cover all the contents treated during the period of treatment. The contents were chosen from the four basic themes of the Junior Secondary Basic Science curriculum. They are shown in Table 3.3:

Table 3.3: Table of Specification for BSCAT

Broad Themes	Remembering	Understanding	Thinking	Total
You and Environment	26,28,34,37,39	2,5,27,38	15,16,20	12
Living and Non-Living Organisms	3,8,12	9,14,18,33	6,29	10
You and Science	11,23	22,25	21,40	06
You and Energy	1,10,31,35,36	4,12,19,32	7,19,30	12
Total	15	15	10	40

An Answer sheet for BSCAT [APPENDIX 1B] was also prepared.

The researcher developed the instrument. It is drawn from an initial 70 item objective test (representative of the selected topics) which was given to four experts in the field of Basic Science and test construction to establish content and face validities. They were asked to ascertain the suitability of the items and their appropriateness for the target population and language clarity. Based on their advice, 10 (ten) items were dropped. Some others were modified for clarity.

The remaining items (60) were then administered on a sample of 35 Junior Secondary I (JSS I) Basic Science students in a school similar to those used for the treatment. An item analysis was performed to determine the difficulty levels and discrimination indices of the test items. Items that were neither too simple nor too difficult were selected. This reduced the items to 51. Forty (40) items were thereafter selected for proportional representation. The reliability co-efficient of the items was calculated to be 0.83 using Kuder-Richardson formula (KR 20). The total obtainable score is 40 marks with each question earning a mark. A marking scheme was also developed for the purpose of assessment. The table below (Table 3.4) shows the Concepts, Period of Treatment and Number of Questions.

Table 3.4: Table of Concepts, Period of Treatment and Number of Questions for BSCAT

Broad Themes	Selected Concept \ Topics	Period of Treatment (week)	Number of Questions
You and Environment	Environmental conservation and Safety	3	12
Living and Non-Living Organisms	Matter and characteristics of Living and Non-Living Things	2	10
You and Science	Gravitation and Weightlessness	1	06
You and Energy	Forces	3	12
Total		09	40

3.4.2 Attitude Towards Science Scale (ATSS) [Appendix 2A]

This instrument is designed to assess students' attitude towards science and is made up of Sections A and B. Section A consists of personal data of the subjects while Section B is a 47 item 5-point Likert type scale. It was scored on a 5-point basis. Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree (D), and Strongly Disagree (SD). An answer sheet for ATSS was also prepared and attached (Appendix 2B).

ATSS was given face validation by four experts in Science Education and test construction. The items were scrutinized in terms of relevance, suitability, general test format and language. Their comments formed the minor adaptation made in the scale which is the already standardized and universally accepted Modified Fennema-Sherman Science Attitude Scale. (Doepken, Lawsky & Padwa, 2008).

The researcher however felt it worthwhile to carry out a re-validation of the final version of the instrument by administering it on an independent but similar sample of 30 junior secondary students. A Cronbach Alpha coefficient of 0.86 was obtained.

Each positive item in the instrument received points as follows: SA = 5, A = 4, NS = 3, D = 2, SD = 1. The scores were reversed for negative items. The highest possible score for positive

statements in Table 3.5 is 120 points while the highest score for negative statements is 115 points.

Table 3.5: Table of Specification for ATSS

Attitude Categories	Items		Total
	Positive	Negative	
Personal Confidence about subject matter	1,12,25,33,37,41	4,8,19,23,32, 43	12
Usefulness of the subject's content	3,10,17,27,34,44	5,13,21,29,39,42	12
Subject is perceived as a male domain	6,15,28,31,38,46,	9,11,18,24,36	11
Perception of teachers' attitude	2,14,20,35,45,47	7,16,22,26,30,40	12
Total	24	23	47

3.4.3 Conception of Scientific Phenomena Assessment Sheet (CSPAS)[Appendix 3A]

This instrument was designed to explore students' conception of specific scientific phenomena. It is made up of Sections A and B. Section A was used to collect students' personal data. Section B is a 20-item multiple choice test with four options (A-D) designed to reflect both cultural and scientific views. An answer sheet was developed and attached to the instrument. A 'No idea' option was included to allow for full expression of the learners.

CSPAS was given face validation by two experts in ethnoscience and test construction. They made useful suggestions which were utilized in the production of the final version. The instrument was adapted from Abonyi (1998). The adaptation was in the modification of some of the sentences to reflect local beliefs and the non-inclusion of the need to explain the reasons for possible shift in conception. As a conception test, there is no fear of testing effect.

The instrument was quantitatively assessed by the number of shifts from local beliefs to scientific beliefs in respect of the 20 items making the obtainable scores 20. A reliability coefficient of the instrument after administrations on an independent but similar sample of 30 junior secondary schools students was calculated to be 0.82 using Kuder-Richardson formula (KR 20). An Answer sheet for CSPAS (APPENDIX 3B) was also prepared.

3.4.4 Teachers Instructional Guide on Ethnoscience (TIGE) [Appendix 4A]

This instructional guide was designed as a comprehensive guide for teachers in the Ethnoscience Instructional Method group. The guide involves the following broad steps:

1. The teacher briefly introduces the concept.
2. The teacher enumerates and explains related common sayings on the concept using information from ED.
3. Learners respond and are encouraged to list more related common sayings and other prior knowledge.
4. The teacher presents the new science concept and jointly with the students interacts with relevant ethnoscience instructional materials.
5. Students compare new concept and related common *Yorùbá* sayings and classify the sayings into:
 - (a) Compatible sayings
 - (b) Modifiable sayings
 - (c) Contradictory sayings
6. The teacher demonstrates and allows learners to interact with relevant instructional materials
7. The teacher asks questions and allows the students to ask questions and takes summary of the lesson.
8. The teacher gives assignment.

Specifically, the ethnoscience paradigm intervention is in respect of teachers and students activities in which information available in the Ethnoscience Database (ED) in respect of the theme or concept is made use of to complement normal classroom activities. Instructional materials that relate to the concept and common *Yorùbá* sayings were also used as shown in Appendix 4A. The instrument was face validated by two experts in this area. Their comments and suggestions were made use of in the final preparation of the instrument.

3.4.5 Teachers Instructional Guide on Modified Lecture Method (TIGMLM) (Appendix 5)

This instructional guide was designed as a comprehensive guide for teachers in the Modified Lecture Method group. The guide involves the following broad steps:

1. The teacher briefly introduces the concept.
2. The teacher reviews the students' prior knowledge.
3. The teacher presents the new science concept.
4. The teacher demonstrates and allows the learners to interact with relevant instructional materials.
5. The teacher asks questions and allows the students to ask questions.
6. The teacher gives assignment.

However, ethnoscientific paradigm intervention is absent. The steps as shown in Appendix 5 are normal lecture method steps. It is modified because demonstration activities are included. The instrument was also face validated by two experts. Their comments and suggestions were made use of in the final preparation of the instrument.

3.4.6 Teachers Performance Evaluation Sheet (TPES)[Appendix 6]

This is the instrument designed to assess the performance of the trained teachers in the class after the training before the commencement of the treatment. They were assessed in terms of the following themes:

- i. Statement of objectives.
- ii. Organization of the lesson.
- iii. Presentation of the subject content as it relates to either the experimental or control group.
- iv. Evaluation.

Two observations were made per teacher and each sub-theme was based on a maximum obtainable score of 5. There were two sub-themes for presentation of the subject content as they relate to the experimental and control groups. The average of the two observations per teacher

was determined. Teachers with an average of 70% and above were considered for selection. The best two teachers in each group out of a total of ten (6 in the Ethnoscience group and 4 in the Modified group) and their schools were eventually chosen for the study.

Two experts in the field of evaluation were contacted to face validate the performance sheet in term of its appropriateness before the observations were made and their suggestions were helpful in preparing the final draft.

3.5 Research Procedure

3.5.1 Ethnoscience Database Development

The nature of this study required a multi-stage procedure in its data collection. The data collection procedure for Ethnoscience Database involved four stages, namely:

- (i) Collection, validation and standardization of Ethnoscience Database items and standardization of the Database.
- (ii) Development of a storage and retrieval system.
- (iii) Development of the Framework of Incorporation.
- (iv) Field testing of Database.

3.5.1.1 Collection, Validation and Standardization of the Ethnoscience Database items and Standardization of the Database

The procedure for this stage consists of the following sequential stages of database development:

- i) Gathering of common *Yorùbá* sayings
- ii) Sorting out of the sayings.
- iii) Identification of science-related sayings.
- iv) Item validation of each of the sayings.
- v) Items standardization.

vi) Database standardization.

i) Gathering of common *Yorùbá* sayings

This sub-stage involved the collection of sayings from various sources in the chosen sample area. The sources included:

- a) Personal survey
- b) Interview of Elders and Community leaders
- c) Students' responses
- d) Review of Literature

a) Personal Survey

The researcher based on his experience as a member of the community listed twenty six (26) common *Yorùbá* sayings and their cultural meanings.

b) Interviews of Elders and Community Leaders

Thirty one selected elders and community leaders (18 males and 13 females) were interviewed to identify some of their common sayings and the meanings of such sayings. The respondents were randomly selected from peri-urban centres in the cities of Ibadan, Abeokuta and Ado-Ekiti (12, 10 and 09 respectively). This is considered to be representative of the six south western states of Nigeria made up of *Yorùbá* people with common cultural background.

The unstructured interview technique was used. The technique is defined as interviews in which neither the question nor the answer categories are predetermined. Instead, they rely on social interaction between the researcher and the informant (Minichiello et al., 1990). The researcher was however guided by the purpose of the interview which is essentially to elicit cultural beliefs, sayings and assertions that are likely to be science related.

The researcher was guided by the following steps according to Punch (1998) and Fontana and Frey (2005) and as listed by Zhang and Wildermuth (2010):

Step 1: Getting in: accessing the setting. The researcher relied on his experience as a member of the society and accorded the elders due respect and courtesies, negotiating interactions with consciousness of the possible socio-political and legal implications of the interview.

Step 2: Understanding the language and culture of the interviewees. The interview was conducted in Yoruba by the researcher who is himself a Yoruba man.

Step 3: Deciding on how to present oneself. The researcher as the interviewer acted as a “learner” in the conversation, trying to make sense of the interviewee’s experiences from his or her point of view

Step 4: Locating a good informant. A good informant is an insider who is knowledgeable and willing to talk with you. The researcher asked around before selecting his informants.

Step 5: Gaining trust and establishing rapport. Gaining trust and establishing rapport is essential to the success of unstructured interviews. Only when a trustful and harmonious relationship is established will the interviewee share his or her experience with the interviewer, especially if the topic of the conversation is sensitive. The interviewer was very careful and gradually established the trust required for this type of research’

Step 6: Capturing the data. This was done through both audio recording and note taking.

Step 7: Constant recourse to check list. In this case the checklist includes:

A) Eliciting cultural beliefs, sayings and assertions that are likely to be science related.

B) Asking for the cultural meaning and interpretation of items elicited.

c) Students’ responses

Twelve secondary schools (6 junior and 6 senior) were selected for this purpose. Two junior secondary and two senior secondary schools (all co-educational) were randomly selected each from Ibadan, Abeokuta and Ado Ekiti respectively. They were informed about the intention of the researcher to identify their common sayings that had relationship with modern

science and the meanings of such sayings. Common examples were given, they were therefore asked to submit at least 20 common sayings and their meanings after a week. They were encouraged to consult others including their parents, elders and colleagues at home. They were however discouraged from copying from their classmates.

Research assistants were asked to go round the schools after four days to remind and encourage the students to carry out the assignment diligently and submit as scheduled. The researcher also enjoyed the support of their teachers in this respect. A total of 3,055 students were able to submit the assignment after a week as planned representing more than half of the total population of students in the 12 schools which was put at 6,021 including truants.

d) Review of Literature

This was carried out by searching through the literature on previous attempts at documenting cultural sayings and what they mean to the people. Previous works obtained were very few and not in detail. They were however useful in their own little way especially the work of Okeke and Njelita (2002) and Bajah (1981).

3.5.1.2 Sorting Out of Common Yorùbá Sayings

This involves collating the common sayings such that none was repeated unless there were different interpretations. 232 sayings were listed. They were then linked to particular Yorùbá beliefs, such as the belief in *Òrìṣà* and *Ìrúnmọ̀lẹ̀* who often act as liaisons between *Ọ̀run* (the invisible realm) and *Aayé* (the physical realm), belief in *Ìwà* (human character) and so on, from which the sayings were derived. Falade (2012) states that *Irúnmọ̀lẹ̀* are known as the primordial who were the first beings given specific tasks to complete by *Olódùmarè* (God). They are not human beings. They are pure spirit/energy. Each *Irúnmọ̀lẹ̀* was assigned a specific duty by *Olódùmarè* and should not be considered gods.

The *Òrìṣà* were either *Irúnmọ̀lẹ̀* or *Ìmọ̀lẹ̀* but because these spirits decided to manifest into physical form and they completed their destinies and left a legacy for others to follow here

in the world, they are revered and elevated by other human beings as *Òrìsá* when they returned back to their spirit form. Some of the *Irunmole / Imole* kept the same names while here in the world as humans and others did not. Some of the sayings were however derived from long-time observations and assertions. Many of the assertions that relate to natural objects and phenomena were made without expressed reasons, while others were clear preventive measures against harms and injuries.

3.5.1.3 Identification of Science Related *Yorùbá* Common Sayings

Copies of the final collection were given to four experts in different areas of science education to identify the common *Yorùbá* sayings that had any form of resemblance with science concepts and whether they were contradictory, compatible or modifiable. 148 of such sayings were identified out of 232.

3.5.1.4 Item validation of each of the common *Yorùbá* saying

The final list containing 148 items was then randomly divided into equal five parts with the last one having 28 items. The items had their cultural meanings removed. Copies of these were made and given randomly to students from another set of six co-educational secondary schools (3 Junior and 3 Senior) randomly selected from Ibadan, Abeokuta and Ado-Ekiti respectively. The students were to give the cultural meaning of the sayings. A saying was thereafter accepted based on the criterion that its earlier identified meaning had a frequency of not less than 60% among the total number of responses. This was to guarantee that the saying documented actually existed and were known to majority of the students. A final list was then drawn which included 103 science related common sayings.

3.5.1.5 Item Standardization

A copy each of the final list was given to four science education experts to suggest science concepts that were related to each of the sayings and to suggest whether the sayings were contradictory, compatible or modifiable when compared with the scientific understanding of the concepts. A number of professionals in Agriculture, *Yorùbá*, Zoology, and Medicine among others were also consulted. The researcher also carried out extensive literature search. A 50% concurrence in agreement amongst the science experts and similar percentage amongst the professionals in a few specific areas was taken as quantitative evidence of concept/construct validity. The final version of the study termed Ethnoscience Database (ED) [Appendix 4B] consisted of 103 common *Yorùbá* sayings, their relationship with specific cultural belief or whether they were long-time observations or assertions, their cultural meanings, related science concepts and related science subjects.

3.5.1.6 Standardization of Database

Since an Ethnoscience database has not been previously developed before, validity based on comparative analysis with previously developed Ethnoscience database could not be carried out. However content validity was carried out apart from item and general standardization as follow:

a) Validity

This process ensures that the information obtained and included in the database measure the variable they are supposed to measure.

i) Content Validity

Cohen, Manion and Morrison (2007) state that the major criterion for content validity of an instrument is that it must fairly and comprehensively cover the domains or items that it purports to cover. The content validity of the database is borne out by the method of collecting data from Southwestern Nigeria. The universe of the content, as evident from the method

employed in collection of common sayings, was covered widely and sampled through personal survey, interview of elders and community leaders, students' responses and review of related literature.

Ogunleye (2007) maintains that to make meaning out of their experiences in science classrooms, students need to negotiate a cultural transition from their life world into the world of school science. He concludes that science education must be culture sensitive for it to serve the emerging global community. Baimba (1993) maintains that culture is not an accidental collection of customs and habits. It is transmitted from generation to generation in form of hidden curricula, even if it was not taught in formal school education. He concludes that the disparity between traditional and scientific cultures has not engendered positive outcomes from studying science in many non-western societies. He advises that instead of superimposing value that are hardly ever assimilated by traditional children, science education might best serve as a medium for bridging the gap between traditional and scientific outlooks of nature and knowledge. He stresses that cultural consideration in science curriculum innovations in non-Western societies is a must.

From the above, it can be concluded that this researcher's understanding of culture, its beliefs aspect and relationship with modern science is similar to that which is generally accepted.

b) Reliability

A scale is reliable if it gives consistent results over several administrations. The method used in assessing reliability of the database is the test retest correlation coefficient.

Because of the large volume of the database, 30 common sayings were randomly selected and four cultural interpretations each were given with only one correct option. They were then administered twice, at an interval of three weeks on 30 students in a school similar to the ones used for the study. A test-retest correlation coefficient of $r = 0.86$ was obtained. This confirms the stability of the scale and thus its reliability.

3.5.2 Development of a storage and retrieval system

3.5.2.1. Ethnoscience Database (ED) Computer Programme Design

Research and product/package development design in education according to Nworgu (1991) is a process whereby educational products such as textbooks, equipment or curricular are developed and trial tested in the field to ensure their effectiveness. Designing and developing Ethnoscience Database computer programme involve steps similar to any problem-solving task.

There were five main steps in the programming process. These are:

- i) Defining the problem
- ii) Entering the Data
- iii) Formatting the Database
- iv) Using the Database Tools in Ethnoscience Database
- v) Ethnoscience Database Verification, Testing and Validation

Defining the Problem

The task of defining the problem involves identifying what one knows (input-given data), and what one wants to obtain (output-the result). What is known is the Ethnoscience Database and what is to be obtained is a data storage and retrieval system.

In order to make the Database information easily available, a storage and retrieval system was developed using the latest version of Microsoft Excel (2010 version) to create a database file. It was then saved as Excel 97-2003 workbook for easier access by the expected users. An average computer user feels more comfortable with the Excel application than Access or any other more complicated database and can easily control the programme himself.

The steps involved in developing the Database using Microsoft Excel are:

Entering the Data

The basic format for storing data in an Excel database is a table. This involves entering the data in rows and columns. The rows in database format are referred to as RECORDS while the columns are referred to as FIELDS.

Each field has a heading to identify the data it contains. In this case, there are eight (8) fields. These are:


- a. Code
- b. Science related common *Yorùbá* sayings
- c. Cultural belief from which the saying was derived.
- d. Cultural explanation of the sayings
- e. Related modern scientific concepts
- f. Explanation of modern science concepts
- g. Classification of the sayings
- h. Intervention
- i. Related science concepts

The records are one hundred and five in number. The first record contains the title of the database i.e. ETHNOSCIENCE DATABASE. The second record contains the headings of each field. The remaining one hundred and three records contain full information about each of the collected science related common sayings. Once the table has been created, Excel's data tools can be used to search, sort, and filter records in the database to find specific information. Effort was made to make sure that the data were correctly entered to prevent data errors that are caused by incorrect data entry. The problem of incorrect data entry has been indicated in many problems related to data management. In entering the records, the following guidelines were taken into consideration as suggested by French (2012):

1. Leave no blank rows in the table being created, not even between the headings and the first row of data.
2. A record can contain data about only one specific item.
3. A record must also contain ALL the data in the database about that item. There can't be information about an item in more than one row.

Formatting the Database

The database was then formatted using the following guideline suggested by French (2012) by:

1. Drag selecting cells A1 to H1 in the spread sheet.
2. Clicking on the Merge and Centre icon on the Formatting Toolbar to centre the title.
3. Clicking on Fill Colour icon to open the background colour drop down list while still selecting cells A1 to H1.
4. Choosing Dark Blue (Text 2, 80%) from the list to change the background colour of cells A1 - H1 to dark Blue.
5. Clicking on the Font Colour icon again (a large letter "A ") to open the font colour drop down list.
6. Choosing white (Background 1) from the list to change the colour of the text in cells A1 - H1 to white.
-  7. Drag selecting cells A2 - H2 on the spreadsheet.
8. Clicking on the Fill Colour icon on the Formatting Toolbar to open the background colour drop down list.
9. Choose Blue (Accent 1, Lighter 80%) from the list to change the background colour of cells A2 - E2 to light blue.
10. Drag selecting cells A3 - H105 on the spread sheet.

Alternatively, having saved the data on Microsoft Excel spread sheet, select for top cells from the columns of data you have created, then click on Data in the Menu Bar, select and click Filter which automatically turns the spread sheet into a database. To save database, go to File on the Menu Bar, select Save as, and then change the format to XML Spreadsheet.

Using the Database Tools in Ethnoscience Database

Database tools are located under the drop down arrows beside each field name and can be used to filter the data. Retrieving information from the database can be done by filtering data in the Database following these steps:

1. Click on the drop down arrow next to CODE field name or any of the field names.
2. Type the key word you want information about into the search box.
3. Click OK.

The record containing the information is then displayed. Use undo to go back to the full database.

Ethnoscience Database Verification, Testing and Validation

Software verification provides objective evidence that the design outputs of a particular phase of the software development life cycle meet all of the specified requirements for that phase of the software development (U.S. Department of Food and Drug Administration, 2002). Software testing is one of many verification activities to confirm that software development output meets input requirements. Meanwhile, software validation according to U.S. Department of Food and Drug Administration refers to confirmation by examination and provision of objective evidence that software specifications conform to user's need and intended uses that the particular requirements implemented through software can be consistently fulfilled. In short, verifications, testing, inspections, examinations, and other verification techniques are embedded in validation.

A documented software requirements specification provides a baseline for both validation and verification (U.S. Department of Food and Drug Administration, 2002). Verification, testing and other tasks that support software validation occur during each phase of the software life cycle activities. Software requirements specification was evaluated to verify for accuracy, completeness, consistency, testability and clarity among others. The evaluators who are software Engineers / Programmers attested to its compliance. Software testing entails running software products under known conditions with defined inputs and documented outcomes that can be compared to the predefined expectation (U.S. Department of Food and Drug Administration, 2002). Alpha testing, which is an actual operational testing by the potential users or customers or an independent team at the developer's site was conducted. Complex validation was however unnecessary since the database is a simple one.

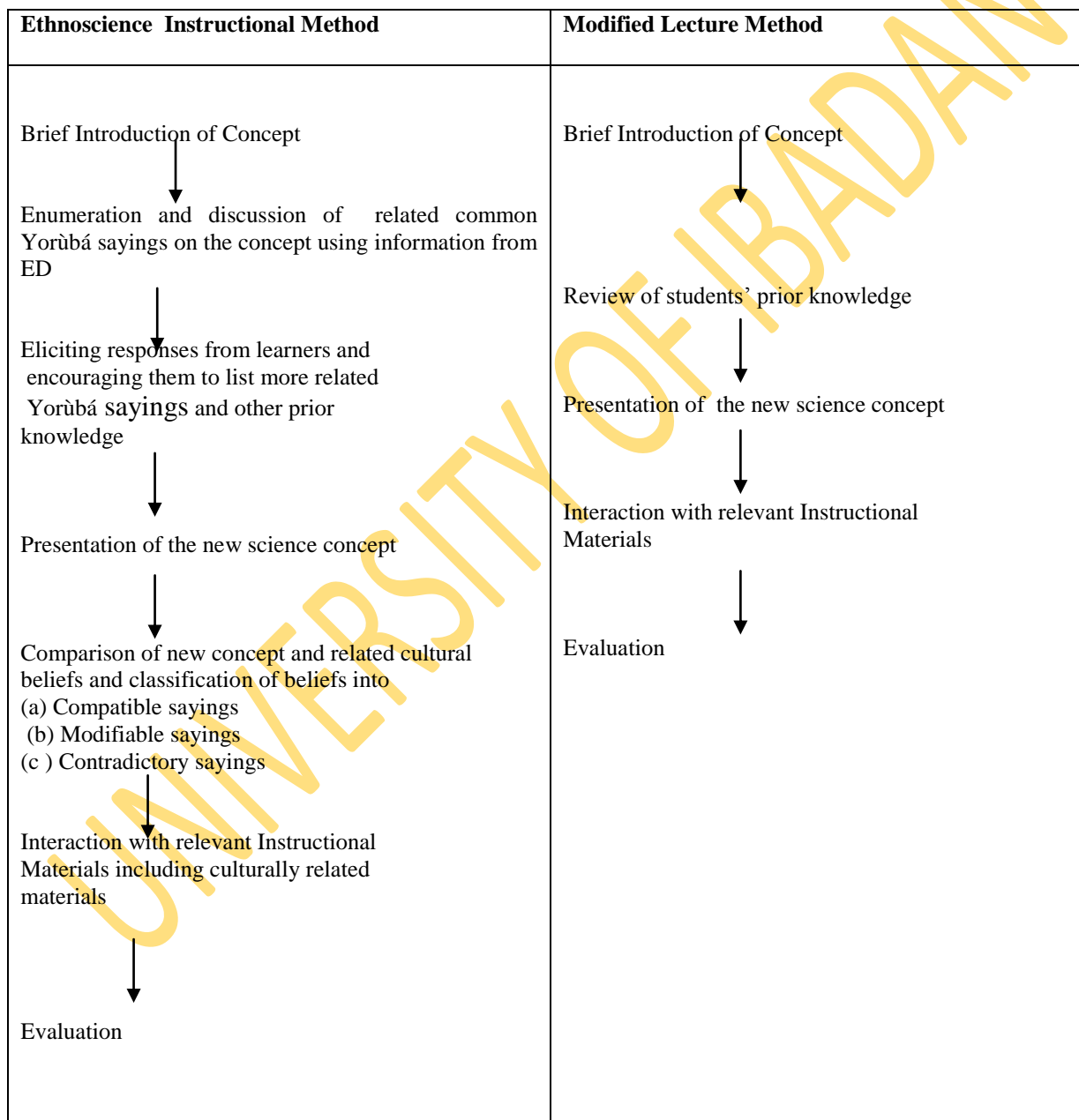
3.5.3 Development of a Framework of Incorporation

In developing a framework for the incorporation of Ethnoscience sayings into the classroom setting, the researcher was guided by the following positions:

- i) That a teacher who expects to simply point out students' mistakes to them is not likely to record much success where and when misconceptions exist. Misconceptions are not easily given up. George (2001) states that it takes just as much work to deconstruct those ideas and let go of the incorrect ones.
- ii) The need for the awareness and diagnosis of prevailing understanding of the concepts and likely misconceptions. This involves analysing related and recorded (from the database) Ethnoscience sayings in respect of the new concept or topic being introduced and not assuming that the information provided in the database is exhaustive by probing the students further on their understanding of the new concept or topic.

iii) Structuring experiences and the learning environment so that there are opportunities for learners to ‘test out’ their ideas and prove the correct concepts to themselves. This method of teaching often brings out conceptual change in the learner. The framework of incorporation of Ethnoscience Method, placed side by side with the conventional teaching model is diagrammatically represented below:

Figure 3.1 Diagrammatic Representation Of Methods



3.5.4 Procedure for Data Collection on the Field

Permission of the Principals and teachers in the participating schools was sought before the commencement of the training. The procedure and work schedule is as follows:

Table 3.6 Procedure and Work Schedule

S/N	Activity	Duration
1	Training of teachers on the use of the two methods	2 weeks
2	Administration of Pretest	1 week
3	Treatment	8 weeks
4	Administration of Posttest	1 week

3.5.4.1 Training of Teachers

An orientation programme was organized for 10 participating Basic Science teachers. Separate sessions were organized for two groups of teachers. One group consisting of six teachers was trained in the use of the Ethnoscience Instructional method and another group consisting of four teachers was trained in the use of the Modified Lecture Method. During the training session, a general description of the treatment and control as well as the procedure involved was practically demonstrated respectively.

The treatment group was exposed to both soft and hard copies of ED. Teachers in this group were asked to compare the two copies in terms of ease of use. They all agreed that the soft copy was easier to access than the hard copy. On whether they would be using the soft copy for their classes if selected for the study, the answer was a unanimous no. They preferred the hard copy because none of them had a personal computer. The teachers were thereafter

- i) made to organize and teach lessons based on their assigned roles.
- ii) trained on how to administer the data gathering instruments.

Teachers Performance Evaluation Sheet (TPES) {Appendix 6} was then used to assess the performance of the teachers. One teacher from each sub-group (Rural Modified lecture method, rural Ethnoscience method, Urban Modified lecture method, and Urban Ethnoscience method) was finally selected based on their performance. One teacher was engaged in each school.

3.5.4.2 Administration of Pretest

The instruments were administered in the following order: Attitude Towards Science Scale (ATSS) was administered first followed by Conception of Scientific Phenomena Assessment Sheet (CSPAS) to avoid a possible influence of Basic Science Cognitive Achievement Test (BSCAT) on students' attitude to science. The administration of BSCAT therefore followed immediately. All the subjects participated in the pre-test exercise.

3.5.4.3 Treatment

This lasted for eight weeks. The instructional procedure for implementing the instructional method that was employed to teach the concepts for each group is as follows:

3.5.4.3a Experimental Group: Ethnoscience Instructional Method (EIM) in Basic Science Group.

Treatment in this group involved the following steps:

- Teacher introduces the concept without going into the scientific details.
- Teacher enumerates and discusses common *Yorùbá* sayings that are related to the concept being learnt based on available information from Ethnoscience Database (ED).
- Students' responses are elicited and they are encouraged to mention more related common *Yorùbá* sayings and other prior knowledge in respect of the concept.
- The new scientific concept is then presented by the teacher.
- Students listen to the teacher, write down chalkboards illustrations and are allowed to ask questions on areas of the topic not clear to them.
- Students are asked to classify the local sayings into compatible, modifiable and contradictory groups when compared with the new science concept.
- Students interact with instructional materials.
- Teacher interacts with students to re-examine the compatible and modifiable beliefs into the scientific concept without condemning the contradictory beliefs.

- Students are asked to explain possible reasons for the contradiction between the scientific concept and the local sayings.
- Teacher gives questions on the topic to the students in form of quiz.
- Students answer the questions randomly.
- Teacher recognizes and praises correct responses and guides others to correct answers.
- Teacher gives assignment.

There were three periods per week for eight weeks.

3.5.4.3b Control Group: Modified Lecture Method (MLM) in Basic Science Group

The control group's lesson involved the following steps:

- i) Teacher introduces the concept without going into the scientific details.
- ii) Teacher elicits students' prior knowledge on the science concept.
- iii) Teacher presents the lesson in form of lecture and demonstrations.
- iv) Students listen to the teacher, write down chalkboard illustrations and are allowed to ask questions on areas of the topic not clear to them.
- v) Students interact with instructional materials.
- vi) Teacher asks few questions and randomly picks students to answer them.
- vii) Teacher recognizes and praises correct responses and guides others to correct answers.
- viii) Teacher gives assignment to the students.

There were three periods per week for eight weeks.

3.5.4.4 Administration of Posttest

After 8 weeks of treatment, post-test was administered on the two groups (Experimental and Control groups). ATSS, CSPAS and BSCAT were re-administered again in that order.

3.6 Data Analysis

The study adopted the use of both descriptive and inferential statistics for analysing the data gathered. Analysis of Covariance (ANCOVA) was used to test the hypotheses and differences between the groups using the pretest scores as covariates. Estimated Marginal Means was used to identify where such differences occurred to determine the performance of each group. Line graphs were also used to show the estimated marginal mean of post scores where significant differences were obtained. Simple main effects analysis was also used to decompose the significant interaction effects.

UNIVERSITY OF IBADAN

CHAPTER FOUR

RESULT AND DISCUSSION

This chapter presents the result, and discusses the findings of the study. The sequence of presentation is in accordance with the research questions raised and the hypotheses tested.

4.1 Answering of Research Questions

4.1.1 Research Question 1:

To what level is the Ethnoscience Database standardized?

To answer this question, reference is made to the standardization procedure of ED (3.5.1-3.5.3) which established content validity and reliability. To determine its reliability and because of the large volume of the database, 30 common *Yorùbá* sayings were randomly selected and each given four cultural interpretations with only one correct scientific option. This was then administered twice, at an interval of three weeks on 30 students in a school similar to the ones used for the study. A test-retest correlation coefficient of $r=0.86$ was obtained which is considered good enough as shown in the reliability procedure in 3.5.1.6.b. It can be concluded that ED met standardization procedure was established and followed.

4.1.2 Research Question 2:

What are the collected science-related common *Yorùbá* sayings in terms of science classification? To answer this question, simple frequency and percentage distribution were used. The result is presented in Table 4.1 that follows:

Table 4.1: Frequency and Percentage Distribution of Collected Science Related Common Yorùbá Sayings According to Classes of Science

SCIENCE CLASSES No.	PHYSICAL SCIENCES	MEDICAL SCIENCES	PHARMACEUTICALS	BIOLOGICAL SCIENCES	TOTAL
No in Database	1,3,6,9,10,11,12,15,16,22,34,35,36,39,40,44,46,51,57,58,59,64,66,73,79,93,96	2,4,5,7,8,9,13,18,19,21,23,26,27,28,29,30,31,32,33,37,38,(40),41,42,45,48,50,(51),52,54,56,60,61,62,63,65,70,74,75,76,77,78,80,81,82,84,85,86,87,89,90,91, 92,94,98,102,103	0	14,17,24,25,44,(46),47, 49, 53,55,67,68,69,71,72,83,88,95,97,99,100, 101	103
Total	27	55	0	21	103
%	26.2	53.4	0	20.4	100%

*Numbers in brackets () can be classified into two groups

Using Nwala (1997) classification of natural sciences, Table 4.1 shows that 27 (26.2%) out of the 103 collected science-related common Yorùbá sayings relate to the physical sciences. It also shows that a large proportion of the common science-related sayings [56] (53.4%) among the sampled population relate to medical sciences. Of note is the revelation from the database that none of the collected science-related sayings (0%) can be classified as belonging to pharmaceuticals. However 21 (20.4%) of the science related common Yorùbá sayings are classified as belonging to the biological sciences.

4.1.3 Research Question 3:

How compatible are the collected science-related common Yorùbá sayings with modern scientific concepts?

To answer this question, simple frequency and percentage distribution are used. The result is presented in Table 4.2.

Table 4.2: Frequency and Percentage Distribution of Collected Science-Related Common Yorùbá Sayings in Terms of Compatibility with Orthodox Scientific Beliefs.

	COMPATIBLE COMMON YORÙBÁ SAYINGS	MODIFIABLE COMMON YORÙBÁ SAYINGS	CONTRADICTIONARY COMMON YORÙBÁ SAYINGS	TOT AL
	3,4,22,36,(37),41, 60,63,66,67,73, (79),	5,6,9,34,37,44,49,52, 54,64,74,80,81,88,90, 93,97	1,2,7,8,10,11,12,13,14,15,16,17, 18,19,20,21,23,24,25,26,27,28, 29,30,31,32,33,,35,38,39,40,42, 43, 46,47,48,50,51,53,55, 56,57,58,59,61,62,65,68,69,70, 71,72,75,76,77,78,79,82,83,84, 85,86,87,89,91,92,94,95,96,98, 99,100,101,102,103	
TOTAL	10	17	76	103
%	9.7%	16.5%	73.8%	100%

*Numbers in brackets () can be classified into two groups

Using the conclusions of experts in science education in terms of classification of the collected cultural beliefs as explained in 3.5.13, Table 4.2 shows that 10 (9.7%) of the collected science-related common Yorùbá sayings are actually compatible with identified scientific concepts. While 17 (16.5%) require some elements of modifications before they can agree with and reinforce the understanding of related science concepts being taught, 76 (73.8%) clearly contradict related scientific concepts.

4.2 Testing of Hypotheses

4.2.1a Hypothesis 1 (H₀₁)

H₀₁(a): There is no significant main effect of treatment on students' cognitive achievement in science.

Table 4.3 reveals that there is a significant main effect of treatment on students' cognitive achievement in science ($F_{1, 339} = 431.95, p < 0.05$). This means that students exposed to treatment differ significantly in their post-test mean scores. Hence, Hypothesis 1(a) is not supported.

The size effect of treatment is moderate with Partial Eta Squared (η_p^2) being 0.56, which means that 56% of the variance in scores is accounted for by treatment.

Table 4.3: Summary Of Analysis Of Covariance (ANCOVA) of Students' Achievement Scores by Treatment, Location and Parent Educational Status (PES)

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8241.82(a)	12	686.82	111.61	.000*	.798
Intercept	3573.60	1	3573.60	580.73	.000*	.631
Covariate	2948.34	1	2948.34	479.12	.000*	.586
Treatment	2658.08	1	2658.08	431.95	.000*	.560
School Location	6.07	1	6.06	.99	.322	.003
PES	15.93	2	7.96	1.29	.275	.008
Treatment*School Location	3.01	1	3.01	.49	.485	.001
Treatment* PES	8.50	2	4.25	.70	.502	.004
Location * PES	37.13	2	18.57	3.02	.050	.017
Treatment*S/ Location* PES	27.22	2	13.61	2.21	.111	.013
Error	2086.08	339	6.15			
Total	172782.00	352				
Corrected Total	10327.90	351				

a R Squared = .798 (Adjusted R Squared = .791)

* Significant at $p < 0.05$

To find out the treatment group with higher adjusted mean score, the Estimated Marginal Mean table (Table 4.4) of achievement scores with the graph (Figure 4.1) are presented below.

Table 4.4 and Figure 4.1 show that learners in the Ethnoscience Instructional Method (EIM) group had higher adjusted mean score ($\bar{X} = 24.72$) than the Modified Lecture Method (MLM) group ($\bar{X} = 17.85$) in students' cognitive achievement in science. Table 4.3 shows that the difference in the adjusted mean scores is significant. The implication of this is that EIM is a more effective method in improving learners' cognitive achievement than MLM.

Table 4.4: Estimated Marginal Mean of Achievement Scores

Dependent Variable: post-achievement

	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
EIM	24.72(a)	.20	24.32	25.12
MLM	17.85(a)	.26	17.35	18.36

a Covariates appearing in the model are evaluated at the following values: pre-achievement = 11.99.

UNIVERSITY OF IBADAN

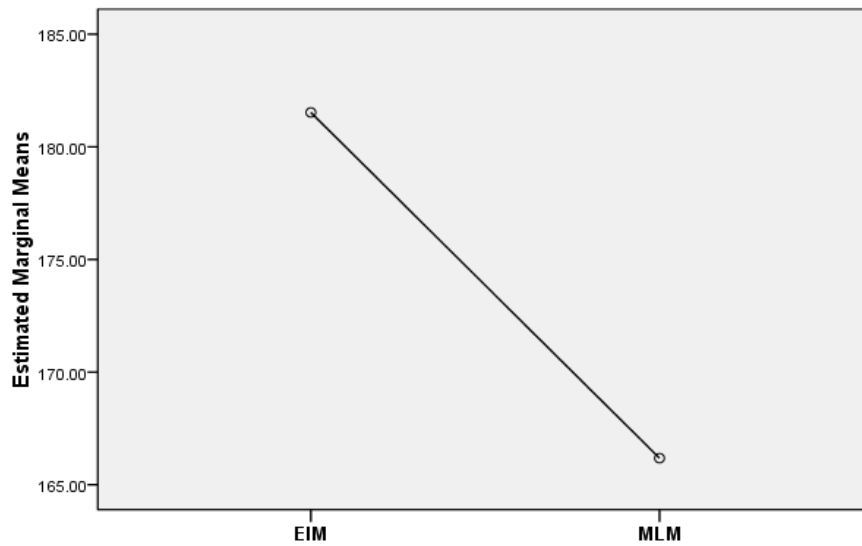


Figure 4.1 Line graph of Estimated Marginal Mean of Post Achievement Scores

4.2.1b Hypothesis 1 (b)

H₀1(b): There is no significant main effect of treatment on students' attitude to science.

Table 4.5 reveals that there is a significant main effect of treatment on students' attitude to science ($F_{1,339} = 39.78, p < 0.05$). This means that students exposed to treatment differ significantly in their post-test mean scores. Hence, Hypothesis 1(b) is not supported.

Table 4.5: Summary of Analysis of Covariance (ANCOVA) of Students' Attitude Scores by Treatment, Location and Parent Educational Status (PES)

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	123635.72(a)	12	10302.98	0.77	.000*	.521
Intercept	12656.35	1	12656.35	37.80	.000*	.100
Covariate	99095.65	1	99095.65	295.97	.000*	.466
Treatment	13320.55	1	13320.55	39.78	.000*	.105
School Location	561.90	1	561.90	1.68	.196	.005
PES	824.30	2	412.15	1.23	.293	.007
Treatment * School Location	4445.63	1	4445.63	13.28	.000*	.038
Treatment * PES	42.56	2	21.28	.06	.938	.000
Location * PES	212.80	2	106.40	.32	.728	.002
Treatment *S/ Location * PES	465.87	2	232.94	.70	.499	.004
Error	113501.18	339	334.81			
Total	10967145.00	352				
Corrected Total	237136.91	351				

a R Squared = .521 (Adjusted R Squared = .504)

* Significant at $p < 0.05$

The size effect of treatment is however weak with Partial Eta Squared being 0.105, which means that 10.5% of the variance in scores is accounted for by treatment. To find out the group with higher adjusted mean score, the Estimated Marginal Mean table (Tables 4.6) of posttest attitude score with the line graph (Figure 4.2) presented below show that learners in the Ethnoscience Instructional Method (EIM) group have higher adjusted mean score ($\bar{X} = 181.53$) than the Modified Lecture Method (MLM) group ($\bar{X} = 166.18$) in students' attitude towards science. The implication of this is that EIM is a more effective method in improving students' attitude to science than MLM.

However this interpretation must be taken with caution since the interaction effect of treatment and school location is significant with respect to attitude to science as shown in Table 4.5. Concluding that the main effect of treatment on attitude to science is significant would be misleading and may not give us an accurate understanding of the result. An accurate interpretation of the result would take the interactive effect treatment and school location on students' attitude to science into consideration.

Table 4.6: Estimated Marginal Mean of Attitude Score

Dependent Variable: post-attitude

	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
EIM	181.53(a)	1.50	178.58	184.47
MLM	166.18(a)	1.91	162.43	169.93

a Covariates appearing in the model are evaluated at the following values: pre-attitude = 165.18.

UNIVERSITY OF IBADAN

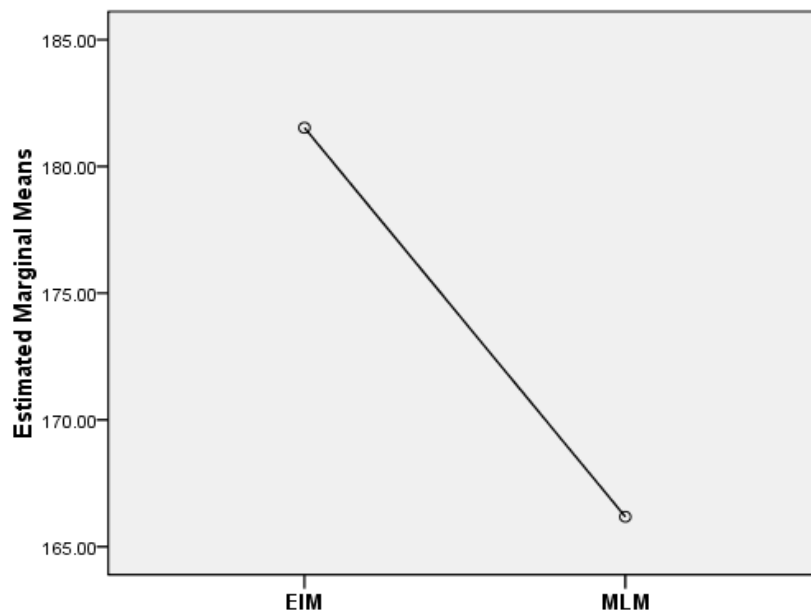


Figure 4.2: Line graph showing Estimated Marginal Mean of Attitude Scores

4.2.1c Hypothesis 1 (c)

H₀1(c): There is no significant main effect of treatment on students' conception of scientific phenomena.

Table 4.7 below reveals that there is a significant main effect of treatment on students' conception of scientific phenomena ($F_{1, 339} = 111.86, p < 0.05$). This means that students exposed to treatment differ significantly in their posttest mean scores. Hence, Hypothesis 1(c) is not supported.

The size effect of treatment is however modest with Partial Eta Squared being 0.248, which means that 24.8% of the variance in scores is accounted for by treatment.

Table 4.7: Summary of Analysis of Covariance (ANCOVA) of Students' Conception of Scientific Phenomena Scores by Treatment, Location and Parent Educational Status (PES).

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2479.25(a)	12	206.60	44.18	.000*	.610
Intercept	568.28	1	568.28	121.53	.000*	.264
Covariate	1018.36	1	1018.36	217.78	.000*	.391
Treatment	523.09	1	523.09	111.86	.000*	.248
School Location	4.49	1	4.49	.96	.328	.003
PES	3.37	2	1.68	.36	.698	.002
Treatment * School Location	22.43	1	22.43	4.80	.029*	.014
Treatment * PES	15.21	2	7.60	1.63	.198	.010
Location * PES	12.91	2	6.46	1.38	.253	.008
Treatment *S/ Location * PES	19.46	2	9.73	2.08	.126	.012
Error	1585.20	339	4.68			
Total	22364.00	352				
Corrected Total	4064.44	351				

a R Squared = .610 (Adjusted R Squared = .596)

* Significant at $p < 0.05$

To find out the group with higher adjusted mean score, the Estimated Marginal Mean Table (Table 4.8) of concept score with the line graph (Figure 4.3) below show that learners in the Ethnoscience Instructional Method (EIM) group have higher adjusted mean score ($\bar{X}=8.64$) than the Modified Lecture Method (MLM) group ($\bar{X}=5.56$) in students' conception of scientific phenomena. The implication of this is that EIM is a more effective method in improving students' conception of scientific phenomena than MLM.

As said earlier, this interpretation must also be taken with caution since the interaction effect of treatment and school location is equally significant in respect of conception of scientific phenomena as shown in Table 4.7. Concluding that the main effect of treatment on conception of scientific phenomena is significant would also be misleading and may not give us an accurate understanding of the result. An accurate interpretation of the result would equally take the interactive effect of treatment and school location on students' conception of scientific phenomena into consideration.

Table 4.8: Estimated Marginal Mean of Concept Score

Dependent Variable: post-conception

	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
EIM	8.64(a)	.18	8.29	8.99
MLM	5.56(a)	.23	5.12	6.01

a Covariates appearing in the model are evaluated at the following values: pre-conception = 5.42

UNIVERSITY OF IBADAN

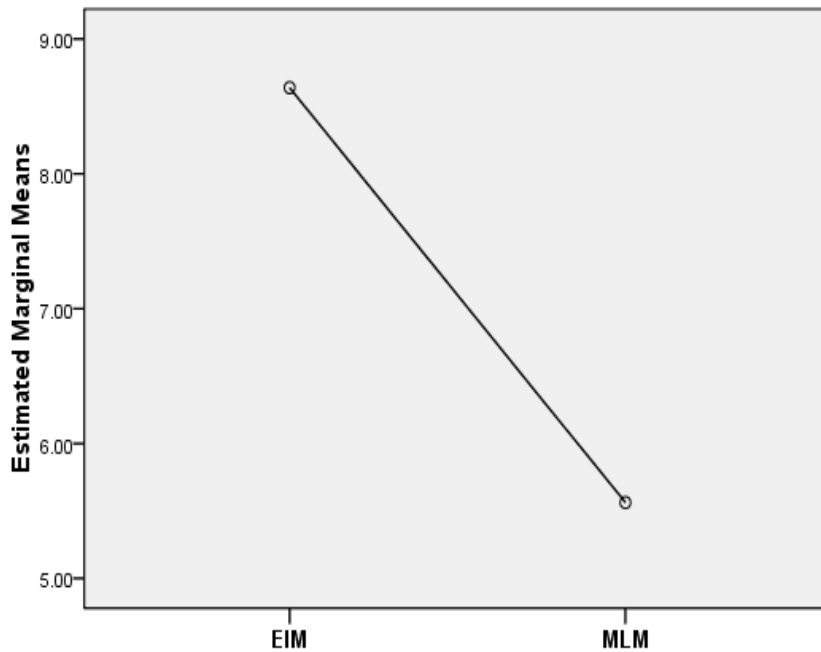


Figure 4.3: Line graph showing the Estimated Marginal Mean of Post Concept Scores

4.2.2 Hypothesis 2(H₀₂):

4.2.2a Hypothesis 2 (a)

H₀₂(a): There is no significant main effect of school location on students' cognitive achievement in science.

Table 4.3 reveals that there is no significant main effect of school location on students' cognitive achievement in science ($F_{1,339} = .99, p > 0.05$). This means that there is no significant difference in the cognitive achievement of students in urban centres and those in rural areas in their posttest mean scores. Hence, Hypothesis 2(a) is supported.

4.2.2b Hypothesis 2 (b)

H₀2(b): There is no significant main effect of school location on students' attitude to science.

Table 4.5 reveals that there is no significant main effect of school location on students' attitude to science ($F_{1,339} = 1.68, p > 0.05$). This means that there is no significant difference between the attitude of students in urban centres and those in rural areas to science as shown in their posttest mean scores. Hence, Hypothesis 2(b) is supported.

4.2.2c Hypothesis 2(c)

H₀2(c): There is no significant main effect of school location on students' conception of scientific phenomena.

Table 4.7 reveals that there is no significant main effect of school location on students' conception of scientific phenomena ($F_{1,339} = 0.96, p > 0.05$). This means that there is no significant difference between conception of scientific phenomena by students in urban centres and those in rural areas as shown in their posttest mean scores. Hence, Hypothesis 2(c) is supported.

4.2.3 Hypothesis 3 (H₀₃)

4.2.3a H₀3(a): There is no significant main effect of parent educational status on students' cognitive achievement in science.

Table 4.3 reveals that there is no significant main effect of parent educational status on students cognitive achievement in science ($F_{2,339} = 1.29, p > 0.05$). This means that there is no significant difference in students' cognitive achievement in science among students with low, average and high parent educational status as shown in their posttest cognitive achievement in science scores. Hence, Hypothesis 3(a) is supported.

4.2.3b Hypothesis 3 (b)

H₀3(b): There is no significant main effect of parent educational status on students' attitude to science.

Table 4.5 reveals that there is no significant main effect of parent educational status on students' attitude to science ($F_{2,339} = 1.23, p > 0.05$). This means that there is no significant difference among students with low, average and high parent educational status in their posttest attitude to science scores. Hence, Hypothesis 3(b) supported.

4.2.3c Hypothesis 3 (c)

H₀3(c): There is no significant main effect of parent educational status on students' conception of scientific phenomena.

Table 4.7 reveals that there is no significant main effect of parent educational status on students' conception of scientific phenomena. ($F_{2, 339} = 0.36, p > 0.05$). This means that there is no significant difference in conception of scientific phenomena among students with low, average and high parent educational status as shown in their posttest conception scores. Hence, Hypothesis 3(c) is supported.

4.2.4 Hypothesis 4 (H₀₄)

4.2.4a H₀4(a): There is no significant interaction effect of treatment and school location on students' cognitive achievement in science.

Table 4.3 reveals that there is no significant interaction effect of treatment and school location on students' cognitive achievement in science. ($F_{1,339} = 0.49, p > 0.05$). Hence, Hypothesis 4(a) is supported. The implication of this finding is that school location does not matter with respect to cognitive achievement whichever of the treatment methods is used.

4.2.4b Hypothesis 4 (b)

H₀4(b): There is no significant interaction effect of treatment and school location on students' attitude to science.

Table 4.5 reveals that there is a significant interaction effect of treatment and school location on students' attitude to science. ($F_{1,339} = 13.28, p < 0.05$). The interaction is disordinal. Hence, Hypothesis 4(b) is not supported. To explain the interaction effect, Estimated Marginal Means in Figure 4.4 and Table 4.9 are presented below showing the disordinal interaction. To interpret the interaction as shown in Figure 4.4, the treatment by school location interaction effect is analysed using a simple main effects analysis. The Univariate Tests of the Simple Effects of school location within each level of treatment (Table 4.9) shows that school location influences learners' attitude to science in the Ethnoscience Instructional Method (EIM) group ($F_{1, 339} = 15.93, p < 0.05$) but school location did not influence attitude to science in the Modified Lecture Method (MLM) group ($F_{1, 339} = 2.20, p > 0.05$).

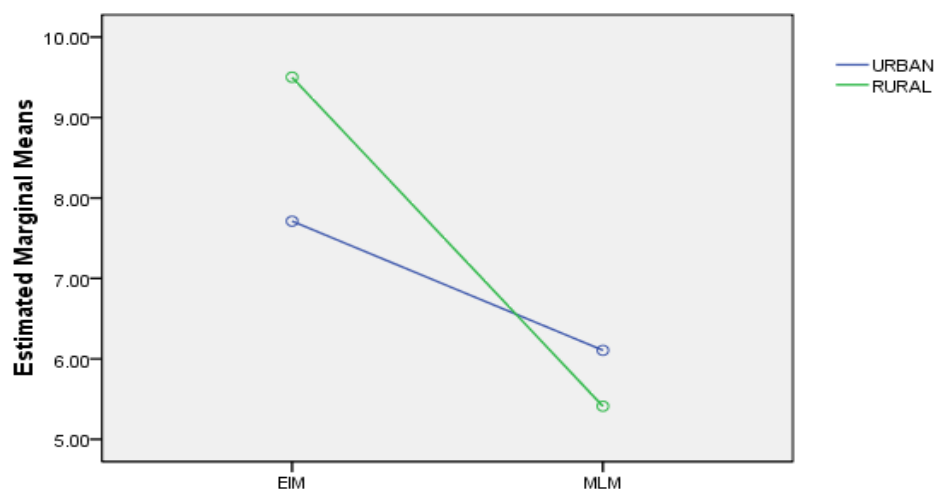


Figure 4.4: Line graph showing the Significant Interaction Effect of Treatment and School Location on Students' Attitude to Science

Table 4.9: Univariate Tests of the Simple Effects of School Location Within each Level of Treatment

Dependent Variable: postattitude						
Treatment		Sum of Squares	df	Mean Square	F	Sig.
EIM	Contrast	5334.52	1	5334.52	15.93	.000*
	Error	113501.18	339	334.81		
MLM	Contrast	737.09	1	737.09	2.20	.139
	Error	113501.18	339	334.81		
Each F tests the simple effects of School Location within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.						

However since there are two levels of school location, we need to know the level of school location within which the Ethnoscience Instructional Method (EIM) is significantly different. There is therefore the need for a pairwise comparison of the treatment within the school location as shown in Table 4.10 below. The significant simple main effects of the school location are analysed by pairwise comparison using Sidak adjustment for multiple comparisons. A significant main effect of Ethnoscience Instructional Method (EIM) is recorded in favour of those in rural area as shown in Table 4.10 with a mean difference of 11.96. For students in the Modified Lecture Method (MLM) group, there was a mean difference of 5.66 between the scores of those in urban and rural areas in favour of those in urban area but the difference is not significant.

Table 4.10: Pairwise Comparisons of the Treatment within the School Location

Dependent Variable: postattitude							
Treatment	(I) School Location	(J) School Location	Mean Difference (I-J)	Std. Error	Sig. ^a	95% Confidence Interval for Difference ^a	
						Lower Bound	Upper Bound
EIM	Urban	Rural	-11.96*	2.995	.000*	-17.847	-6.064
	Rural	Urban	11.96*	2.995	.000*	6.064	17.847
MLM	Urban	Rural	5.66	3.812	.139	-1.842	13.155
	Rural	Urban	-5.66	3.812	.139	-13.155	1.842
Based on estimated marginal means							
*. The mean difference is significant at the .05 level.							
a. Adjustment for multiple comparisons: Sidak.							

Learners in the EIM group in the rural area had better attitude to science ($\bar{X}=187.50$ SE= 2.17) than those in the urban centre ($\bar{X}= 175.55$ SE= 2.07) as shown in the Estimated Interaction Means table (Table 4.11) below. The implication of this is that Ethnoscience Instructional Method brings out greater improvement in attitude to science among students in rural areas than those in urban centres.

Table 4.11 Estimated Interaction Means

Dependent Variable: postattitude					
Treatment	School Location	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
EIM	Urban	175.55a	2.07	171.49	179.61
	Rural	187.50a	2.17	183.24	191.77
MLM	Urban	169.01a	2.08	164.92	173.09
	Rural	163.35a	3.20	157.06	169.64

a. Covariates appearing in the model are evaluated at the following values: preattitude = 165.18.

4.2.4c Hypothesis 4 (c)

H₀4(c): There is no significant interaction effect of treatment and school location on students' conception of scientific phenomena.

Table 4.7 reveals that there is a significant interaction effect of treatment and school location on students' conception of scientific phenomena ($F_{1,339} = 4.797, p < 0.05$). The interaction is disordinal. Hence, Hypothesis 4(c) is not supported. To explain the interaction effect, Estimated Marginal Means (Figure 4.5) is presented below showing the disordinal interaction.

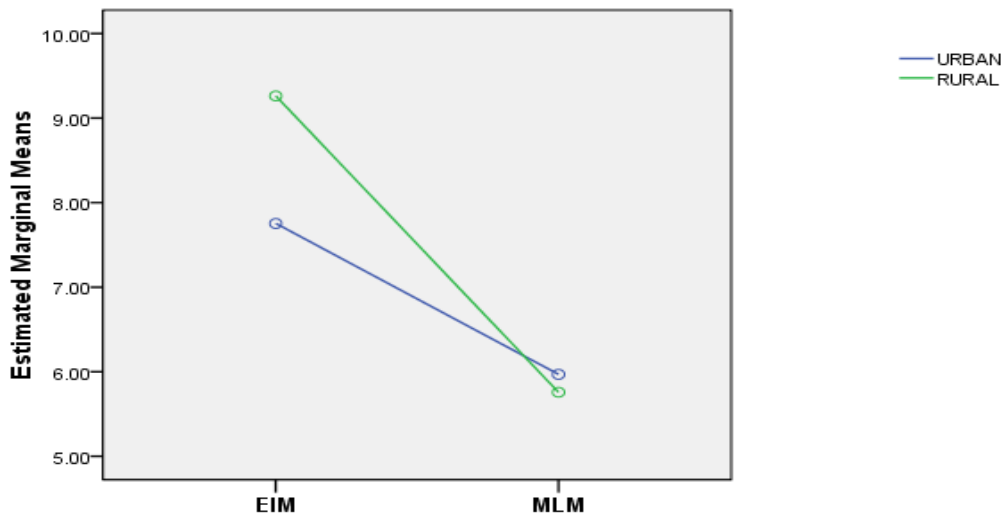


Figure 4.5: Line graph showing Significant Interaction Effect of Treatment and School location on Students' Conception of Scientific Phenomena.

To interpret the interaction as shown in Figure 4.5, the treatment by school location interaction effect is analysed using a simple main effects analysis. The Univariate Tests of the Simple Effects of school location within each level of treatment (Table 4.12) shows that school location influences learners' conception of scientific phenomena in the EIM group ($F_{1, 339} = 6.78, p < 0.05$) but it does not influence conception of scientific phenomena in the MLM group ($F_{1,339} = .59, p > 0.05$).

Table 4:12 Univariate Tests of The Simple Effects of School Location Within Each Level of Treatment

Dependent Variable:postconception						
Treatment		Sum of Squares	df	Mean Square	<i>F</i>	Sig.
EIM	Contrast	31.71	1	31.71	6.78	.01*
	Error	1585.20	339	4.68		
MLM	Contrast	2.77	1	2.77	.59	.44
	Error	1585.20	339	4.72		

Each F tests the simple effects of school location within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

However since there are two levels of school location, we need to know the level of school location within which EIM is significantly different. There is therefore the need for a pairwise comparison of the treatment within the school location. This is shown in Table 4.13 below. The significant simple main effects of the school location were analysed by pairwise comparison using Sidak adjustment for multiple comparisons. A significant main effect of Ethnoscience Instructional Method (EIM) is recorded in favour of those in rural area with a mean difference of 0.92. For students in the Modified Lecture Method (MLM) group, there is a mean difference 0.35 between the scores of those in urban and rural areas in favour of those in urban area but the difference is not significant.

Table 4.13: Pairwise comparisons for School Location within each level of Treatment

Dependent Variable:postconcept							
Treatment	(I) School Location	(J) School Location	Mean Difference (I-J)	Std. Error	Sig. ^a	95% Confidence Interval for Difference ^a	
						Lower Bound	Upper Bound
EIM	Urban	Rural	-.92*	.35	.01	-1.61	-.23
	Rural	Urban	.92*	.35	.01	.23	1.61
MLM	Urban	Rural	.35	.46	.44	-.55	1.26
	Rural	Urban	-.35	.46	.44	-1.26	.55
Based on estimated marginal means							
*. The mean difference is significant at the .05 level.							
a. Adjustment for multiple comparisons: Sidak.							

Learners in the EIM group in the rural area have better conception of scientific phenomena ($\bar{X}= 9.10$ SE= .26) than those in the urban centre ($\bar{X}= 8.18$ SE= .24) as shown in the Estimated Interaction Means table (Table 4:14) below. The implication of this is that Ethnoscience Instructional Method brings out better understanding of scientific phenomena from students in rural areas than those in urban centres.

Table 4.14: Estimated Interaction Means

Dependent Variable: postconception					
Treatment	School Location	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
EIM	Urban	8.18a	.24	7.70	8.66
	Rural	9.10a	.26	8.59	9.61
MLM	Urban	5.74a	.25	5.26	6.22
	Rural	5.39a	.39	4.63	6.14

a. Covariates appearing in the model are evaluated at the following values: preconception = 5.41.

4.2.5 Hypothesis 5 (H05):**4.2.5a Hypothesis 5 (a)**

H₀₅(a): There is no significant interaction effect of treatment and parent educational status on students' cognitive achievement in science.

Table 4.3 reveals that there is no significant interaction effect of treatment parent educational status on students' cognitive achievement in science ($F_{2,339} = 0.691, p > 0.05$). Hence, Hypothesis 5(a) is supported. This implies that that parent educational status does not matter with respect to cognitive achievement whichever of the treatment methods is used.

4.2.5b Hypothesis 5 (b):

H₀₅(b): There is no significant interaction effect of treatment and parent educational status on students' attitude to science.

Table 4.6 reveals that there is no significant interaction effect of treatment and parent educational status on students' attitude to science ($F_{2,339} = 0.064, p > 0.05$). Hence, Hypothesis 5(b) is supported. This implies that parent educational status does not matter with respect to students' attitude to science whichever of the treatment methods is used.

4.2.5c Hypothesis 5 (c):

H₀5(c): There is no significant interaction effect of treatment and parent educational status on students' conception of scientific phenomena.

Table 4.9 reveals that there is no significant interaction effect of treatment parent educational status on conception of scientific phenomena. ($F_{2,339} = 1.626, p > 0.05$). Hence, Hypothesis 5(c) is supported. This also implies that parent educational status does not matter with respect to students' conception of scientific phenomena whichever of the treatment methods is used.

4.2.6 Hypothesis 6 (H₀₆):

4.2.6a Hypothesis 6 (a)

H₀6(a): There is no significant interaction effect of school location and parent educational status on students' cognitive achievement in science.

Table 4.3 reveals that there is no significant interaction effect of school location and parent educational status on students' cognitive achievement in science. ($F_{2,339} = 3.017, p > 0.05$). Indeed, $p = 0.050$ which is not less than 0.05 that could have made it significant. It is therefore safer to conclude that it is not significant. Hence, Hypothesis 6(a) is supported. However further research in this respect area would be required since $p = 0.050$ which is very close to being significant.

4.2.6b Hypothesis 6 (c)

H₀6(b): There is no significant interaction effect of school location and parent educational status on students' attitude to science.

Table 4.6 reveals that there is no significant interaction effect of school location and parent educational status on students' attitude to science. ($F_{2,339} = 0.318, p > 0.05$). Hence,

Hypothesis 6(b) is supported. This also implies that location does not matter with respect to students' attitude to science whichever of the parent educational status they belong.

4.2.6c Hypothesis 6 (c)

H₀6(c): There is no significant interaction effect of school location and parent educational status on students' conception of scientific phenomena.

Table 4.9 reveals that there is no significant interaction effect of school location and parent educational status on students' conception of scientific phenomena. ($F_{2,339}=1.381$, $p > 0.05$). Hence, Hypothesis 6(c) is supported. The implication is that location does not matter with respect to students' conception of scientific phenomena whichever of the PES they belong.

4.2.7 Hypothesis 7 (H₀7):

4.2.7a Hypothesis 7 (a)

H₀7(a): There is no significant interaction effect of treatment, school location parent educational status on students' cognitive achievement in science.

Table 4.3 reveals that there is no significant interaction effect of treatment, school location and parent educational status on students' cognitive achievement in science. ($F_{2,339}=2.212$, $p > 0.05$). Hence, Hypothesis 7(a) is supported.

4.2.7b Hypothesis 7 (b)

H₀7(b): There is no significant interaction effect of treatment, school location and parent educational status on students' attitude to science.

Table 4.6 reveals that there is no significant interaction effect of treatment, school location and parent educational status on students' attitude to science ($F_{2,339}=0.696$, $p > 0.05$). Hence, Hypothesis 7(b) is supported.

4.2.7 Hypothesis 7 (c)

H₀7(c): There is no significant interaction effect of treatment, school location and parent educational status on students' conception of scientific phenomena.

Table 4.9 reveals that there is no significant interaction effect of treatment, school location and parent educational status on students' conception of scientific phenomena ($F_{2,339}=2.081, p > 0.05$). Hence, Hypothesis 7(c) is supported.

4.3 Discussion

4.3.1 Standardization of Ethnoscience Database (ED)

Reference is made to the standardization procedure of ED (3.5.1.1-3.5.6) which was established for both validity and reliability. Only content validity was established other forms of validity could not be done since the database is just been developed without a previous one to compare it with. To determine its reliability and because of the large volume of the database, 30 common *Yorùbá* sayings were randomly selected and each given four cultural interpretations with only one correct scientific option. This was then administered twice, at an interval of three weeks on 30 students in a school similar to the ones used for the study. A test-retest correlation coefficient of $r=0.86$ which is considered good enough.

4.3.2 Science Classification of Collected Science Related Common *Yorùbá* Sayings:

Finding from this study reveals that 27 (26.2%) out of the 103 collected science related common *Yorùbá* sayings relate to the physical sciences, 56 (53.4%) relate to medical sciences, 21 (20.4%) of the sayings are classified as belonging to the biological sciences. Of note however is the revelation from the database that none of the collected science related beliefs (0%) can be classified as belonging to pharmaceuticals.

The finding in this respect shows that the largest proportion (53.4%) of expressed science related common *Yorùbá* sayings of the sampled population is linked to objects and

problems affecting human and animal health. This is however not surprising since medical problems definitely affect day to day activities of man. This category is followed by science related common sayings of the Physical sciences (26.2%) dealing with physical and inanimate objects such as rocks, rivers, mountains etc. and closely followed by those of the Biological sciences (20.4%) relating to living bodies such as human beings, insects, plants, livestock etc. The sampled population is very close to nature which probably accounted for the percentages of the two classes. The surprising revelation is in respect of the class of pharmaceuticals without a single collected science related common *Yorùbá* sayings.

Possible explanation for this is that issues relating to local drugs and drug contents of plants and other objects are clothed in top secrecy and myths. Since this work avoided mythology and focused mainly on science related common *Yorùbá* sayings, the absence of a saying in this group is explicable and understandable. These findings are in tandem with the findings of Okeke and Njelita (2002). They collected 22 science related sayings and grouped them into the three basic science subjects of Biology (76.1%), Physics (14.2%) and Chemistry (9.5%). A closer look at their study shows that the two common *Yorùbá* sayings classified under Chemistry have no relationship with pharmaceuticals.

4.3.3 Compatibility of Collected Science Related Common *Yorùbá* Sayings with Modern Science Concepts

Finding from this study shows that 10 (9.7%) of the collected science related common *Yorùbá* sayings are compatible with identified scientific concepts, 17 (16.5%) require some modifications before they can agree with and reinforce the understanding of related science concept being taught and 76 (73.8%) contradict related scientific concepts.

This finding is an empirical proof against the conclusion of many researchers in this respect. For instance, Wasagu (1999) and Adeniyi (1987) maintain that scientific knowledge and

explanations have not been an integral part of African social life. Even though the total percentage is small (9.7%), it establishes the fact that some of the sayings of the *Yorùbá* of Southwestern Nigeria and their explanations are in line with modern scientific explanations. It however supports the assertion of Clement et al (1989) that not all preconceptions are misconceptions. One major implication of this is that prior knowledge that is compatible with concepts being learnt would likely facilitate learning of such concepts. This finding however confirmed the fear that most of the science related common *Yorùbá* sayings are actually contradictory to modern scientific concepts. This accentuates the need for an intervention which ethnosience instruction satisfies.

4.3.4 Effect of Ethnosience Instructional Method on Students' Cognitive Achievement in Science

This study as shown in Table 4.1 reveals that there is a significant main effect of Ethnosience Instructional Method on cognitive achievement in science. The effect size is moderate. A practical significance is thus indicated. The Estimated Marginal Mean of Achievement Scores as shown in Table 4.4 are 24.72 and 17.85 for Ethnosience Instructional Method (EIM) and Modified Lecture Method groups respectively.. This means that Ethnosience Instructional Method (EIM) is a more effective method in improving learners' cognitive achievement in science than the Modified Lecture Method which served for control. This finding shows that EIM assisted science learners in making sense of extant knowledge. It facilitated negotiation of meanings of science concepts since the method provides an opportunity for comparing what was known to new experiences and resolving discrepancies between what was known and what seemed to be implied by new experiences.

These discrepancies have been very prominent in areas where science education has been influenced by common *Yorùbá* sayings. The result could also be explained by the link EIM establishes between day-to-day experiences of the science learner and the world of modern

science. The method derives strength from accessing prior common sayings of learners that are related to science which give them the opportunity to re-examine the cultural meanings attached to the beliefs in terms of how realistic or logical they are. They have the opportunity to either hold on to the cultural meanings of the sayings, modify or reject them outright. Whichever is the case, it brings about improvement in the cognitive achievement of the learner.

It accentuates the need to integrate indigenous knowledge into school science in order to prevent cultural clashes whenever students attempt to learn meaningful school science. This will likely enable sustainable development and cultural survival. EIM clearly facilitates the easiness with which students across cultural borders into school (western) science, thus encouraging meaningful learning of science. This result should whet the appetite of an increasing number of science educators who want to understand the influence of culture on school science achievement of students whose cultures and languages differ from the predominant Eurocentric culture and language of science whether such students live in non-Western countries like Nigeria, Egypt, Malawi or in Western countries like Britain, America, Canada etc. but are not at home with the culture of Eurocentric science which permeates their school science classes. EIM is equally an answer to scholars who wonder what role the integration of these knowledge systems will play in human life that the well-established three-century old science could not independently achieve (Sithole, 2005). Since science education does not occur in a vacuum, teaching and learning in science must be socially situated and this will impact positively on learning outcomes.

This finding is in consonant with the thoughts of Aikenhead and Ogawa (2007) in their writing on indigenous knowledge and science revisited. The finding is also supported by Igbokwe (2010) who concludes that students who are taught using ethnoscience cultural learning model performed better than those taught using the conventional method in cognitive achievement in science. It therefore concludes that since the cultural activities of each child as

experienced from his cultural environment guide or influence his future observation and also determine what is learnt, for effective learning of science concepts to occur, the model should be adopted.

It also confirms the assertion that it is not only what we teach but also how we teach it that are important considerations in how to improve student success (Moore 1989). The finding is also supported by Hiwatig (2008) whose study reveals that a comparison of ethnoscience class and the conventional class performance per item indicates that the ethnoscience class and the conventional class significantly differ in terms of their proficiency in science posttest in four out of six items. The ethnoscience class had a higher mean score than the conventional class. The finding also provides empirical support for the four conditions listed by Posner, Strike, Hewson, and Gertzog (1982) which foster accommodation in students' thinking. These are:

- a) There must be dissatisfaction with existing conceptions.
- b) A new conception must be intelligible.
- c) A new conception must appear initially plausible.
- d) A new concept should suggest the possibility of a fruitful research program.

EIM makes it possible for learners to engage in critical comparison between the two knowledge systems. Such exercise develops the cognitive structure and understanding of the learner. It is a better approach that clearly removes the assumption or pretence that indigenous knowledge has nothing to offer in the teaching and learning of science. There is no doubt that psychological and sociological approaches are useful in education but the inclusion of elements of indigenous knowledge in classroom activities as brought about by Ethnoscience Instructional Method provides fresh insight into and solutions to problems associated with students learning science. This confirms earlier assertion of Cobern and Aikenhead (1998) on the issue of cultural aspect of learning science.

Since students also have the opportunity of interacting with related cultural materials as instructional materials, their understanding of science concepts improves. The impression of science being 'foreign' or "oyinbo" (whiteman) knowledge as usually said locally is erased from their minds. They probably see the science concept as now being their own.

The method also promote discourse in science among learners since it gives them the opportunity to be actively involved in discussing both the science concept being learnt and the related common *Yorùbá* sayings. They trek a familiar path in the discussion rather than the teacher pouring down all the 'facts'. Finally Niaz, Aguilera, Maza, and Liendo (2002) also conclude that if students are given the opportunity to argue and discuss their ideas, their "understanding can go beyond the simple regurgitation of experimental detail."

This finding also establishes the theory of social constructivism which, according to Linn and Burbules (1993), characterises the nature of knowledge to include the following:

- (1) knowledge is not a passive commodity to be transferred from a teacher to learners,
- (2) pupils cannot and should not be made to absorb knowledge in a spongy fashion,
- (3) knowledge cannot exist separate from the knower,
- (4) learning is a social process mediated by the learner's environment, and
- (5) the prior or indigenous knowledge of the learner is of significance in accomplishing the construction of meaning in a new situation.

Linn and Burbules (1993) also state that all learning is mediated by culture and takes place in a social context. The role of the social context is to scaffold the learner, and provide hints and help that foster co-construction of knowledge while interacting with other members of the society. Jegede and Aikenhead (2005), while summarising some previous works, also conclude that contemporary literature has shown that recognising the social context of learning, as well as the effect of the learner's socio-cultural background in the teaching and learning of science, is of

primary importance if a strong basic foundation is to be established for successful pupil achievement and affect outcomes.

The study equally affirms the postulations of collateral learning theory which states that learning generally involves two or more conflicting schemata held simultaneously in long-term memory (Jegede 1997). It recognises variations in the degree to which the conflicting ideas interact with each other and the degree to which conflicts are resolved. At the opposite extremes of collateral learning (parallel and secured), conflicting schemata do not interact at all (as is the case of parallel collateral learning) or consciously interact (as is the case of secured collateral learning) and the conflict is resolved in some manner. The person will have developed a satisfactory reason for holding on to both schemata even though the schemata may appear to conflict, or else the person will have achieved a convergence toward commonality by one schema reinforcing the other, resulting in a new conception in long-term memory. It is also possible that for the learner to have a reason to drop one schema.

4.3.5 Effect of Ethnoscience Instructional Method on Students' Attitude Towards Science

Findings from the study as shown in Table 4.5 reveal a significant main effect of Ethnoscience Instructional Method (EIM) on students' attitude to science. The effect size is however weak. The Estimated Marginal Mean table (Tables 4.6) of attitude score shows that learners in the Ethnoscience Instructional Method (EIM) group have higher adjusted mean score ($\bar{X} = 181.53$) than the Modified Lecture Method (MLM) group ($\bar{X} = 166.18$) in students' attitude towards science. The effect size is however weak. This, however, does not mean that EIM is not a more effective method of improving students' attitude to science than the Modified Lecture Method. Leech, Barrett and Morgan (2011) maintain that it is quite possible, with a large sample, to have a statistically significant result that is weak (i.e., has a small effect size). The weak effect size is also typical of attitude research since it takes a long time to effectively change the attitude of a people. The period of treatment is not long enough to bring about a very strong attitudinal

change. It is therefore worth noting that if a significant difference is achieved within the short period of treatment, then a greater positive attitudinal change to science is possible on exposure to longer period of EIM.

The significant interaction effect of treatment and school location could also be responsible for this. The finding in this respect could be because Ethnoscience Instructional Method (EIM) motivates students through the style of teaching the science concepts which relates to their everyday lives. The interest of the learners is aroused when questions are asked about related common science- related sayings which are preconceptions they bring to the class. They tend to show greater interest when given an opportunity to relate their cultural beliefs which are expressed verbally with scientific concepts.

This finding is supported by Leonard (2010) who maintains, based on his study that, making the learning and the teaching of the topics more relevant to students' lives helps them see the value of science and in turn motivates them to develop a better attitude towards science and science education. Adesoji (2008) equally concludes that the use of appropriate instructional strategies would ensure improved attitude to science. It is also supported by the assertion of Etkina and Mestre (2004) that instructors of introductory science classes should try to motivate their students by asking them to consider the preconceptions about science-related topics that they bring to the class. This is corroborated by Abonyi (2002a) that ethnoscience package is superior to the conventional package in fostering interest in science. The work of Hiwatig (2008) in which the ethno-scientific class had a significantly ($p=0.031$) higher positive mean rating in their attitude towards science (83.35 or 83%) than the conventional class (79.55 or 80%) also lends credence to the result from the study.

It however contradicts the study of Cage (2004) that there is no significant difference in attitude towards science between students involved in integrated, activity-based science curriculum and those involved in traditional science programme. It also contradicts the

conclusion of Shymansky, Yore, and Anderson (2000) in a study of responses in the Third International Mathematics and Science Study of students taught with constructivist, student interactive science teaching strategies which indicates that attitude may be more of a reflection of classroom and school environment than of the science curriculum. They found no significant differences in attitude or awareness in science.

Movahedzadeh (2011) notes the implication of positive attitude to science saying it helps in making good decisions because science is a way of knowing and understanding through the exercise of reason- a construction of the mind based on actual observation to explain natural phenomena. Ungar (2010) therefore concludes that it is in the interest of society, and the responsibility of educators to improve students' attitudes toward science, and to prepare students to live in a highly scientific and technological society. He asserts that the future of our society will be determined by citizens who are able to understand and help shape the complex influences of science and technology on our world.

However with a significant interaction effect of treatment and school location with respect to learners' attitude to science as shown in Table 4.5, an interpretation requires caution. Concluding that the main effect of treatment on attitude to science is significant may not give the complete picture of the result leading to inaccurate understanding of the result since accurate result would take the interactive effect of school location into consideration. Hinkelmann and Kempthorne (2005) maintain that where there are significant main and interaction effects, the main effects must be interpreted with caution. The caution in this case is that the significance is influenced by school location.

4.3.6 Effect of Ethnoscience Instructional Method on Students' Conception of Scientific Phenomena.

Finding from the study as shown in Table 4.7 reveals a significant main effect of Ethnoscience Instructional Method on students' conception of scientific phenomena. The Estimated Marginal Mean table (Table 4.8) of concept scores shows that learners in the Ethnoscience Instructional Method (EIM) group have higher adjusted mean score ($\bar{X}=8.64$) than the Modified Lecture Method (MLM) group ($\bar{X}=5.56$) in students' conception of scientific phenomena. Students exposed to this method performed better than those exposed to Modified Lecture Method. The size effect was modest. A practical significance is also indicated. This means that Ethnoscience Instructional Method (EIM) is a more effective method in bringing about conceptual change in the learner than the Modified Lecture method which served for control. One should however not be unmindful of the significant interaction effect between treatment and school location in this respect. A more practical application of the result would consider school location. This does not however remove the main significance of treatment.

This significance can be explained from the fact that Ethnoscience Instructional Method (EIM) gives the teacher the opportunity to understand the students' preconception of science concepts to be taught using common *Yorùbá* sayings as a periscope and such is directly addressed by Ethnoscience Instructional Method. It also embraces various beliefs, concepts and materials that the learner interacts with in his environment which improves his attitude towards science. The method provides opportunity for the learners to discuss their common sayings and science concepts thereby proving right an assertion by Niaz, Aguilera, Maza, and Liendo (2002) that if students were given the opportunity to argue and discuss their ideas, their "understanding can go beyond the simple regurgitation of experimental detail."

Finding in this respect is supported by Abonyi (1999) who found out that ethnoscience instructional package facilitated a shift in conception towards modern scientific conceptual types.

It is equally supported by Niaz, Aguilera, Maza, and Liendo (2002) who conclude from their study that not all preconceptions are easy to change which may explain the modest nature of the effect size. Some preconceptions can be easily and readily revised through instruction, but others are robust and highly resistant to change, even when not supported by observations.

Ethnoscience Instructional Method seems to have triggered dissatisfaction with some existing preconceptions thereby providing an opportunity to see the science concepts being taught as both comprehensible and plausible through observable and compatible data. The exposure of the learners' opens preconception to critical assessment in terms of common sayings that are derivatives of local cultural beliefs led to three things; a reduced emotional attachment to cultural meanings of the sayings that are contradictory to modern science concepts, a modification of the modifiable ones to bring out intended meanings of modern scientific concepts and a reinforcement of the understanding of the compatible ones. This is supported by Posner et al. (1982) who maintain that to become more effective in nurturing conceptual change, teachers should seek to understand students' naive conceptions so they can be addressed directly by instruction. They also maintain that if students were given the opportunity to argue and discuss their ideas, their "understanding can go beyond the simple regurgitation of experimental detail." It is also an empirical evidence to support Mikkila-Erdmann (2002) who suggests the use of written questions and statements or text that guide students to accept conceptions.

Again with a significant interaction effect of treatment and school location with respect to learners' conception of scientific phenomena as shown in Table 4.7, an interpretation requires caution. Concluding that the main effect of treatment on conception of scientific phenomena is significant would not give us an accurate understanding of the result since accurate result would take the interactive effect of school location into consideration. This is supported by Shaughnessy, Zechmeister and Zechmeister (2003) who maintain that if the interaction term is statistically significant, simply interpreting the main effects will not lead to an accurate

understanding of the results. Any interpretations made of the main effects will need to be qualified to include information about the interaction effects.

4.3.7 Effect of School Location on Students' Cognitive Achievement in Science.

Findings from this study reveal that there is no main significant effect of school location on students' cognitive achievement in science. This implies that there is no difference in the cognitive achievement of students in urban centres and those in rural areas with the use of Ethnoscience Instructional Method.

This contradicts the finding of Owoeye and Yara (2011) who conclude from their study that students in urban areas have better academic achievement than their rural counterparts in senior school certificate examinations. It is however supported by the work of Reeves (2005) whose results do not support the claim that rural students achieve less than their non-rural peers in mathematics and science. Adeyemi (1990), concludes that urban subjects did not perform better than rural subjects in biology achievement when covariance adjustment was used for her analysis, also supports the current finding. However Osokoya and Akuche (2012) in their own study of the effects of school location on students' learning outcomes in practical physics, found a significant main effect of school location on cognitive attainment in practical physics with learners in urban schools performing better than those in rural schools.

Various reasons can be adduced for the current finding. Despite the seeming disadvantaged position of students in rural schools in terms of infrastructure, they were still matches for students from the urban centre in terms of cognitive achievement. EIM removes the strangeness in science concepts and appeals to them in the language they understood. They feel science through the platform provided by the method which establishes a link with their day to day life activities and expressions. Students in rural schools are believed to be closer to culture than those in urban schools. Their expressions and beliefs show greater attachment to culture. It is therefore not surprising to find them better motivated in learning science when the method of

instruction used is culturally appealing. Some of the instructional materials used under EIM are more often used by students in rural areas. For instance catapult is a common tool used in hunting expeditions by students in rural areas. They use it in killing birds, lizards and so on. While the sight of catapult is not strange in urban centre, it is of limited use since children are warned against it because it could lead to the breakage of vehicle windscreens, glass windows and other breakable materials apart from causing physical injuries to man. This finding can also not be divorced from the fact that EIM from this study improves learners' attitude to science. Previous researches show that positive attitudes toward science lead to better results on achievement measures of science capability (Weinburgh, 1998).

4.3.8 Effect of School Location on Students' Attitude Towards Science.

Finding from this study reveals that there is no significant main effect of location on students' attitude to science. This means that there is no significant difference in the attitude of students in urban centres and those in rural areas to science. Ethnoscience Instructional Method (EIM) removes the gap between students in rural schools and those in urban schools in their attitude towards science through its greater appeal to students in rural areas. In line with the effect of EIM on students in rural schools, this finding is not unexpected since EIM induces greater enthusiasm among learners in rural schools. Such enthusiasm would encourage improved attitude towards science especially among students in rural areas thereby bridging the much talked about attitudinal difference towards science between students in rural and urban areas in favour of students in urban areas.

This finding contradicts that of Adeyemi (1990) who carried out an empirical study on the effect of school setting on students' attitude to biology which shows that the posttest scores favour the urban subjects in terms of attitudes towards biology. The current finding is supported by the finding of Osokoya and Akuche (2012) in their own study of the effects of school location

on students' learning outcomes in practical physics which shows no significant main effect of school location on learners' attitude towards practical physics.

4.3.9 Effect of School Location on Students' Conception of Scientific Phenomena.

Finding from this study shows that there is no significant main effect of school location on students' conception of scientific phenomena. This implies that there is no significant difference in conception of scientific phenomena by learners in urban and rural schools. The plausible reason for this could be that since the learners are of the same cultural background, school locational difference has not brought about significant difference between students in rural schools and those in urban schools in their conception of scientific phenomena. EIM seems to have had similar effects on the two groups of students. The effects of Globalization, Information and Communication Technology (ICT) and GSM have also greatly reduced the hitherto differences between students in rural and urban centres.

4.3.10 Effect of Parent Educational Status on Students' Cognitive Achievement in Science.

Findings in this study reveal that there is no significant main effect of parent educational status on students' cognitive achievement in science. This implies that there is no significant difference in cognitive achievement in science by learners with low, average and high parent educational status. One major reason for this could be the fact that most parents (fathers and mothers) of all categories in term of educational attainment now spend so much time running after means of sustenance that they no longer have time for their children's educational achievement. This is especially the case with parents of learners in public schools who invest little in the educational development of their children confirming the local saying that '*oogun ti a fi owo se, eyin aaro lo ngbe*' meaning a drug freely given easily goes unused. Emerging facts also show that most parents who attach importance to education in Southwestern part of Nigeria no longer send their children to public schools because of the poor learning conditions in the

schools. Rather they prefer sending them to private schools. Improved quality of education delivery will help reverse this trend.

This finding is supported by Ojedokun (2006) and Ojo (2008) who maintain that parent education is the single most important predictor of participation in Mathematics and Science but contradicts Ogwu (2006) who maintains that parent educational status is significantly and positively related to achievement. This is also the conclusion of Awofala (2010) who asserts based on his study that there is a significant main effect of parent education background on students' achievement in Mathematics word problem. Students from high parent educational background performed better than their peers from low educational background.

4.3.11 Effect of Parent Educational Status on Students' Attitude Towards Science.

Finding in this study reveals that there is no significant main effect of parent educational status on students' attitude towards science. This implies that there is no significant difference in cognitive achievement in science by learners with low, average and high parent educational status. The reason for this could be in the earlier assertion that a lot of parents are no longer consciously setting aside time to be with their children on a regular basis. They are busy running after bread and butter whether they have low, average and high educational status.

This finding contradicts the submission of Cokadar and Kulce (2008) which identifies parent educational status as one of the major factors affecting students' attitude towards science such that learners having parents with higher educational status show more positive attitude towards science.

It is however supported by Awofala (2010) whose study showed no significant main effect of parent educational background on students' attitude to Mathematics words problem.

4.3.12 Effect of Parent Educational Status on Students' Conception of Scientific Phenomena.

Finding in this study reveals that there is no significant main effect of parent educational status on students' conception of scientific phenomena.

This means that there is no significant difference in conception of scientific phenomena in science by learners with low, average and high parent educational status. Therefore, whatever is the educational status of parents, whether low, average or high, it has no influence on conception of scientific phenomena of learners.

4.3.13 Interaction Effect of Ethnoscience Instructional Method and School Location on Students' Attitude to Science.

Finding from this study reveals that there is a significant interaction effect of Ethnoscience Instructional Method and school location on students' attitude to science. The interaction is disordinal. The study shows that students in the Ethnoscience instructional method group in the rural schools have better performance in the post attitude test than those in the urban schools but in the Modified Lecture Method group, students in urban schools perform better than those in rural schools even though the difference was not significant. The finding suggests that school location should inform the types of instructional method to be used in improving students' attitude towards science. A teacher should plan his learning activities to suit the learners' school setting when selecting the materials to be used in the teaching of science. In this case, learners in the rural areas are better exposed to Ethnoscience Instructional Method to improve their attitude to science while exposure of learners in the urban areas to Modified Lecture Method is likely to bring about improved attitude to science. Because of the other findings in this study, a combination of the two strategies in teaching learners in urban schools is advisable to enhance improved performance in all the selected learning outcomes.

This finding that students in rural are more conversant with Ethnoscience Instructional modes is supported by the study of Agboghoromai (2009) whose study reveals an interaction effect of school setting (urban and rural) and instructional mode on students' knowledge in integrated science. He concludes that school circumstances require well-suited types of instructional modes which demand that teachers should plan learning activities that best suit their school setting when selecting the materials to be used in the teaching of integrated science.

4.3.14 Interaction Effect of Ethnoscience Instructional Method and School Location on Students' Conception of Scientific Phenomena.

Finding from this study as shown in Table 4.7 also reveals that there is a significant interaction effect of Ethnoscience Instructional Method and school location on students' conception of scientific phenomena. The interaction is also disordinal. The study also shows that students in the Ethnoscience instructional method group in the rural school have better performance in the concept scores than those in the urban school but in the Modified Lecture Method group, students in urban schools perform better than those in rural schools. It can equally be concluded that school location should inform the types of instructional method to be used in improving students' conception of scientific phenomena. A teacher should plan his learning activities to suit the learners' school setting when selecting the materials to be used in the teaching of science.

The conclusion in this particular case is that learners in the rural areas when taught using Ethnoscience instructional method are likely to improve their conception of scientific phenomena while exposure of learners in the urban areas to Modified Lecture Method is likely to bring about improved conception of scientific phenomena. It is however recommended that a combination of the two strategies be used in teaching learners in urban schools in order to enhance improved performance in other selected learning outcomes.

4.4 Summary of Findings

The research results presented and discussed in chapter four are summarized as follows:

1. The result shows that the people of South-western Nigeria are willing to divulge information about their common cultural beliefs and this should be a welcome development for intending researchers in this area. It also reveals that ED met the standardization criteria.
2. It shows from the result that the soft copy of ED even though, provided easier and faster access to its content was not appealing enough for use in the classroom by the teachers because none of the trained teachers had an own personal computer. The computer programme was however retained because the study has a global vision.
3. It was also found out that 27 (26%) out of the 104 collected science related common *Yorùbá* sayings relate to the physical sciences, 56 (54%) to medical sciences, none to pharmaceuticals and 21 (20%) to the biological sciences. It also shows that 10 (9.6%) of the collected science related common sayings actually complement identified scientific concepts, 17 (16.5%) require some elements of modification before they can complement and reinforce the understanding of related science concept being taught while 76 (73.8%) clearly contradict related scientific concepts.
4. There is a significant main effect of treatment on cognitive achievement in science, attitude to science and conception of scientific phenomena with students taught using Ethnoscience instructional method performing better than those taught using Modified Lecture Method.
5. There is no significant main effect of school location on cognitive achievement in science, attitude to science and conception of scientific phenomena. That is the treatment is suitable for students in urban and rural areas.
6. There is no significant main effect of parent educational status on cognitive achievement in science, attitude to science and conception of scientific phenomena. That is the treatment is good for students of high, medium and low parent educational statuses.

7. There is no significant interaction effect of treatment and school location on students' cognitive achievement in science. However, there is a significant interaction effect of treatment and school location on both students' attitude to science and conception of scientific phenomena. That is the treatment is effective in enhancing the attitude and conception of scientific phenomena of students in rural areas than those in urban areas.

8. There is no significant interaction effect of treatment and parent educational status on students' cognitive achievement in science, attitude to science and conception of scientific phenomena.

9. There is no significant interaction effect of school location and parent educational status on students' cognitive achievement in science, attitude to science and conception of scientific phenomena.

10. There is no significant interaction effect of treatment, school location and parent educational status on students' cognitive achievement in science, attitude to science and conception of scientific phenomena.

CHAPTER FIVE

SUMMARY, CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

This chapter presents the summary of findings, conclusion, educational implications of findings and recommendations. Also presented are the limitations of the study and suggestions for further research.

5.1 Summary

This 4-stage study developed an ethnoscience database, designed a storage and retrieval system for it, produced a framework of its incorporation into a classroom setting and conducted a field test of the data on teaching and learning of selected science concepts. Classification of its items was equally carried out, both in terms of broad classification of science concepts and compatibility with the understanding of related modern science concepts. Its impact on cognitive achievement in and attitude to science was investigated. Also investigated was its impact on conception of scientific phenomena. The moderating effects of school location and parent educational status on these learning outcomes were also determined.

The study was carried out in two phases. Each phase had its own research design. Descriptive survey design with the use of unstructured personal interview of elders and community leaders, students' responses, review of previous work and personal survey were utilized for the first phase involving the development of Ethnoscience Database (ED) [Appendix 3A]. The second phase involved the adoption of the pretest, posttest, control group quasi-experimental design.

The target population of the first phase of the work for the development of the database consisted of all the six south western states of Nigeria made up of mainly the *Yorùbá* with common cultural background. Stratified random sampling was used to select three of the states- Oyo, Ekiti and Ogun. 31 elders and community leaders (18 males and 13 females) from peri-urban centres of cities of Ibadan, Abeokuta, and Ado-Ekiti (12, 10, and 09 respectively) who

were also involved in the study. They were purposively selected. Additionally all students of two junior secondary and two senior secondary schools each randomly selected from Ibadan, Abeokuta and Ado Ekiti respectively numbering 3,055 were also used for data collection. The target population of the second phase of the study consisted of all Junior Secondary I students in Ibadan Municipality (Urban and Rural centres) made up of 11 local government Areas (5 in urban and 6 in rural areas). Stratified random sampling was used to select four public co-educational Junior Secondary Schools that were used.

Two schools were randomly selected from one randomly selected local government in the urban centre of Ibadan while two schools were also randomly selected from one randomly selected local government in the rural centre of Ibadan. Two randomly selected intact classes were used in each school. A total of 352 JS1 students participated in this phase of the study.

Three response instruments were used for data collection while four stimulus instruments were also used by the teachers involved in the study.

Three Research Questions and seven Hypotheses were raised and answered.

The study adopted the use of both descriptive and inferential statistics for analyzing the data gathered. Analysis of Covariance (ANCOVA) was used to test the hypotheses and differences between the groups using the pretest scores as covariates.

Findings from the study reveal that:

1. Out of the 103 collected science related common Yorùbá sayings, 27 (26.2%) relate to the physical sciences, 56 (53.4%) to medical sciences, none to pharmaceuticals and 21 (20.4%) to the biological sciences. It also shows that 10 (9.7%) of the collected science related common sayings actually complement identified scientific concepts, 17 (16.5%) require some elements of modification before they can complement and reinforce the understanding of related science concept being taught while 76 (73.8%) clearly contradict related scientific concepts.

2. There is a significant main effect of treatment on cognitive achievement in science, attitude to science and conception of scientific phenomena with students taught using Ethnoscience Instructional Method performing better than those taught using Modified Lecture Method.
3. There is no significant main effect of school location on cognitive achievement in science, attitude to science and conception of scientific phenomena.
4. There is no significant main effect of parent educational status on cognitive achievement in science, attitude to science and conception of scientific phenomena.
5. There is no significant interaction effect of treatment and school location on students' cognitive achievement in science.
6. However, there is a significant interaction effect of treatment and school location on both students' attitude to science and conception of scientific phenomena.
7. There is no significant interaction effect of treatment and parent educational status on students' cognitive achievement in science, attitude to science and conception of scientific phenomena.
8. There is no significant interaction effect of school location and parent educational status on students' cognitive achievement in science, attitude to science and conception of scientific phenomena.
9. There is no significant interaction effect of treatment, school location and parent educational status on students' cognitive achievement in science, attitude to science and conception of scientific phenomena.

5.2 Educational Implications

The primary objective of this study is to develop an Ethnoscience database, design a storage and retrieval system for it, produce a model of its incorporation into a classroom setting

and conduct a field test of the data on teaching and learning of selected science concepts. In the light of the findings discussed, this study has the following educational implications.

The development and validation of an Ethnoscience Database and its subsequent field trial reveals the significance of accessing the prior cultural beliefs of learners that are expressed verbally and creating a link between them and modern science concepts. This will create the bridge needed by the learner for transmitting between his life-world and the world of school science.

It confirms the assertion that most of the science related common sayings of the sampled population is contradictory to modern science concepts. This however accentuates the need for the adoption of ethnoscience instructional method in the teaching and learning of science concepts. The study shows clearly that not all science related cultural beliefs that are verbally expressed are contradictory to modern scientific concepts. In actual fact some of them are compatible to science concepts while others are modifiable.

The findings shows appreciable improvement in the cognitive knowledge, attitude to science and conception of scientific phenomena of students taught using Ethnoscience-based instructional method over those taught using Modified lecture method. This is a great contribution to knowledge. The study did not stop at this; it goes on to find out the moderating effects of location and parent educational status on the dependent variables. Both showed no significant main effects.

Above all, availability of a ready source of information on science related cultural expressions and observations would be of great assistance to educators, curriculum planners, teachers and students. This accentuates the need to equip teachers of today with modern teaching aids such as the computer. It also establishes the fact that learner centred instructional approaches require the exploration of related students' traditional beliefs brought into the science class to facilitate learning in science.

Finally researchers should not be afraid of exploring this area of research based on the anxiety of negative reaction of the indigenous people because the reaction of the people of south western Nigeria may not be an isolated one.

5.3 Limitation of the Study

The study covered the South Western part of Nigeria that is mainly populated by the Yorùbá. Therefore generalization of the database is limited to this set of people.

5.4 Suggestions for Further Research

This study has opened up vistas of unexplored research grounds. Some of the areas for further research are:

1. A replication of this study in other geographical regions among people of same cultural background is desirable.
2. It should also be replicated at other levels of educational settings.
3. A study of this nature can also be carried out in specific areas of science such as in Agricultural Science, Biology, Chemistry, Physics etc.
4. Information from the Ethnoscience Database show that the study is awaiting exploration by researchers in the various fields of applied sciences such as Medical sciences, Engineering, Astronomy etc.
5. Additionally research on the effect of Ethnoscience based Instructional Method on other learning outcomes and moderating variables apart from those used in the present study should be carried out.
6. Further research on the interaction effect of school location and parent educational status on students' cognitive achievement in science would also be required since the $p = 0.05$ recorded is very close to the requirement of $p < 0.05$ to be significant.

5.5 Conclusion

This study was carried out as part of efforts by educators and researchers at understanding how prior knowledge influences learning. It invested efforts on determining the effects of incorporating the knowledge of learners' cultural beliefs, expressed here through common *Yorùbá* sayings, into class interaction. Findings in the study revealed the usefulness of having a database of science related common sayings reflecting local cultural beliefs and long-time observations and assertions and how it would assist students in better understanding of science concepts. Its incorporation into classroom interaction improved both attitude to science and conception of scientific phenomena. It helped to identify differences among students due to school location and parent educational status.

This finding empirically establishes the assertion by UNESCO (1999) that:

...traditional and local knowledge systems are dynamic expressions of perceiving and understanding the world which can make and historically have made, a valuable contribution to science and technology, and that there is need to preserve, protect, research and promote this cultural heritage and empirical knowledge. Science curricula should include ethics, as well as training in the history and philosophy of science and its cultural impact.

It is hoped that this work would engender the much desired improvement in learning outcomes in science education irrespective of cultural differences.

5.6 Recommendations

Based on the findings of this study, the following recommendations are made:

1. A project should be commissioned by the university authority in collaboration with the Federal Government, UNESCO and other interested organizations for the production of an

Ethnoscience Database that will cover all the geographical zones of Nigeria having the same cultural background, in view of the importance of such database as revealed in this work.

2. The government through its organs should also recommend this to UNESCO with a view to doing same in all other countries since the issue of cultural belief is not limited to Nigeria or Africa alone.

3. Ethnoscience Instructional Method should be adopted in teaching and learning of science concepts.

4. Educators, administrators and other stake holders in the education sectors should be trained on the importance and use of Ethnoscience based instructions and encouraged to start using it for classroom instruction.

5. There should be the incorporation of basic Ethnoscience materials into the national curriculum to effect the much desired improvement in learning outcomes in science.

6. Teachers should be empowered with the provision of modern teaching aids by their employers including laptop personal computers.

7. Learning environment and funding should be improved in public schools to attract children of middleclass and elites.

REFERENCES

- Abonyi, O. S. 2002a. Effects of Ethnoscience -based instructional Package on Students' Interest in Science. *Journal of the Science Teachers Association of Nigeria* 37.1 & 2, 60-68.
- _____ 2002b. Science and Technology Education for Sustainable Development: A Case for Ethnoscience. Proceedings 43rd of Annual Conference of the Science Teachers Association of Nigeria. 180
- Abonyi, O. S. 1999. Effects of an Ethnoscience- Based Instructional Package on Students' Conception of Scientific Phenomena and Interest in Science. Thesis. University of Nigeria. Nsukka. 111
- Absalom D. K. P. 2008. Exploring the Integration of Indigenous Science in the Primary School Science Curriculum in Malawi. Thesis. Teaching and Learning .Virginia Polytechnic Institute and State University. 67
- Achimugu, L. 1995. Effects of Selected Improvised Conventional Teaching Materials on Students Achievement in and Attitude Towards Chemistry. Thesis. Science Education, Education. University of Nigeria
- Adams, H. H. 1983. African Observers of the Universe: The Sirius Questions. *In I.V. Sertima (Ed) Blacks in Science: Ancient and Modern*. New Brunswick. Transaction Books. 55
- Adebayo, S. A. 2002. Effect of Concept of Mapping on Students' Performance in the Junior Secondary School Integrated Science in Ilorin Metropolis in Nigeria. Dissertation. Science Education, University of Ilorin. 69
- Adeniyi, E.O. 1987. Epistimological consideration in Science Curriculum Development in Nigeria. CESAC paper No. 17.
- Adesoji, F.A. 2008. Managing Students' Attitude towards Science through Problem-Solving Instructional Strategy. *Anthropologist*, 10(1): 21-24.
- Adesoji, F. A. and Akpan, B. B. 1991. Teaching Science, Mathematics and Technology in Mother Tongue: A Path to Curriculum Evaluation. 32nd Annual Conference Proceedings of Science Teachers Association of Nigeria. pp 70-73.
- Adesokan, C.O. 2000. Students Attitude and Gender as Determinants of Performance in JSS Integrated Science. Project. University of Ado-Ekiti. Nigeria.
- Adeyemi, M. A. 1990. Effects of Cognitive style, School setting and Instruction mode on Students' Attitude to Biology. *Journal of Nigerian Educational Research*, 9(10) 84-93.
- Adodo S.O and Gbore L.O. 2012. Prediction of attitude and interest of science students of

different ability on their academic performance in basic science. *International Journal of Psychology and Counselling* Vol. 4(6) 68-72. Retrieved on 21/04/2013 from www.academicjournals.org/IJPC

- Afuwape, M.O. and Olatoye, R.A. 2004. Improving Students' Achievement in integrated Science. The Role of Simulation game and Numerical ability. Programme and Abstract; European Conference on Research in Chemical Education. 24th- 28th August, Ljubljana, Stovenia pp39- 41
- Agboghoromai, T.E. 2009. Interaction Effects of Instructional Mode and School Setting on Students' Knowledge of Integrated Science. *International Journal of Scientific Research in Education*, Vol. 2(2), 67-75.
- Ahmed, M.A., Abimbola I.O, Omosewo E.O. and Akanbi A.O. 2012. Availability and Utilisation of Instructional Resources for Teaching Basic Science and Technology in Secondary Schools in Ilorin, Nigeria. Proceedings 43rd of Annual Conference of the Science Teachers Association of Nigeria. pp203
- Aikenhead, G. S. 1996. Science Education; Border Crossing into the subculture of Science. *Studies in science education*, 27, 1-52.
- Aikenhead, G. S. and Jegede, O. J. 1999. Cross Cultural Science Education. A Cognitive Explanation of a Cultural Phenomenon. *Journal of Research in Science Teaching*. 36(3) pp. 267-271.
- Aina, S.A. 2006. Students Cognitive and Affective factors as Determinants of Achievements in Senior Secondary Physics in Oyo and Ogun states. Thesis. University of Ibadan, Ibadan.
- Ajayi, A. C. 2005. Effect of Concept Mapping on Students' Achievement and Interest in Integrated Science. Thesis. University of Ado-Ekiti, Nigeria
- Ajayi, K. and Ogunyemi, B. 1990. The Relationship Between Instructional Resources and Socio-Economics Status in Selected Population of High School. *Dissertation Abstract International Vol 25, No 2*.
- Ajelabi, P.A. 1998. The relative effectiveness of Computer- Assisted and Text- Assisted Programmed Instructions on student learning outcomes in social studies. Thesis. University of Ibadan.
- Ajiboye, J. O. 1996. A Self Learning Programme, the Modified Lecture Method and Students Cognitive and Affective Outcomes. In Some Population Education Concepts. Thesis. Teacher Education, University of Ibadan.
- Akinjiyan, T. 2002. An Appraisal of problems of Practical Agricultural Science Management in some selected Secondary Schools in Ondo State. Project. Department of Agricultural Science. Adeyemi College of Education. Ondo State, Nigeria.
- Akintunde, S. A. 2004. Effects of Structure and Unstructured Group Interaction patterns

- on Learning Outcomes of Primary School Pupils in Some Environmental Education Concepts in Ibadan. Thesis Teacher Education. University of Ibadan.
- Akpan, O. E. and Anamuah-Mensauh, J. 1992. The Tricontextual Millieu to Science Concept Learning. *Journal of Science and Mathematics Education 1(1)* 4-24.
- Albert, S. J. 1974. American Indian Ethnoscience: A study of its effect on Student achievement. Thesis, University of Maryland.
- Ann, K. and Ladi, S. 1979. Towards Indigenous. Literacy. Science Teachers Learn to use Resources . *Indigenous Knowledge and Development Monitor. Vol 5(1)* 13-14.
- Awofala, A.O.A. 2010. Impact of Personalised Instruction on Senior Secondary School Students' Learning Outcomes in Mathematics Word Problems. Thesis. Teacher Education, Faculty of Education. University of Ibadan.
- Ungar, S.J. 2010. Seven Major Misperceptions About the Liberal Arts. *The Chronicle of Higher Education*.
- Baggaley, A.R. 1973. *Manual for the Academic Interest and Interest inventory*. Los Angelis. Wester Psychological Services.
- Baimba, A. A.1993. The scientific Knowledge/Cultural Interface:Implication for Science Education in Non-Western Cultures. *Journal of Science Teachers Association of Nigeria, 28 (1 & 2)* 13 - 19.
- Bajah, S. T. 1998. *Teaching Effectiveness*. Keynote Address Delivered at the Maiden National Conference on Teaching Effectiveness. Adeniran Ogunsanya College of Education, Lagos. 14-17.
- Bajah, S. T. 1981. Dichotomy of Science and Education for Africa. *Journal of Science Teachers Association of Nigeria. 20* 22-37.
- Bak, H. J. 2001. Education and public attitudes toward science: Implications for the "Deficit Model" of education and support for science and technology. *Social Science Quarterly, 82* : 779-795.<http://dx.doi.org/10.1111/0038-4941.00059>
- Banks, J. A. 1999. Information on Multicultural education (2nd Ed.) Boston: Allyn & Bacon.
- Baptiste, P. and Key S.1996.Cultural Inclusion: Where does your program stand? *The Science Teacher, 32*–35.
- Barba, R. H. 1995. Science in Multi-cultural classroom. A guide to Teaching and Learning Boston M. A. Allyn and Bicon Simo Schuster company
- Berg, C. A. R. 2005. Factors related to observed attitude change toward learning chemistry among university students. *Chemistry Education Research and Practice – 2005, 6 (1)*, 1-18. Retrieved on January 12, 2005, from http://www.rsc.org/Education/CERP/issues/2005_factors.asp.

- Bilesanmi-Awoderu, J.B. 2002. The status of biology practical skills' acquisition among Nigerian Secondary School Seniors in Ogun State. *African Journal of Educational Research* Vol. 8. 1&2
- Birmingham, D. M. 1996. Local Knowledge of Soils, the Case of Contrast in Cote d'Ivoire and its Consideration for Extension. Thesis. University of Wisconsin-Madison 19-22.
- Bloom, B.S.1971. *Individual Differences in School Achievement. A vanishing Point ?* Bloomington Indiana. Phil. Delta Kappa.
- Bulach, C. R., Malone, B. and Castleman, C. 1995. An investigation of variables related to Student Achievement. *Mid-Western Educational Researcher* 8. 2: 23-29.
- Cage B.N. 2004. The Effects of an Integrated, Activity-Based Science Curriculum on Student Achievement, Science Process Skills, and Science Attitudes. *Electronic Journal of Literacy through Science* Vol. 3
- Caldas, S. J. 1993. Reexamination of input and process factor effects on public school achievement, *Journal of Educational Research*,86(4), 206–214.
- Cajete, G. A. 1994. Look to the mountains: An ecology of Indigenous Education. Durango, Co:Kikavi Press.
- Campbell, J., Hombo, C., and Mazzeo, J. 1999. NAEP 1999 trends in academic progress: Three decades of student performance. *Education Statistics Quarterly*. 2, 4.
- Cannon, R., and Simpson, R. 1985. Relationships among attitude, motivation, and Achievement of ability grouped, seventh grade, life science students. *Science Education*. 69(2), 121-138
- Chen, Q. 2009 Family Background, Ability and Student Achievement in Rural China : Identifying the Effects of Unobservable Ability Using Famine-Generated Instruments. *Gansu Survey of Children and Families Papers*
- Chi, M. T. H. and Roscoe, R. D. 2002. The process and challenges of conceptual change. In M. Limon & L. Mason (Eds.) *Reconsidering conceptual change: Issues in theory and practice*. pp. 3-27. Dordrecht: Kluwer.
- Chubb, J. E., and Moe, T. M. 1990. *Politics, markets, and America's schools*. Washington, D.C.:The Brookings Institution.
- Clement, J., Brown, D. and Zeitsman, A. 1989. Not all preconceptions are misconceptions. *International Journal of Science Education*, 11, 554-565.
- Cobern, W.W. 1995. Science education as an exercise in foreign affairs. *Science and Education* 4.3: 287-302
- Cobern, W.W. 1991. World view Theory and Conceptual change in science education.

- Cobern, W.W and Aikenhead G.S. 1998. Cultural Aspects of Learning. *The International Handbook of Science Education*. Kluwer Academic Publishers. Great Britain.
- Cohen, L., Manion, L. and Morrison, K. 2007. *Research Methods in Education*. Sixth Edition. Routledge, London, New York.
- Cokadar, H. and Kulce, C. 2008. Pupils' Attitudes towards Science: A Case of Turkey. *World Applied Sciences Journal*, 2(1), 102-109.
- Danmole B.T. 2011. Emerging Issues on the Universal Basic Education Curriculum in Nigeria: Implications for the Science and Technology Component. *Pakistan Journal of Social Sciences*. Vol.8 no. 1. 62-68
- Davidson, B. 1987. *The Africans: An entry to cultural History*. Longman. Green and Co.
- Davis, J. 2001. Conceptual Change. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Retrieved May 04 2011 from <http://projects.coe.uga.edu/epltt/>
- Department of Education (Third Elementary Education Project, TEEP) and UP College of Education, 2002. *Culture-responsive Curriculum for Indigenous Peoples (CCIP)*.
- DiSessa, A. A.2002. Why conceptual ecology is a good idea. In M. Limon & L. Mason (Eds.). *Reconsidering conceptual change: Issues in theory and practice* . 29-60. Dordrecht: Kluwer.
- Doepken, D., Lawsky E. and Padwa L. 2008. Modified Fennema - Sherman Attitude Scale. Retrieved 24 June, 2009 from <http://www.woodrow.org/teaching/math/gender/08scale.html>
- Dewey, J. 1983. *John Dewey; The Later Works*. Carbondale and Edwardsville, Southern Illinois, University Press.
- Duada, D.M and Udofia N 2010. Comparing the Objectives, Themes and Sub-Themes of the Integrated and Basic Science Curriculum of the Junior Secondary Schools (JSS). *Journal of Science Teachers Association of Nigeria*. 45 (1&2) 36-46.
- Dryfoos, J. G. 1990. *Adolescents at risk*. NY: Oxford University Press.23
- Education Matters, 2005. Student achievement in mathematics – the roles of attitudes, perceptions and family background, 2.1. Catalogue number 81-004-XIE. Retrieved September 20, 2010, from <http://www.statcan.gc.ca/pub/81-004-x/2005001/7836-eng.htm>
- Eiks, T. 2002. Learning at ststions in Secondary level Chemistry lessons. *Education International* 13(7) 11-18.
- Economist Intelligence Unit.2007. The 2007 e-readiness rankings. Raising the bar. Retrieved on

- Eraikhuemen, L. 2003. The influence of Gender and School Location on Students' Academic Achievement in Senior Secondary School Mathematics. *Ife Journal of Theory and Research in Education*. Vol. 7.2 : 99 – 112.
- Eshiet, I.I .1991. Teaching Science, Mathematics and Technology in Mother Tongue. Philosophical Implications. 32nd Annual Conference Proceedings of Science Teachers Association of Nigeria. 3-10.
- Etkina, E., and J.P. Mestre. 2004. Implications of Learning Research for Teaching Science to Non-Science Majors. Sencer Backgrounder. Presented at SSI 2004. <http://www.sencer.net/Resources/pdfs/Backgrounders>. Retrieved 28-08 2012.
- Ezeagbasili, N. 1977. *African Science: Myth or Reality*. New York Vantage Press.
- Falade, F. 2012. Study the teachings of Ifa. Retrieved 24/04/2013 from Awonifa.com.
- Fafunwa, A. B. 1990. New direction for science, technology and mathematics (STM)- Education in Nigeria for the 90s. 31st Annual Conference Proceedings of Science Teachers Association of Nigeria
- Fafunwa, A. B. 1983. Wanted: Science and technology in mother tongue. A keynote address. 24th Annual Conference Proceedings of Science Teachers Association of Nigeria
- Fafunwa, A.B., Macauley, J.I. and Sokoya, J.A.F. 1989. Education in mother tongue: the Ife primary education research project, 1970-1978.
- Fasasi, R. A. 2003. Comparative Effects of Laboratory Work and Fieldwork and Students' Learning Outcomes in Agricultural Science. Dissertation. Teacher Education, Faculty of Education. University of Ibadan.
- Fernandez, M. E. 1994. Gender and Indigenous Knowledge. *Indigenous Knowledge and Development Monitor*. Vol 2. 6-7.
- Fernandez, M. E. 1992. The Social Organization of Production in Community-based Agro-Pastoralism in the Andes. Ed. C. M. McCorkle (ed.) *Plants, Animals and People: Agropastoral Systems Research*. Boulder: West View.
- Federal Republic of Nigeria 2006. *Universal Basic Education Programme. A Flag tip Programme of the Federal Government of Nigeria*. Abuja. Federal Government Publication.
- Federal Republic of Nigeria 2005. *National Policy on Education (Revised)*. NERC Press, Lagos.
- Federal Republic of Nigeria 2004. Education for all is the responsibility of all. The compulsory free universal Basic Education Act, 2004 and other related matters Abuja. UBE Building IBB Close.

- Federal Republic of Nigeria 1984. *Junior Secondary School Syllabus in Science, Introductory Technology Business Education EC Comparative Education Study and Adaptation Centre (CESAC)*. Nigeria Secondary School Technology Project (NSSTT). Lagos. Federal Government Publication.
- Fontana, A., and Frey, J.H. 2005. The interview: From neutral stance to political involvement. In Denzin, N.K., & Lincoln, Y.S. (eds.), *The Sage Handbook of Qualitative Research*. 3rd ed. Thousand Oaks, CA: Sage, 695-728.
- Freedman, M. P.1997. Relationship among Laboratory Instruction, Attitude toward science, and Achievement in Science Knowledge. *Journal of Research in Science Teaching*, 34 (4) 343-357.
- Friedman T. 2005. Still Eating Our Lunch: Singapore, New York Times.
- French, T. 2012. Excel 2003 Step by Step Database Tutorial. Retrieved June 4, 2012 from www.spreadsheets.about.com.
- Geelan, D. R.2000. Sketching some postmodern alternatives: Beyond paradigms and research. Programs as referents for science education. *Electronic Journal of Science Education*, 5(2). Retrieved November 9, 2001 from <http://unr.edu/homepage/crowther/ejse/ejsev5n1.html>
- George, J. 2001.Culture and Science Education. A look from the Developing World. An Action Bioscience. www.id21.org/education/e31g2.html. Retrieved 23 Aug. 2009
- Gott, R. and Duggans, 1996. Practical work: Its role in the understanding of Evidence in Science. *International Journal of Science Education* 18 (7) 719 –806.
- Harrison, P. 1989. *The Greening of Africa*. London. Paladin Grafton Books.
- Hiller, S. 1984. Cultural Differences in Mathematical Concept Learning. *American Anthropologist*. 66(3) 201-222.
- Hinkelmann K. and Kempthorne O. 2005.. *Design and Analysis of Experiments*. Vol. 2. New York: Wiley.
- Hiwatig, A.D.F. 2008. Ethno-Scientific Teaching Approach, Student Proficiency, and Attitude Toward Science and Ethnic Culture. *EDUCATION QUARTERLY*, Vol. 66 (1), 3-21, December.
- Hunter, D. E. and Whitter P. 1990. *Encyclopedia of Anthropology*.Oxford. Oxford University Press.
- Ibraheem, T.L. and Oladele, O. 2010. Information and Communication technology (ICT) Availability, Accessibility and Usability in the Teaching- Learning Process in Micheal Odetola College of Primary Education (MOCPED) Noforija-Epe. *Journal of Applied Education and Vocational Research*, 7(2): 168-177.

- Ifamuyiwa, A. S. 2007. Effects of Cooperative Learning, Self and Cooperative Instructional Strategies. Thesis. University of Ibadan, Ibadan.
- Igbokwe, O.C. 2010. The Effect of Multicultural Learning Environment on Cognitive Achievement of Pupils in Primary Science. *Journal of the Science Teachers Association of Nigeria*. Volume 45, Issue 1 & 2.
- Ige, T. A. 2001. Concept Mapping and Problem Solving Teaching Strategies as Determinants of Achievement in Secondary School Ecology. *Ibadan Journal of Educational Studies*. Vol. 1 May.
- Ige, T. A. 1999. Improving Practical Assessment in Biology by using Practical Skills Inventory. *African Journal of Education Research*. Vol. 5 .2 : 34-44
- Iran – Njad, A. 1987. Cognitive and Affective Causes of Interest and Liking. *Journal of Educational Psychology*. 79(2).
- Isiugo-Abanihe, L. M. and Labo-Popoola, S. O 2004. School Type and Location as Environmental Factors in Learning English as a Secondary Language. *West African Journal of Education*. Vol. XXIV No 1, 55-63.
- Ivarsson, J., Schoultz, J., and Saljo, R. 2002. Map reading versus mind reading: Revisiting children's understanding of the shape of the earth. In M. Limon & L. Mason (Eds.) *Reconsidering conceptual change: Issues in theory and practice*. pp. 77-99. Dordrecht: Kluwer.
- Ivowi, U. M. O. 1992. Raising the standard of Performance in Public Examination in Science, Technology and Mathematics. STAN Position No 4.
- Jabor, M.K, Machtmes K, Kungu K, Y, Buntat Y and Nordin M. S, 2011. Does Parent Educational Status Matter on the Students' Achievement in Science? *International Conference on Social Science and Humanity IPEDR* vol.5
- Jacob, E. J. 1995. Culture, Cognition and Education. *Perspectives on International Encyclopaedia of Education*.
- Jegede, O. 1995. Collateral learning and the eco-cultural paradigm in science and mathematics in Africa, *Studies in science education*. 25, 97-137.
- Jegede, O. 1996. Whose education, whose worldview, and whose framework:? An indigenous perspective on learning. A paper presented at the conference on "Pathways: Indigenous Education: Past, Present, Future," November. University of Southern Queensland, Toowoomba, Australia.
- Jegede, O. 1997. School science and the development of scientific culture: A review of contemporary science education in Africa. *International Journal of Science Education*, 19, 1-20.
- Jegede, O.J., and Aikenhead, G.S. (1999). Transcending cultural borders: Implications for Science teaching. *Journal for Science & Technology Education*, 17, 45-66.

- Jegede, O. J. and Okebukola, P.A.O. 1991. The Effect of Instruction on Socio-Cultural Beliefs Hindering the Learning of Science. *Journal of Research in Science Teaching* 28(3). 275-282.
- Kakonge, J. O. 1995. Traditional African Values and their use in Implementing Agenda 21. *Indigenous Knowledge and Development Monitor* 3(2) 14-15.
- Kannapol, P. J. and Deyoung, A. T. 1999. The Rural School Problem in 1999. A Review and Critique of The Interline. *Journal of Research in Rural Education*. 15, 57-79.
- Kawagley, O. 1995. A Yupiaq worldview. Prospect Heights, IL: Waveland Press
- Keeves, J.P. 1992. Learning Science in the changing world. Gross National Studies of Science Achievement. 1970-1984. I.E.A International Headquarters. Australia.
- Key S. 2009. Diversity in Science Education. Research Into Practice. SCIENCE. Pearson Scott Foresman.
- Kyle, W. C. Jn. 1989. Enhancing Learning Through Conceptual Teaching. Paper presented at 30th Annual Conference of STAN at Minna. pp 73.
- Lapointe, A.E 1992. Learning Science. International Assessment of Education Progress Report. No 22 – (AEP-02)
- Lawani, L.A. 2004. A casual model of Home and school factors as determinants of primary school pupils' Achievement in English Language and Mathematics. Thesis, University of Ibadan.
- Lee, O. 1997. Scientific literacy for all: What is it, and how can we achieve it? *Journal of Research in Science Teaching*, 34, 219-222.
- Lee, V., Bryk, A., and Smith, J. 1993. The Organization of Effective Secondary Schools. Review of Research in Education, 19, 171-267.
- Leonard, B. 2010. "Controversial Issues in Biology Education? You bet! Here Are Some." *The American Biology Teacher* 72 (7): 407.
- Leech, N.L, Barrett K.C. and Morgan G. A. 2011. IBM SPSS FOR INTERMEDIATE STATISTICS- Use and Interpretation. 4th Ed. Routledge Taylor & Francis Group. New York.
- Leonard, B. 2010. "Controversial Issues in Biology Education? You bet! Here Are Some." *The American Biology Teacher* 72 (7): 407.
- Levy - Bruhl, L and Clave L. A. 1992. *Primitive Mentality*. New York. The Macmillan Company.
- Linn, M. C., and Burbules, N. C. 1993. Construction of knowledge and group learning. In K. G.

- Tobin (Ed.), *The practice of constructivism in science education*, (pp. 91-119). Washington, DC: American Association for the Advancement of Science (AAAS) Press
- Lloyd, G. E. 1992. *Methods and Problems. The History of Ancient Science*. ISIS (4): 564-577.
- Lock, R. 1992. Gender and Practical skill Performance in Science. *Journal of Research in Science Teaching and Research in Science*. 3: 227 –241.
- Lowe, J.A. 1995. The impact of school science on the world-view of Solomon Island students Prospects, 15, 653-667.
- MacIvor, M. 1995. Redefining science education for Aboriginal students. In M. Battiste & J Barman (Eds.), *First Nations education in Canada: The circle unfolds*. Vancouver, Canada: University of British Columbia Press, pp. 73-98
- Macleen, C. M.1986. Hospitals or Healers. An Attitude Survey in Ibadan. *Human Organization* 25(2) 131-139.
- Maundu, P. 1995. Methodology for Collecting and Sharing Indigenous Knowledge: A Case Study. *Indigenous Knowledge and Development Monitor*. Vol 3.2.
- Medvitz, A.G. 1996. Science, schools and culture: The complexity of reform in science education. A paper presented to the 8th symposium of the International Organization for Science and Technology Education (IOSTE), Edmonton, Canada. pp. 15
- Mikkila-Erdmann, M. 2002. Science Learning Through Text: The effect of text design and text comprehension skills on conceptual change. In M. Limon & L. Mason (Eds.), "Reconsidering conceptual change: Issues in theory and practice" Dordrecht: Kluwer. 337-356.
- Minichiello, V., Aroni, R., Timewell, E., and Alexander, L. 1990. In-depth Interviewing: Researching people. Hong Kong: Longman Cheshire Pty Limited.
- Modo, J.V.O. 2002. *The Nigeria Child: His Education in Sociological and Psychological Environment*. Lagos , IVY Press Ltd.
- Moore, R. 1989. "What Versus How We Teach." *The American Biology Teacher* 51 (2). 86.
- Morrell, P.D., and Lederman, N.G. 1998. Students' Attitudes Toward School and Classroom Science: Are They Independent Phenomena? *School Science and Mathematics*, 98(2): 76-83.
- Mortimer, E. F.1995. Conceptual change or conceptual profile change? *Science and Education*, 4, 267-285.
- Movahedzadeh, F. 2011. Improving Students' Attitude Toward Science Through Blended Learning. *Science Education and Civil Engagement*
- National Science Foundation 2002. Science and Engineering Indicators. Arlington, VA

(NSB 02-01) [April]

- Ndukwu, P.N. 2002. School and teacher factors as determinants of classroom material resources utilization in pre-primary schools in Lagos State. Thesis, university of Ibadan.
- Neito, S. 1999. *The Light in Their Eyes: Creating Multicultural Learning Communities. Multicultural Education Series.* New York, NY: Teachers College Press. pp 48.
- Nelson-Barber, S. and Estrin, E.T. 1995. Culturally responsive mathematics and science education for Native students. San Francisco: Far West Laboratory for Education Research and Development.
- Niaz, M., Aguilera, D., Maza, A., and Liendo, G. 2002. Arguments, contradictions, resistances, and conceptual change in students' understanding of atomic structure. "*Science Education*," 86, 505-525
- Novak, J. D. and Mosunda, A. 1991. A Timeline Year Longitudinal Study of Science Concept Learning. *American Education Researcher Journal* 28, 1: 117-153,
- Nwala, T.U. 1997. Definitions, branches and aims of science in Nwala T.U. (ed.) *History and Philosophy of Science.* Niger Books and Publishing Co. Ltd. Nsukka, 1-6.
- Obe, E. O. 1984. Urban-Rural and Sex Differences in Scholastic Aptitude of Primary School Finalists in Lagos State. *In Education and Development. Lagos* 4 .1&2.
- Obemeata, J. O. 1984. The Effect of Urban-Rural Environment on Intelligence Test Performance. *The West African Journal of Education.*
- Odebode, S.O 2002. *Modern Trends in Agricultural Science Teaching. A title in teaching strategies for Nigeria Secondary Schools.* Ibadan power house Press Limited, 242 – 256.
- Odogwu, H. N. 2002. Female Students' Perception and attitude to Mathematics: A bane to their SMT Education. *The Journal of the Mathematical Association of Nigeria.* 27.1.
- Ogonnaya, U.P. 2011. Fostering the Understanding of Biological science concepts at the Senior Secondary School level using Collateral learning Strategy. *Journal of Science Teachers Association of Nigeria.* 52: 242-247.
- Ogundare, J. T.1990. The Effect of Gender and Achievement Tasks on Causal Attributions, *Ifè Journal of Theory and Research in Education* 2.2 : 17-25.
- Ogunbunmi, S. and Olaitan H. 1988. Elements of Physics in Yoruba Culture. *Journal of African, Philosophy and Studies* 1.1: 13-24.
- Ogunlola, B.O, 1995. *Agriculture in Primary Education Studies,* Ibadan. Emmanecil Publishers. 38-40.
- Ogunkola, B. J. 2002. Instructor expressiveness, Student locus of control and cognitive entry behaviour as measures of student achievement in and attitude towards Biology. Thesis. University of Ibadan.

- Ogunleye, A. O. 2007. Defining science from Multicultural and Universal Perspectives: A Review of Research and its Implications for science Education in African. *International Journal of Multicultural Education* Vol. 1. 1: 31-55.
- Ogunleye, B. O. 2002. Evaluation of the Environmental Aspect of the Senior Secondary School Chemistry Curriculum in Ibadan Nigeria. Thesis. Teacher Education, Education. University of Ibadan.
- Ogunniyi, M. B. 1996. Science, Technology and Mathematics: The problem of developing critical human capital in Africa. *Journal of Research in Science Teaching* 27, 661-669.
- Ogwu, S. 2006. Influence of Parental SES on Academic Performance of JSS students in Kano metropolis: Implication for educational planning and administration. Project. Bayero University, Kano.
- Ojedokun, O.E. 2006. Effects of Concept-Intergration and Two Life-Skill Methods on Secondary Schools Students Knowledge of, Attitude to, and Risk-Practices Related to HIV/AIDS. Thesis. Teacher Education, University of Ibadan.
- Ojo, O. A. and Bassey - Briggs 2000. A textbook for Midwives in the Tropics. 2nd ed. ELBS Low priced edition. Edward Arnold, Huddersfield & Stoughton, Kent TN 13 2xx
- Ojo, O. J. 2003. Relative Effects of Self-regulatory and Cooperative Learning Strategies on Learning Outcome in Secondary Physics. Thesis. University of Ibadan, Ibadan.
- Ojo, T.A. 2008. Impact of Video CD and Audiotape-based Instructions on Secondary School Students Learning Outcome in selected Environmental Education Topics in Biology. Thesis. University of Ibadan, Ibadan.
- Okafor, N. P. 1997. Effects of Cooperative Learning on Students Academic Achievement in Chemistry. Thesis. University of Ibadan, Ibadan.
- Okebukola, P. O. A. 2002. A review of the state of science in developing countries. *Science Education Review*. 46(6), 23-45.
- Okebukola, P. O. A. 1992. Can Good Concept Mappers be Good Problem Solver? *Science Education Psychology* 12, 2: 113-128.
- Okeke, A. U.G. and Njelita C. B. 2002. Cultural Beliefs and their implications to science Teaching/Learning in Secondary Schools in Anambra State. 43rd Annual Conference Proceeding of Science Teachers Association of Nigeria.
- Okpala, P. N. 1995. Science and Technology Education for all. In UNESCO, BREDA (Ed) report on the State of Education in Africa, Education Strategies, for the 1990. Orientations and Achievements. *UNESCO/BREDA Publications* 95-99.

- Okpala, P. N. and Onocha, C. O. 2002. Student Factors as Correlation of Achievement in Physics. *A Journal of British Institute of Physics*. 6: 261-265.
- Okpala, P.N. and Onocha, C.O. 1995. Difficulties in Students Performance of Hierarchical Cognitive Tasks. A function of Time to Learn. UNESCO Africa. (*A Six Monthly Journal of the Dakar UNESCO Regional Office*).
- O'Loughlin, M. 1992. Rethinking science education: Beyond Piagetian constructivism toward a sociocultural model of teaching and learning. *Journal of Research in Science Teaching*, 29, 791-820.
- Olagunju, A. M. 1998. The Impact of Two Curriculum Packages in Environmental Education in Biology on Learners Performance, Problem - Solving Abilities and Environmental Attitudes. Thesis. Teacher Education, Education. University of Ibadan, Ibadan.
- Olanrewaju, K. 2003. Wednesday April 30th WAEC Decries Woeful Performance in English, Maths etc. *The Comet (News)*.4
- Olatoye, R.A.2002: A Causal Model of School Factors as Determinants of Science Achievement in Lagos State secondary schools. Thesis. University of Ibadan, Ibadan.
- Oliver, J. S., Okpala, P. N. 1995. Science and Technology Education for all. In UNESCO, BRENDA (Ed) report on the State of Education in Africa, Education Strategies, for the 1990. Orientations and Achievements. *UNESCO/BRENDA Publications 95-99*.
- Simpson, R. D. 1988. Influences of Attitude Toward Science, Achievement, Motivation, and Science Self-concept on Achievement in Science: a Longitudinal Study. *Science Education*, 72(2), 143-155
- Olotu, B. 1992. The major causes of students underachievement in Agricultural Science. *Journal of Science Teachers Association of Nigeria*. 27 (2) 76 – 80
- Omosehin, M. F. 2004. Effects of A Training Programme in Cooperative Learning of Pre-Service Teachers Classroom Practice and Public's Learning Outcomes in Social Studies. Thesis. University of Ibadan.
- Onwu, G.O.M. 1981. Learning difficulties in Chemistry: Capacity limitation or strategy deficit. *African Journal of Educational Research* 4(1 & 2) 125.
- Onibokun, O.N. 1999. Evaluation of Social Studies. In Obemeta J.O. (Ed.). *Evaluation in Africa*. In Honour of E.A. Yoloje, pp 40-59.
- Orji, U. E 2004. Personal and School factors as determinants of students' perception of Teaching Effectiveness in Nigeria in Colleges of Education, Thesis. University of Ibadan.
- Osborne, J.F. 2001. Science Education for Contemporary Society. Problems, Issues and Dilemmas In O. Dejong, E. R. Science Bergy, A. Alblas

- (Eds). *Teaching for Scientific Literacy*, Utrech, The Masterland.
- Osokoya, M.M and Okpala, P. N. 1995. Science and Technology Education for all. In UNESCO, BREDA (Ed) report on the State of Education in Africa, Education Strategies, for the 1990. Orientations and Achievements. *UNESCO/BREDA Publications 95-99*.
- Akuche U.E. 2012. Effects of School Location on Students' Learning Outcomes in Practical Physics. Ife Psychologia. March. www.readperiodicals.com
- Oscamp, S.1977. Attitudes and Opinion. New Jersey. Prentice Hall Engle Wood.
- Padma Kumar V. 1998. Farmers' Reliance on Ethnoveterinary Practices to Cope with Common Cattle Ailments. *Indigenous Knowledge and Development Monitor*. 6(2): 14-15
- Osuafor, A.M. 2008. Extent of Involvement of Secondary School Science, Technology and Mathematics (STM) Teachers in Conduct of Research and Participation in Science Teachers Association of Nigeria (STAN)Activities: Implications for STM Development in Nigeria. *Journal of Science Teachers Association of Nigeria*. 43(1&2), 27-33
- Owoeye, J. S. 2000. The Effect of Interaction of Location, Facilities and Class Size on Academic Achievement of Secondary School Students in Ekiti State. Thesis. University of Ibadan.
- Owoeye, J.S Okpala, P. N. 1995. Science and Technology Education for all. In UNESCO, BREDA (Ed) report on the State of Education in Africa, Education Strategies, for the 1990. Orientations and Achievements. *UNESCO/BREDA Publications 95-99*.
- Pfundt, H., and Duit, R. 1991. Bibliography. *Students' alternative frameworks and science education* (3rd Ed.). Kiel, Germany:Institute for Science Education at the University of Kiel.
- Pomeroy, D. 1994. Science education and cultural diversity: Mapping the field. *Studies in Science Education*, 24, 49-73.
- Popoola, A. A. 2002. Effects of Heuristic Problem Solving and Programmed Instructional Strategy on Senior Secondary Students Learning Outcomes. Thesis. University of Ibadan.
- Posner, G. J., Strike, K. A., Hewson, P. W., and Gertzog, W. A.1982. Accommodation of a Scientific conception: Towards a theory of conceptual change. "*Science Education*," 66 (2), 211-227.
- Postlethwaite, T.N and Wiley, D.E. 1991: The I.E.A. study of science II. Science Achievement in Twenty-three Centuries. Oxford, Perganon Press.
- Punch, K.F. 1998. Introduction to Social Research: Quantitative and Qualitative Approaches. Thousand Oaks: Sage
- Raimi, S. A. and Adeoye, F. A. 2002. Gender Differences Among Students as Determinants of Performance in Integrated Science. *Paper Presented at the 1st*

- Rhea, A., and Otto, L. 2001. Mothers' influences on adolescents' educational outcome beliefs. *Journal of Adolescent Research*, 16(5),491-510.
- Reeves, E.B. 2005. The Effects of School Location on Math and Science Achievement Trends: A Primer on Growth Modeling in Education Policy Research. Paper presented at the 12th Annual International Learning Conference held at the University of Granada, Granada, Spain during July 2005. Occasional Research Paper, No. 11. Morehead State University
- Reeves, E. B., and Bylund, R. A. 2005. Are rural schools inferior to urban schools? A Multilevel Analysis of school accountability trends in Kentucky. *Rural Sociology*, 70, 360-386.
- Rokeach M. 1968. Beliefs, Attitudes and Values: A theory of Organization and Change. Jossey Bass. San-Francisco. pp 4.
- Rumberger, R. W. 1995. Dropping out of middle school: a multilevel analysis of students and schools, *American Educational Research Journal*, 32, 583–625.
- Saljo, R. 1995. Culture and Learning. *International Encyclopedia of Education. Vol. 3* 1248. Salta, K., & Tzougraki, C. 2004. Attitudes Toward Chemistry Among 11th Grade Students in High Schools in Greece. *Science Education*, 88, 535- 547.
- Science News 2012. Global Student Achievement in Math, Science and Reading Literacy: Results of 2011 TIMSS and PIRLS Assessments. Retrieved on 20/04/2013 from <http://www.sciencedaily.com/releases/2012/12/121211130434.htm>
- Scoboria, A., Mazzoni, G., Kirsch, I., and Jimenez S. 2006. The effects of prevalence and script information on plausibility belief and memory of autobiographical events. *Applied Cognitive Psychology*, 20(8), 1049-1064.
- Selden, R. 1990. Should test results be adjusted for socioeconomic differences? *School Administrator*, 47, 14–18.
- Shaughnessy J.J, Zechmeister E.B. and Zechmeister J.S. 2003. Research Methods in Psychology. Sixth Edition. McGraw
- Shymansky, J. A., Yore, L. D., and Anderson, J. O. 2000. A Study of Changes in Students' Science Attitudes, Awareness, and Achievement Across Three Years as a Function of the Level of Implementation of Interactive-Constructivist Teaching Strategies Promoted in a Local Systemic Reform Effort. (ERIC Document Reproduction Service No. ED 439 954)
- Siegel, M. A. and Ranney, M. A. 2003. Developing the Changes in Attitude about the Relevance of Science (CARS) Questionnaire and Assessing Two High School Science Classes. *Journal Of Research In Science Teaching*, 40(8), 757-775.

- Silva, M., Groeger, J., and Bradshaw, M. 2006.. Attention-memory interactions in scene perception. *Spatial Vision*, 19, 9-19.
- Sirin, S. R. 2005. Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, 75.3; 417-453.
- Sithole, M. P. 2005. Science versus indigenous knowledge: A conceptual accident. *Ingede: Journal of African Scholarship* 1 (1), 1-5.
- Soyibo, K. 1991. A Review of Empirical Research on Nigerian Students Achievement in Biology (1979-1988). *Journal of Science Teachers Association of Nigeria*. 27.1: 181-186.
- Snively, G and Corsighia J. 2000. Discovering Indigenous Science: Implications for Science Education. Paper presented at the National Association for Research in Science Teaching. San Diego, C A, April.
- Spindler, G. D 1983. *Education and Culture: Anthropological Approaches*. New York. Holt, Rinehart and Winston.
- Stephens, M. and Sandra, M. 2006. Gender and Students' Achievement in English Schools. London. Centre of Economics Education, London School of Economics.
- Strike, K.A. and Posner, G.J. 1985. A conceptual change view of learning and understanding. In L.H.T. West and A.L. Pines (Eds.), *Cognitive Structure and Conceptual Change*. New York: Academic Press. Sturtevant W. C. 1984. Studies in Ethnoscience. *American Anthropologist* 66(3) 99-131.
- Suping, S.M.2003. Conceptual Change among Students in Science. *ERIC Clearinghouse for Science Mathematics and Environmental Education*
- Swick, K. J. and Duff, E. 1978. The parent–teacher bond. relating, responding, rewarding, (Dubuque, IA, Kendall/Hunt).
- Teachman, J. D. 1987 Family background, educational resources and educational attainment, *American Sociological Review*, 52, 548–557.
- Tucker, C. M., Harris, Y. R., Brady, B. A., and Herman, K. C. 1996, The association of selected parent behaviors with the Academic achievement of African American children and Caucasian children. *Child Study Journal*, 26(4), 253-277.
- TIMSS 2012. Trends in International Mathematics and Science Study- 2011. Retrieved on 20/04/2013 from <http://timssandpirls.bc.edu/data-release-2011>
- Tobin, T.G. 1991. Construtivist perception on Teaching-Learning. *Paper presented at the Biennial Conference on Chemical Education*. Atlanta G.A.O.
- Udeani, U.2007. Teaching for the Understanding and Application of Science

Knowledge and Processes. *International Journal of Multicultural Education* Vol 1, No 1 pp 173-185.

- UNESCO 1990. Education for All by 2015? Retrieved on March 28, 2011 from www.unesco.org/education/efa/index.shtml
- UNESCO 2010. Factors associated with the cognitive achievement of students in Latin America and the Caribbean. Briefing Paper. Stefanie Block (Ed.) 1/2010.OREALC/2010/PI/H/11. Gráfica Funny. www.unesco.org/santiago
- Urevbu, A.1984. School science and Innovation:An African perspective .*Journal of Science Education*,6217-225.
- U.S. Food and Drug Administration 2002. General Principles of software validation; final Guidance for Industry and FDA staff. Retrieved on March 7, 2009 from <http://www.fda.gov/cdrh/comp/guidance/938.pdf>
- Useem, E. L. 1992. Middle schools and maths groups: parents' involvement in children's placement. *Sociology of Education*. 65,263–279.
- Von, S.C.2002. Effects of inquiry based teacher practices on science excellences and equity *Journal of Educational Research* 69 (1) 24-30.
- Vosniadou, S. 2002. On the nature of naive Physics. In M. Limon & L. Mason (Eds.). *Reconsidering conceptual change: Issues in theory and practice*. pp. 61-76. Dordrecht: Kluwer.
- Vygotsky, L. 1978. *Mind in Society. The Development of Higher Psychological Processes*. Harvard University Press. Cambridge, Massachusetts. 57
- Wasagu, M. A. 1999. The Relationship between Science Students' Cultural Beliefs and their Academic Achievement at the Senior Secondary School Level in Sokoto State. *Journal of Science Teachers Association of Nigeria* Vol 34 No. 1 and 2.
- Weinburgh, M. 1998. Gender, Ethnicity, and Grade Level as Predictors of Middle School Students' Attitudes Toward Science. Georgia State University. www.ed.psu.edu/CI/Journals/1998AETS/s5_1_weinburgh.rtf.
- Wenning, C.J. 2008. Dealing more effectively with alternative conceptions in science. *Journal of Physics Teacher Education*.Online,5(1), Summer.11-19.
- West, D. 2002. Assisting Performance . A case study from a primary science classroom. *Cambridge Journal of Education*. 32 (2) 165-183.
- West African Examination Council 2006. *The Chief Examiners Report*. WAEC Yaba Lagos.
- . 2003. *The Chief Examiners Report*. WAEC Yaba, Lagos.
- Whorf, B. L. 1989. *Language, thought and reality*. New York Dover Publications.

- Williams, P. 1980 Adolescent identification and academic achievement: reporting the awareness of similarity to role models, *Journal of Youth and Adolescence*, 9(4), 315–321.
- Yara P.O. 2011. School Location and Academic Achievement of Secondary School in Ekiti State, Nigeria. *Asian Social Science*. Vol 7, No 5
- Yoloye, E 1982. Science Education in the Nigerian Primary Schools. A need for radical approach. *Keynote address at the 25th Anniversary Conference of STAN*, Akure, August 23 .
- Young, D. J. 1995. Effect of the Science Learning Environment on Science Achievement: A Comparison of 12 Countries from the IEA Second International Study. *Educational Research and Evaluation*, 1 (2), 129- i 58 .
- Young, D. J. and Fraser, B. J. 1993. Socio-economic and Gender Effects on Science Achievement: An Australian Perspective. *School Effectiveness and School Improvement*, 4(4), 265-289
- Yusuf, M.O. 2007. Effects of Integrating Theory with Practical on Students' Performance In Chemistry. Dissertation. Institute of Education, University of Ibadan.
- Zhang Y., and Wildermuth B. M. 2010. Unstructured Interviews. www.hsmi.psu.ac.th. Retrieved 30th June 2013

APPENDIX 1A
BASIC SCIENCE COGNITIVE ACHIEVEMENT TEST (BSCAT)

Section A: Personal Data

- (i) Name of School..... (ii) Sex (Male/Female).....
(iii) Class:

Section B:

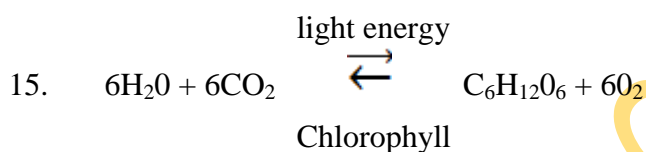
Time: 50 mins

Instruction: This test is to measure your level of understanding of some science concepts. Please choose the correct option from A- D. DO NOT WRITE ON THIS PAPER. Use the answer sheet provided. Attempt all Questions.

1. Any region where a force can be felt is referred to as (A) Force field (B) Force point (C) Force line (D) Force rays
2. Egg, fish, Soya and Beans (Cowpea) are examples of (A) Carbohydrates (B) Fats and Oils (C) Proteins (D) Vitamins.
3. Which of the following is NOT found in the plant cell? (A) Cytoplasm (B) Glycogen (C) Mitochondrion (D) Nucleus
4. In order to reduce friction between two surfaces, (A) oils and greases should be applied on the two surfaces (B) water should be applied on the two surfaces (C) petrol should be used in cleaning the surface very well (D) they must be made blunt.
5. The two atmospheric gases that react during lightning and thunderstorm are:
(A) Carbon (IV) Oxide and Oxygen (b) Oxygen and Nitrogen (C) Oxygen and Argon
(D) Carbon (IV) Oxide and Nitrogen.
6. For proper growth, plants and animals require the following EXCEPT (A) good nutrition (B) clean environment (C) normal functioning of organs (D) effective learning environment.
7. A body is at rest when all the forces acting on it are: (A) equal and in the same direction (B) equal and opposite (C) different and in the same direction (D) different and opposite.
8. The period of incubation in fowls is (A) 10 days (B) 14 days (C) 21 days (D) 28 days.
9. Plants can be grouped into (A) flowering and non-flowering (B) living and non-living

(C) herbivores and carnivores (D) male and female.

10. What is the name given to the force that opposes the motion of an object? (A) Contact (B) Frictional (C) Gravitational (D) Pull
11. The shape of the earth is (A) circular (B) conical (C) spherical (D) triangular.
12. Push, pull and tension are examples of (A) Contact forces (B) non-contact forces (C) balanced forces (D) unbalanced forces.
13. The organs of irritability (sensing stimulus) in animal is the (A) respiratory system (B) digestive system (C) reproductive system (D) nervous system.
14. The three major organs of excretion in living organisms include lung, (A) anus and skin (B) kidney and skin (C) kidney and nostrils (D) skin and mouth.



The above equation represents (A) Chemosynthesis (B) Respiration (C) Photosynthesis (D) Digestion .

16. The oxygen required by animals for respiration is often supplied through (A) radiation (B) photoperiodism (C) photosynthesis (D) transpiration
17. When a substance has equal number of positive and negative charges, it is said to be (A) non-charged (B) charge less (C) Neutral (D) well-charged.
18. The activities of the cell is controlled by the (A) cell membrane (B) chloroplast (C) cytoplasm (D) nucleus
19. If m = mass of an object (in kg)
 g = acceleration due to gravity (in metres per second square)
 h = height (in metres).

What is the formular for gravitational force (G_f) ?

$$A = mg/h \quad (b) \ mgh \quad (c) \ 1/mgh \quad (d) \ h/mg$$

20. Ade develops a protruded belly, thin limbs and big head. What type of disease does he have? (A) Marasmus (B) Kwashiorkor (C) Rickets (D) Beriberi.
21. The force field that acts on other bodies across a distance without contact is termed (A) Potential force (B) Centrifugal force (C) Gravitational force (D) Kinetic force.
22. When you blow a balloon and let it go, it moves upward because of (A) the force of air rushing out (B) heat in the balloon (C) earth's force of attraction (D) the light weight of air.
23. The planet in which human beings live is called (A) Earth (B) Venus (C) Saturn (D) Pluto.
24. Objects fall to the ground due to (A) potential force (B) centrifugal force (C) kinetic force (D) gravitational force.
25. Plants remove their waste products through structures called (A) roots and bark (B) stems and leaves (C) stomata and lenticels (D) lenticels and leaves.
26. A combination of food that provides the body all the nutrients it needs in the required amount is referred to as (A) ration formulation (B) balanced ration (C) good food (D) animal nutrients.
27. Which of these body chemicals is often secreted in the liver (A) Bile (B) Mucus (C) Rennin (D) Pepsin.
28. A person suffering from SCURVY should take a lot of (A) Beans (B) Cereals (C) Citrus fruits (D) Tubers.
29. Which of the following sentences does not show the characteristics of living things (A) An insect crawling on the wall. (B) A car moving on an express road. (C) A boy trekking to his school (D) A plant bending towards the source of light.
30. The force opposing a car moving on a rough road is (A) elastic (B) electrical (C) frictional (D) magnetic.
31. The unit of force is (A) Centimeter (B) Gram (C) Joule (D) Newton
32. Forces field refers to the following EXCEPT (A) frictional forces (B) gravitational forces

(C) magnetic forces (D) Electrical forces.

33. Living organisms that manufacture their own food are called (A) Heterotrophs (B) Omnivores (C) Autotrophs (D) Carnivores.

34. A person suffering from Diabetes will have in blood excess(A) Fat (B) Vitamins (C) Sugar (D) Protein

35. Electrical forces can be classified as (A) Balanced Forces (B) Non- contact forces (C) Unbalanced forces (D) Contact forces.

36. The two ends of a magnet are referred to as the (A) poles (B) points of attraction (C) points of repulsion (D) end points.

37. Yoghurt supplies which nutrients to the body? (A) Protein (B) Carbohydrate (C) Fats and Oils (D) Vitamins.

38. Babies can be protected from infection and diseases by keeping their environment clean and (A) playing with toys (B) allowing them to stay for long in the sun (C) taking balanced diet (D) bathing them with warm water.

39. Which of the following gases does not exist freely in air ? (A) Carbon (IV) Oxide (B) Hydrogen (C) Oxygen (D) Water vapour.

40. A feeling experienced when the weight or gravitational attraction is equal to the force necessary to keep the body moving freely is referred to as (A) Mass (B) Weightlessness (C) Gravitation (D) Centrifugal force.

APPENDIX 1B
BASIC SCIENCE COGNITIVE ACHIEVEMENT TEST (BSCAT)

ANSWER SHEET

Section A: Personal Data

(i) Name of School (ii) Sex (Male/Female)..... (iii) Class:.....

Section B: Time: 50 mins

Instruction: This test is to measure your level of understanding of some specific Agricultural Science concepts. Please choose the correct option from A- D.

QUE No	A	B	C	D	QUE No	A	B	C	D
1.					21.				
2.					22.				
3.					23.				
4.					24.				
5.					25.				
6.					26.				
7.					27.				
8.					28.				
9.					29.				
10.					30.				
11.					31.				
12.					32.				
13.					33.				
14.					34.				
15.					35.				
16.					36.				
17.					37.				
18.					38.				
19.					39.				
20.					40.				

APPENDIX 2A
ATTITUDE TOWARDS SCIENCE SCALE
(ATSS)

General Instruction:

This questionnaire is purely for an academic exercise designed to explore your attitude towards science. Please provide the information required in Sections A and B. Respond by ticking (✓) the appropriate column in Section B. Your right answer is what you truly feel about the statement.

DO NOT WRITE ON THIS PAPER. Use the answer sheet provided.

Section A (Personal Data):

(i) Name of School (ii) Sex (Male/Female).....

iii) Class:

Section B: Choose the option that best described your attitude in respect of the statement made.

Key to Section B: SA: Strongly Agree, **A:** Agree, **NS:** Not Sure, **D:** Disagree, **SD:** Strongly Disagree.

S/N	Statement	SA	A	NS	D	SD
1	I am sure that I can learn science.					
2	My teachers have been interested in my progress in science.					
3	Knowing science will help me earn a living.					
4	I don't think I could advance in science.					
5	Science will not be important to me in my life's work.					
6	Males are not naturally better than females in science.					
7	Getting a teacher to take me seriously in science is a problem.					
8	Science is hard for me.					
9	It's hard to believe a female could be a genius in science.					
10	I'll need science for my future work.					
11	When a woman has to solve a science problem, she should ask a man for help.					
12	I am sure of myself when I do science.					
13	I don't expect to use much science when I get out of school.					
14	I would talk to my science teachers about a career which uses mathematics.					
15	Girls can do just as well as boys in science.					
16	It's hard to get science teachers to respect me.					
17	Science is a worthwhile, necessary subject.					
18	I would have more faith in the answer to a science problem solved by a man than a woman.					
19	I'm not the type to do well in science.					
20	My teachers have encouraged me to study more science.					
21	Taking science is a waste of time					
22	I have a hard time getting teachers to talk seriously with me about science.					
23	Science has been my worst subject.					
24	Girls who enjoy studying science are a little strange.					
25	I think I could handle more difficult science.					
26	My teachers think advanced science will be a waste of time for me.					
27	I will use science in many ways as an adult.					
28	Females are as good as males in science.					

29	I see science as something I won't use very often when I get out of high school.					
30	I feel that science teachers ignore me when I try to talk about something serious.					
31	Girls certainly are smart enough to do well in science.					
32	I can handle most subjects, but I just can do well in science.					
33	I can get good grades in science.					
34	I'll need a good understanding of science for my future work.					
35	My teachers want me to take all the science I can.					
36	I would expect a woman scientist to be a forceful type of person.					
37	I know I can do well in science.					
38	Studying science is just as good for women as for men.					
39	Doing well in science is not important for my future.					
40	My teachers would not take me seriously if I told them I was interested in a career in science and mathematics.					
41	I am sure I could do advance work in science.					
42	Science is not important for my life.					
43	I am not good in science.					
44	I study science because I know how useful it is.					
45	Science teachers have made me feel I have the ability to go on in science.					
46	I would trust a female just as much as I would trust a male to solve important science problems.					
47	My teachers think I'm the kind of person who could do well in science.					

APPENDIX 2B
ANSWER SHEET FOR ATTITUDE TOWARDS SCIENCE SCALE
(ATSS)

General Instruction:

This questionnaire is purely for an academic exercise designed to explore your attitude towards science. Please provide the information required in Sections A and B. Respond by ticking (√) the appropriate column in Section B in this sheet after reading from the ATSS (Questionnaire) provided. Your right answer is what you truly feel about the statement.

Section A (Personal Data):

(i) Name of School (ii) Sex (Male/Female).....
 iii) Class:

Section B: Choose the option that best described your attitude in respect of the statement made.

Key to Section B: SA: Strongly Agree, A: Agree, NS: Not Sure, D: Disagree, SD: Strongly Disagree.

S/N	Strongly Agree (SA)	Agree (A)	Not Sure (NS)	Disagree (D)	Strongly Disagree (SD)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					

UNIVERSITY OF IBADAN

APPENDIX 3A
CONCEPTION OF SCIENTIFIC PHENOMENA ASSESSMENT SHEET
(CSPAS)

Instruction: This test is designed to assess your views about some natural phenomena. Please indicate your honest view by choosing one option reflecting your view from options A - E.

SECTION A

Name of Student:

Name of School:

Class:

SECTION B

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 (E) no idea.

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 the result of anger by Sango .

(D) It is a violent sound caused by rainmakers. (E) No idea .

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) unknown spiritual force. (D) the pull of heavy object by the earth. (E) No idea.

4. Which of the following causes lightning during rainfall? (A) Spells by rain makers (B) Sudden exposure of sparking heavenly bodies (C) Divine signals from Sango, the god of thunder. (D) Sparks from electrically charged cloud. (E) No idea.

5. Which of the following statements is most true of a boy who resembles his dead father? (A) The father has come back to the world as Babatunde (B) Transmission of characters in genes from parents to offspring (C) Embryonic photograph by the spirits (D) The work of god of creation (E) I can't explain it.

6. Before getting married, the man and woman must (A) consult pastors/alfas/local diviner (B) carry out genotype test (C) consider the tribe from which they come (D) just marry and put their trust in God (E) I don't know.

7. When seeds of sweet orange is planted and it bears the fruits of tangelo, it means (A) the orange is not a good specie. (B) the type of soil affected the orange. (C) the evil spirits are at work. (D) the new plant is a hybrid of sweet orange and tangerine. (E) it is impossible.
8. Which of the following is most true about the death of an individual through lightning shock? (A) It is the result of anger by Sango. (B) The person must have committed a crime such as stealing. (C) It is a result of the passage electric charge through the person's body. (D) His enemies are responsible. (E) I cannot explain the death.
9. Cholera outbreak can be caused by ... (A) contamination of water or food by microbes (B) attack by the spirits (C) the act of God (D) poor diets among the people (E) anything.
10. When a girl falls down from the back of her mother (A) she would experience the death of seven husbands in her adult. (B) she must be taken to a doctor who would treat her (C) the mother must make some sacrifice to the spirits (D) it is the work of the devil (E) nothing about it can be explained.
11. Which of the following should be done in preventing the spread of epidemic disease? (A) Isolation of victims (B) Appropriate sanitation of contaminated materials should be carried out. (C) Appropriate sacrifice/atonement to gods should be carried out. (D) Vaccination of uninfected people should be carried out. (E) I do not know.
12. Which of the following is true of leprosy? (A) It is caused by *Irunmolẹ* (spirits of the forest). (B) It is a bacterial disease. (C) It is a sickness sent by Almighty God. (D) It is caused by *Asaasi* (Charm) from wicked people. (E) No idea.
13. The factor that is responsible for offspring resembling their parents is (A) the blood of the parents. (B) the pair of genes of the parents (C) ancestral gods of the parents. (D) nature of the womb (E) I do not know.
14. Which of the following 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 is a result of special concoction (*Ájẹsára*) prepared by native doctors. (D) All of the above. (E) I can't explain the reason.
15. How can weather condition be predicted? (A) Use of natural foresights (B) Use of pure scientific instruments (C) Use of enquiries from spirit governing the earth. (D) All of the above. (E) I have no idea about it.

16. A woman gave birth to an albino because ...(A) she must have walked outside around noon (12 noon -1pm). (B) she must have stayed outside around midnight. (C) Any of A or B. (D) somebody must have been an albino before in her family or her husband's family. (E) God wants it that way.

17. Fertilization takes place inside the body of woman when ...(A) her egg successfully fuses with the spermatozoon of a man (B) her blood has mixed with the blood of a man (C) the spirit of a previously dead person has gone into her womb for re-birth. (D) God has implanted a new child insider her. (E) only God knows what happened.

18. When a pregnant woman eats snail, (A) her child will salivate profusely. (B) she has made the gods angry. (C) she has committed abomination. (D) she will obtain protein and minerals from the meat of the snail. (E) I do not know.

19. A male child that falls down from the back of mother.... (A) must be treated with local medicine but her mother will marry seven times before the husband survives (B) must be treated with local medicine and taken to native doctor for appeasement of the gods (C) must not be treated immediately but taken to the local native doctor's for divination on what is prescribed by the spirits (D) must be treated by a doctor but nothing will happen to the mother (E) only God knows what will happen.

20. The barking of a dog when nobody is present is because (A) of the presence of some spirits. (B) it is being attacked by unseen forces. (C) it is a natural behaviour. (D) it is scaring away evil. (E) I don't really know why.

APPENDIX 3B
ANSWER SHEET FOR CONCEPTION OF SCIENTIFIC PHENOMENA ASSESSMENT SHEET (CSPAS)

Instruction: This test is designed to assess your views about some natural phenomena. Please fill in the space in Section A and indicate your honest view by choosing one option reflecting your view from options A – E in Section B.

SECTION A:

Name of Student:

Name of School:Class:

QUE. No.	A	B	C	D	E
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

APPENDIX 4A
TEACHERS' INSTRUCTIONAL GUIDE FOR ETHNOSCIENCE (TIGE)

WEEK 1

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Environmental Conservation and Safety

SUB-TOPIC: Personal Cleanliness

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to :

- 1.define personal cleanliness;
- 2.describe the methods of keeping their bodies and home clean;
3. list 5 advantages of personal cleanliness;
4. explain the consequences of poor hygiene.

PREVIOUS KNOWLEDGE: Students take care of their bodies through regular bath and brushing of their teeth and are aware of people falling sick from dirty environment.

INSTRUCTIONAL MATERIALS: Toiletries, Cleaning agents, Local scrub (*kainkain -yoruba*), Charts showing a near naked child holding money with his teeth with an arrow pointing at the child with multiple teeth presentation and Posters.

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008 Basic Science for Junior Secondary School 2
(UBE Edition). Longman Nigeria Plc

STAN Nigerian Basic Science Project. Pupils' Textbook One.2007. HEBN Publishers Plc
pp.44-50

PERIODS 1 and 2

PRESENTATION:

STEP 1: Teacher introduces the topic and guides the learner to define personal cleanliness.

STEP 2: Teacher introduces related local cultural beliefs such as:

- (i) the belief that sweeping of the house in the night gradually sweeps away the persons wealth (ED 020).
- (ii) the belief that sneezing intermittently means that someone is discussing about the sneezing person somewhere (ED 027)

(iii) the belief that If the mouth is used in holding money (coins or paper notes),the person will develop multiple teeth presentation (ED 052)

(iv) the belief that if you use the same broom to sweep both inside and outside parts of a house, the fortune of the house is being swept off.(ED 059).

STEP 3: The students are asked by the teacher to enumerate more of such local beliefs that are related to personal hygiene.

STEP 4: Teacher leads discussion on at least five methods of keeping bodies and homes clean and maintenance of personal cleanliness

EVALUATION: Students asked to:

1. Define personal hygiene.
2. List 3 methods of keeping their bodies and homes clean.
3. Name six cleaning agents
4. State four consequence of poor hygiene.

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to explain what personal hygiene means and enumerate methods used in maintaining personal hygiene and to mention some cleaning agents..

STEP 2: Teacher guides the learners to identify five advantages of personal cleanliness and five disadvantages of poor hygiene.

STEP 3: Teacher recalls and asks learners to compare local belief in respect of ED 020 and scientific concept being learnt and classify the local belief into one of the three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly to explain why they need to maintain personal hygiene.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT: Explain the following terms:

1a. Personal hygiene

b. cleaning agents

2. Mention 5 effects of poor sanitary condition on human health.

UNIVERSITY OF IBADAN

WEEK 2

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Nutrition

SUB-TOPIC: Types and Classification of Food

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to :

1. identify food types;
2. group food into classes based on nutrient content;
3. explain the meaning of adequate diet;
4. plan an adequate diet for a home.

PREVIOUS KNOWLEDGE: Students have been taught classification of food at the lower classes.

INSTRUCTIONAL MATERIALS: Local food items Amala, Gari etc., Charts and Posters.

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008 Basic Science for Junior Secondary School 2(UBE Edition).

Longman Nigeria Plc

PERIODS 1 and 2

PRESENTATION

STEP 1: Teacher leads students to identify food types, food nutrients and classes.

STEP 2: Teacher introduces related local cultural beliefs such as:

- (i) belief that if a pregnant woman eats snail, the new child will be producing too much saliva or salivate in excess (ED 014)
- (ii) the belief that if a person eats the cloacae of a fowl, the person would become a gossip.(ED 083)

STEP 3: The students are asked by the teacher to enumerate more of such local beliefs that relate to food types and food nutrients.

STEP 4: Teacher guides students to group food into classes based on nutrient content.

EVALUATION: Students asked to:

1. identify four food types

2. mention four different food items and classify them based on nutrient content

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to mention and classify common food items that are available in their environment. Students interact with the different food items they have been asked to bring to the class and group them into nutrient classes.

STEP 2: Teacher then guides the learners in class discussion on adequate diet and planning an adequate diet at home. They are then grouped into a convenient number and each group is to prepare an adequate diet for a home.

STEP 3: Teacher recalls and asks learners to compare local belief with respect to ED 027 and scientific concept being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly to suggest local food combination that would meet their nutritional requirements

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT: Explain the following terms:

1a. Nutrient

b. Adequate diet

Week 3

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Nutrient Cycles

SUB-TOPIC: Water, Carbon and Nitrogen cycles

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to:

1. draw and explain Water cycle;
2. draw and explain Carbon cycle;
3. draw and explain Nitrogen cycle.

PREVIOUS KNOWLEDGE: Students have been taught elements in classes of food and plant nutrients.

INSTRUCTIONAL MATERIALS: Charts and Posters

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008 Basic Science for Junior Secondary School 2(UBE Edition).

Longman Nigeria Plc

PERIODS 1 and 2

PRESENTATION

STEP 1: Teacher leads students to explain what cycles are.

STEP 2: Teacher introduces related local cultural beliefs such as:

- (i) the belief that when it rains and the sun shines simultaneously a tiger is in the process of parturition {giving birth} (ED 001)
- (ii) the belief that extending ones arms into the rain with fingers spread while staying under the roof or children who attempt to collect falling raindrops in their hands are exposed to death from lightning and thunderbolt and or may develop hand tremor in their adult. (ED 003)
- (iii) the belief that very intense sunlight during the rainy season indicates that it is about to rain (ED 009)
- (iv) the belief that the appearance of rainbow indicates the presence of gold where the rainbow touches the earth (ED 015)

STEP 3: Learners mention other related local cultural beliefs

STEP 4: Teacher then discusses and uses charts to illustrate the Water and Carbon cycles.

EVALUATION: Students asked to:

1. mention four ways by which water is lost from the atmosphere.
2. mention ways by which carbon comes into the atmosphere.

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to mention some of the ways water comes into the atmosphere some ways in which carbon is added to the atmosphere. Students also interact with the different charts and Teacher then discusses and uses charts to illustrate Nitrogen cycle.

STEP 3: Teacher asks learners to compare local beliefs (ED 003, ED 009, and ED 015) and scientific concepts being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly to mention ways by which Nitrogen is lost and added to the atmosphere.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT: Draw and label fully the following natural cycles:

- a. Nitrogen cycle
- b. Carbon cycle and
- c. Water cycle

Week 4

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Matter

SUB-TOPIC: Meaning, Identification, Classification and State of matter.

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to :

1. recognize that all living and non-living things are made up of matter
2. recognize things in our surroundings as matter;
3. list the three states of matter

PREVIOUS KNOWLEDGE: Students can differentiate between Solids, Liquids and Gases.

INSTRUCTIONAL MATERIALS: Nature materials, Local pots, Balloons, ice-block, water and steaming water.

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008. Basic Science for Junior Secondary School 2(UBE Edition).

Longman Nigeria Plc

STAN Nigerian Basic Science Project. Pupils' Textbook One. HEBN Publishers Plc pp.27-35

PERIODS 1 and 2

PRESENTATION

STEP 1: Teacher leads students to explain the meaning of matter.

STEP 2: Teacher introduces related local cultural beliefs such as:

- (i) the belief that very intense sunlight during the rainy season brings rainfall (ED 009)
- (ii) the belief that if a pregnant woman does not fill her container of water from the river. She would give birth to a child with stricken eyes or one eye lost (ED 046)

STEP 3: Students are taken on nature walk to collect different samples of matter.

STEP 4: Students observe the collected specimens and group them by shape, colour and size and participate in class discussion

STEP 5: Students list other related local beliefs.

EVALUATION: Students are randomly asked to:

1. define the term 'Matter'

2. march some of the materials they collected based on shape, colour and size .

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to group a list of ten items each based on shape, colour and size.

STEP 2: Teacher guides the discussion on the three states of matter.

STEP 3: Teacher asks learners to compare local beliefs (ED 009 and ED 046) and scientific concepts being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly to classify items such as stone, milk, wood, sprayed perfume etc into Solids, Liquids and Gases.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT: Mention two differences between Solids, Liquids and Gases.

Week 5

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Living Things

SUB-TOPIC: Introduction and Characteristics of Living Things

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to:

1. collect and identify samples of plants and animals in their environment
2. list the distinguishing characteristics of plants and animals.
3. state the importance of plants and animal to human beings
4. prepare a plant album.
5. Identify self as a living thing

PREVIOUS KNOWLEDGE: Students are familiar with and interact with plants and animals.

INSTRUCTIONAL MATERIALS: Plant and animal specimens, Old Newspapers, Charts and Posters

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008. Basic Science for Junior Secondary School 2(UBE Edition).

Longman Nigeria Plc Page

STAN Nigerian Basic Science Project. Pupils' Textbook One. HEBN Publishers Plc pp.100-118

PERIODS 1 and 2

PRESENTATION

STEP 1: Teacher introduces the concept briefly after randomly asking the learners what they understand by the term living things.

STEP 2: Teacher introduces related local cultural beliefs such as:

- (i) the belief that if a wife serves the husband with soup or stew that is still being cooked , the husband will suddenly die or becomes impotent(ED 010).
- (ii) the belief that if a hen sits on its eggs for twenty one days, the eggs will hatch to become chicks but the bad eggs will not become chicks (ED 067)
- (iii) the belief that if a hunter sees two mating animals in the bush, he should not kill them otherwise his wife would die (ED 068).

STEP 3: Teacher guides class discussion on the differences between plants and animals and their characteristics.

STEP 4: Students collect plant and animal samples.

STEP 5: Students participate in class discussion and lists other related local beliefs.

STEP 6: Students observe the collections and identify distinguishing characteristics of plants and animals.

EVALUATION: Students are randomly asked to:

1. give examples of plants and animals;
2. state differences between plants and animals;

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to explain what living things are.

STEP 2: Teacher guides the discussion on the importance and uses of plants and animals.

STEP 3: students are guided by the teacher to identify themselves as living things.

STEP 4: Teacher asks learners to compare local beliefs (ED 010, ED 067 and ED 068) and scientific concepts being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly to sort out their collections into plants and animals groups.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT:

1. Press and dry ten collected plant materials and prepare a plant album.
2. List five characteristics of living things.

Week 6

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Man in Space

SUB-TOPIC: Gravitation and Weightlessness

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to:

1. explain the meaning of gravitation and weightlessness
2. State the effects of gravitation on objects.

PREVIOUS KNOWLEDGE: Students are familiar with floating balloons and objects falling when thrown up.

INSTRUCTIONAL MATERIALS: Scale balance and various objects such as balloons, metals, wood etc.

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008. Basic Science for Junior Secondary School 2(UBE Edition). Longman Nigeria Plc Page

STAN Nigerian Basic Science Project. Pupils' Textbook One. HEBN Publishers Plc pp.131-136

PERIODS 1 and 2

PRESENTATION

STEP 1: Teacher gives a brief introduction of the subject matter after randomly asking the learners what happens to blown balloons, plastic, wood etc. when thrown up.

STEP 2: Teacher introduces related local cultural beliefs such as:

(i) the belief that when faeces of a bird falls on somebody, it is an indication of good luck (ED 035)

(ii) the belief that if a child falls down from the back of the mother and he or she grows into adulthood, the female will marry seven times before the spouse survives while the male will marry nine times before the spouse survives meaning he would witness the death of eight wives (ED 040)

(iii) Whatever (Lala {Yoruba}) goes up will eventually come down.(ED 080)

STEP 3: Teacher defines and explains the concept of gravitation and weightlessness.

STEP 4: Students participate in class discussion and lists other related local beliefs.

STEP 5: Students carry out demonstrations on gravitation and weightlessness by blowing and throwing balloons and weighing themselves and recording their individual weights..

EVALUATION: Students are randomly asked to:

1. define gravitational pull
2. describe the effect of gravitation on: stone, feather, book

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to explain what gravitation means and what is its effects on feathers, nylons etc.

STEP 2: Teacher guides the discussion on the effect of gravitation and discusses weightless beyond the earth.

STEP 3: Students are allowed to discuss the reasons for weightlessness guided by the teacher.

STEP 4: Teacher recalls and asks learners to compare local beliefs (ED 035, ED 040 and ED 080) and scientific concepts being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly to sort out their collections into plants and animals groups.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT:

State where a person is likely to experience weightlessness.

Week 7

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Forces

SUB-TOPIC: Introduction, Feeling forces and Types of Forces

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to:

1. explain the concept of force.
2. identify contact and non-contact forces.

PREVIOUS KNOWLEDGE: Students are familiar with pulling and pushing objects and have used or seen catapults been used before.

INSTRUCTIONAL MATERIALS: Fixed door, Spring, Rubber band, Local catapult and Charts showing contact and non-contact forces, Objects of known mass, Metre- rule, Newton-rule, Knife edge, slotted weights, Toy car, cardboard papers and rough surface.

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008. Basic Science for Junior Secondary School 2(UBE Edition).

Longman Nigeria Plc

STAN Nigerian Basic Science Project. Pupils' Textbook One. HEBN Publishers Plc pp.153-160

PERIODS 1 and 2

PRESENTATION

STEP 1: Teacher asks the learners whether they have used catapults before and randomly select two or more students to explain its operation and use.

STEP 2: Teacher gives a brief introduction of the subject matter and gives specific examples reflecting the concept of forces

STEP 3: Teacher introduces related local cultural beliefs such as:

(i) the belief that knocking one's leg on the stone or stump unintentionally when trekking indicates that the host in your destination would be absent or your mission would not be accomplished if it is the left leg. The host would be around or your mission would be accomplished if it is the right leg. (ED 006)

(ii) the belief that if there is nothing on a pepper grinding stone and one grinds the two surfaces together, the person's mother would die.(ED 058)

(iii) the belief that if one sings when pounding boiled yam in a mortar to produce pounded yam, the yam pieces will end up not being properly pounded. (ED 095)

STEP 4: Students participate in class discussion and list other related local beliefs

STEP 5: Teacher elaborates more on the subject matter while learners push and pull, squeeze, bend and stretch objects and interact with charts showing contact and non-contact forces. They are grouped into two with a rope to perform the pull and push game.

EVALUATION: Students are randomly asked to:

1. explain the concept of force
2. name two contact and two non-contact forces

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to explain the term "Force" and differentiate between contact and non-contact forces.

STEP 2: Teacher explains gravitational force of attraction and how to calculate it using the formula $G_f = mgh$ and emphasizes the importance of units.

STEP 3: Students carry out class activities involving the calculation of G_f based on the questions given by the teacher.

STEP 4: Teacher recalls and asks learners to compare local beliefs (ED 006, ED 058 and ED 091) and scientific concepts being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT:

State the 2 differences between magnetic and gravitational forces.

WEEK 8

CLASS: JSS 1

SUBJECT: Basic Science

TOPIC: Friction

SUB-TOPIC: Meaning, Uses, Advantages and Disadvantages of friction.

PERIODS: 1st, 2nd and 3rd

DURATION: 40 minutes per period

INSTRUCTIONAL OBJECTIVES: At the end of the lesson, students should be able to :

1. Explain friction
2. Mention 2 uses of friction
3. Mention 2 advantages of friction
4. Mention 2 disadvantages of friction

PREVIOUS KNOWLEDGE: Students are familiar with the meaning and type of forces

INSTRUCTIONAL MATERIALS: Fixed door, Spring, Rubber band, Local catapult and Charts showing contact and non-contact,

Objects of known mass, Metre- rule, Newton-rule, Knife edge, slotted weights, Toy car, cardboard papers and rough surface.

REFERENCE BOOK:

Ndu F.O.C. & Somoye, E.O. 2008 Basic Science for Junior Secondary School 2(UBE Edition).

Longman Nigeria Plc

STAN Nigerian Basic Science Project. Pupils' Textbook One. 2007. HEBN Publishers

Plc pp.153-160

PERIODS 1 and 2

PRESENTATION:

STEP 1: Teacher randomly asks students questions such as:

Why is it that when one pushes an object it eventually slows down and stops?

What is the difference in the force required to pull an object with a string when it is placed on a glass and when it is placed on book?

STEP 2: Teacher introduces the concept of friction and illustrates frictional force between objects through the glass and wood example referred to.

STEP 3: Students engage in class activities involving frictional force between objects, noting advantages and disadvantages of friction.

EVALUATION: Students asked to:

1. explain what happens an arrow is thrown horizontally at an empty space.

PERIOD 3

PRESENTATION:

STEP 1: Students are randomly selected by the teacher to explain with examples why friction is important in day to day activities of man.

STEP 2: Teacher guides the discussion by the students on the advantages and disadvantages of friction.

STEP 3: Teacher recalls and asks learners to compare local beliefs (ED 006, ED 058 and ED 091) and scientific concepts being learnt and classify the local beliefs into three groups with respect to scientific concepts: compatible, modifiable and contradictory and are asked to explain likely reasons for the differences.

EVALUATION: Students are asked randomly mention the advantages and disadvantages of friction.

CONCLUSION: Teacher summarizes class discussion on the chalk board and the learners write down the chalk board summary.

ASSIGNMENT:

Give four examples of friction in your daily activities.