EFFECT OF SCIENCE PROCESS TEACHING APPROACH ON PRIMARY SCHOOL PUPILS' ACHIEVEMENT IN BASIC SCIENCE AND TECHNOLOGY IN KATSINA STATE, NIGERIA

BY

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DECLARATION

I hereby declare that this thesis titled **'Effects of Science Process Teaching Approach on Primary School Pupils' Achievement in Basic Science and Technology** has been written by me. It is absolutely a true record of my research work which has not been presented in any previous work before for a higher degree or published in a book. In the course of writing this thesis, various sources of information had been consulted and these had been fully acknowledged by means of references.

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Ibrahim Abubakar **Date**

DEDICATION

This research work is dedicated to my late father Alhaji Ibrahim Dan-Adahama may his gentle soul rest in perfect peace amin and my mother Hajiya Hauwa'u, my sons, daughters, and my two wives,

CERTIFICATION

This thesis title **"Effects of Science Process Teaching Approach on Primary School Pupils' Achievement in Basic Science and Technology"** by Abubakar Ibrahim meets the regulations governing the award of Master Degree in Education (M.Ed Science Education) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

This study was carried out to determine the effects of science process teaching approach on primary school pupils' academic achievement. The study sample consisted of two classes of different primary schools, one experimental with 88 pupils and the other one as control had 164 pupils. A random sampling technique using balloting method was used in selecting the two schools out of 31 public primary schools in Katsina metropolis, with a total population of 57,402 pupils in the metropolis. A pretest-posttest quasi-experimental design was used. The instrument used was Basic Science and Technology Achievement Test (BSTAT) which was validated and with reliability coefficient of $r = 0.75$. The hypotheses stated were tested using t-test statistics at $P \leq 0.05$ level of significance. Major findings of the study revealed that there is significant difference in the academic achievement among primary school pupils exposed to science process teaching approach and those exposed to conventional teaching method in favour of experimental group. There is also significant difference in the academic achievement of male pupils exposed to science process teaching approach and female pupils exposed to the same treatment in favour of the male pupils. In light of the findings from this study, the following recommendations were offered. Government concerned with the responsibilities of managing the affairs of primary schools should design special training programs for basic science and technology teachers so as to keep them abreast with the current development in methodology of teaching and new innovations that are being invented by educational researchers among others.

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LIST OF ABBREVIATIONS

AAAS - American Association for the Advancement of Science

ANOVA - Analysis of Variance

BSTAT - Basic Science and Technology Achievement Test

F.C.E. - Federal College of Education

NERDC - National Educational Research and Development Council

NOUN - National Open University of Nigeria

NTI - National Teachers' Institute

PPMCC - Pearson-Product-Moment Correlation Coefficient

SAPA - Science-A Process Approach

SPS - Science Process Skills

SPSS - Statistical Package for Social Science

STAN - Science Teachers Association of Nigeria

SSS - Senior Secondary School

USSR - Union of Soviet Socialist Republics

CHAPTER ONE

THE PROBLEM

1.1. Introduction

Science education has been recognized as vital because of the rapid pace of technological change and globalization of the economy which resulted in the need for individuals to have a broad scientific knowledge. On the other hand, the ever growing importance of scientific issues in our daily lives demands a populace who has sufficient knowledge and understanding to follow science and scientific debates with interest, and to engage with the issues science and technology poses, both for them individually, and for our society as a whole (Millar and Osborne, 1998).

Science education is an indispensable tool for national development because of the important position it occupies in the development and growth of all nation. Odunisi (2001) observed that the economic and political strength of a nation is always assessed in terms of her achievement in science and technology. This may be the reason why emphasis is placed on the provision of science education at all level of education in Nigeria.

The emphasis placed on science and technology along side with the important role it plays towards national development makes it pertinent and practically necessary for science to be taught in an organised and well structured pattern, involving activities for both teachers and students. This will undoubtedly make learning more interesting and meaningful.

In contrary, before the mid 1950s science teaching was geared towards memorization and regurgitation of scientific knowledge. Akinmade (1996) observed that most elementary science teachers spend most of their time in the class teaching for memory and comprehension as opposed to teaching for the development of

productive thinking skills. This attitude of teacher centered teaching method continued until when the then Soviet Union launched its first satellite (the sputnik) into space in 1957. This event necessitates a call for a reform in both the curriculum content and method of teaching across the globe.

Several curriculum materials were developed and implemented to reflect this need. This include among others, the Physical Science Study Committee (PSSC), Science – A process Approach (SAPA) e.t.c. In these programs, emphasis was shifted from the acquisition of academic knowledge in science through memorization of fact, to quantitative and applied aspect of science.

In Nigeria, curriculum changes were stimulated by individuals, professional bodies and institutions who called for changes in Nigeria educational system to reflect peculiar circumstances and what the nation required of an individual that is useful to his community. Such institutions and professional bodies according to Danladi (2003) include the Science Teachers Association of Nigeria (STAN) who developed the Nigeria Integrated Science Project. The Comparative Education Study and Adaptation Center (CESAC) now NERDC who developed the Nigeria Secondary School Science Project (NSSP), and the Primary Education Improvement Program of the then Northern Nigeria in collaboration with Ahmadu Bello University, Zaria.

Emphasis in these curriculum materials was placed on learning science through the process of science. This could be achieved through hands-on activity based teaching method which emphasize the acquisition of science skills at the expense of science concept. This is in line with Awodi in Mari (1994) who opined that teachers cannot teach science effectively without employing the process of science, neither can students learn science effectively without employing process of science.

Science is probably more difficult to define than we often imagine. Science is both content and methodology. While some see science as an objective investigation of empirical phenomena, others see it as a body of knowledge. But broadly speaking, science is a distinct methodology (Frankfort-Nachmias and Nachmias, 1996).

Science according to Ogunniyi (1986) is a field of study that is concerned with producing a scientifically literate society. It is an organized body of knowledge. It is a search for meaning or explanation of events in nature. Also Ogunniyi (1986) defined science in terms of methods or processes, that is, what scientists can do; or in term of its product, that is, knowledge in the form of facts, principles, concepts, attributes, laws and theories. Urevbu (1990) defined science as a body of knowledge which has been acquired through experimentation.

Science is a tool for achieving technological ends, solving human problems through tentative hypotheses. Science is research; it is an active pursuit of empirical knowledge based on scientific method. It is also an interconnected series of concepts and conceptual schemes that have developed and is developing as a result of experimentation and observations and are fruitful for further experimentation and observation (Conant, 1951 and Urevbu 1990). Shaibu (1992) also saw science as a human complex activity that leads to production of a body of universal statements called laws, theories or hypotheses which serve to explain the observable behavior of the universe or some aspect of the universe. Science is a mode of thinking, a methodology, says (Frankfort-Nachmias and Nachmias, 1996). Science can also be seen as a process of investigation, which requires special skills called "science process skills." This is needed in order to achieve the objectives of teaching science

at the primary school level as stipulated in the National Policy on Education (FME, 2004).

The National Policy on Education (FME, 2004) stated that Primary Education is the key to success or failure of the educational system, since the rest of the educational system is built upon it. Some of the goals of primary education in the policy are to lay a sound basis for scientific and reflective thinking and give the child opportunities for developing manipulative skills and positive attitude that will enable her to function effectively in the society within the limits of her capacity. This may not be realized if primary science teaching is not given proper consideration such as giving the children the opportunity to experience the learning of science. The National Policy on Education (FME, 2004), stated that, Science Education shall emphasize the teaching and learning of process and principles of science through the following goals:

- cultivate inquiring, knowing and rational mind for the conduct of good life and democracy;
- produce scientists for national development;
- service studies in technology and the cause of technological development; and
- provide knowledge and understanding of the complexity of the physical world, the forms and the conduct of life.

According to Uyoata (2006) early exposure of primary school pupils to science would lay a solid foundation for scientific literacy and learning of science at the higher level of education. It is in line with these goals that Cirfat and Zumyi (2007) stressed that improving science education has to start at the grassroots. Thus, the

philosophy ‘catch them young’ for science. The success or failure in primary science would more or less determine the success or failure of science education of a nation (Leghara and Okafor 2006). Stanley (2007) observed that the purpose of science teaching is to make pupils learn or understand what they are taught. In this direction, Nwoji (2007), pointed out that for the Nigerian child to understand science concepts, the science curriculum must be part of the culture of the child. Therefore, the knowledge a child acquires in the process of “doing” is a product of the “activities” ”context” and culture in which it is developed and used. Nwoji (2007) further stated that science is acknowledged as an important part of every child’s education, yet in many countries, including Nigeria, there is much evidence to suggest that primary science education is still in a parlous state, due to the way it is being taught. Ogunleye (2008) in his write up emphasized that unless teachers of primary school shift from conventional lecture method to science process skills approach, the teaching and learning of science will continue to be with problems. Therefore in this study the effect of science process approach teaching method on primary school pupils’ academic achievement in basic science and technology will be investigated.

According to Urevbu (1990) in teaching science, we need to ask ourselves two basic questions: 1. what do we teach? And 2. How do we teach it? He went ahead to explain that, the first question involves issues relating not only to the content of the school program, but also to the totality of the approaches towards science instruction. This, he stated, involves the content and the structure of discipline. The second question relates to the actual classroom and laboratory teaching and how teachers help the individual pupils to acquire scientific skills. Without the effective use of science process skills, the issue of relating to content, classroom and laboratory teaching will be in jeopardy.

According to Chukwuemeka and Nwosu (2008) science process skills are the generalizable and transferable intellectual and physical capabilities. Chukwuemeka and Nwosu (2008) went on to explain that these skills are needed to learn the concepts and broad principles used in making valid inductive inferences which are reflective of the behaviors of the scientists. These skills they stated include observing, measuring, classifying, communicating, predicting, inferring, questioning, controlling variables, hypothezing, defining operationally, formulating hypotheses and models, designing experiments and interpreting data. Saat and Abubakar (2005) viewed science process skills as the foundation for scientific inquiry, and the knowledge is developed inductively from sensory experiences. These skills consist of basic and integrated science process skills. However, majority of the primary school pupils are at the concrete operational stage, hence the use of basic process skills at that level. Teachers' effective manipulation of classroom environment facilitates the learners' interactions with material resources which may enhance effective acquisition of functional knowledge in science and acquisition of science process skills. The acquisition of science process skills is a demand of the basic science core-curriculum hence, the need for all primary science pupils to acquire the skills to ensure the implementation of the curriculum (Chukwuemeka and Nwosu 2008). Ivowi (2006) mentioned that there is the need to impart into children scientific skills. This is to prepare them for future activities and contribution to national development. Science process teaching approach will as well make the pupils to acquire the science process skills.

From the foregoing, therefore, the issue of poor performance in science has been of great concern to many scholars. Rosier (1990) reported that the performance of Nigerian primary school pupils in science when compared with pupils from other

developed countries of the world, such as United State of America, Britain, and Australia, is unsatisfactory. The effect of poor performance of pupils in science at the primary level has been attributed to so many factors such as attitude toward science, use of inappropriate method of instruction as most teachers used conventional lecture method of instruction, lack of use of instructional materials, as well as lack of the use of appropriate teaching strategy that would aid the academic achievement of pupils at the primary school level.

According to Mari (2001) science process skills approach is not gender friendly, who found out that science process skills are more effective in promoting the acquisition of the skills in females than in their male counterparts. Also the findings of Mari (2001), revealed the existence of superiority in performance of female students over their male counterparts in tasks involving science process skills. Therefore, this study, intends to investigate the effect of science process teaching approach on primary school pupils, achievement in basic science and technology.

1.2 Theoretical Framework

According to Piaget (1961) the child's mental process is limited to thinking about things when the age is 6 – 12 years. The child's concepts of quantity, time, space, conservation and reversibility develop during this period. The learner can classify things at this stage and he acquires logical process of observation, describing, classifying and measuring real objects. Learning should go from simple to complex and importantly the learner should deal with concrete materials first before going to complex and he can learn abstract concepts and generalizations.

According to Piaget's cognitive theory (1961) has relevance to science teaching, learners must occupy themselves with exploration particularly at the primary stage.

Problem solving rather than role memorization should be the focus of science. Exploration and interaction with environment using locally available materials should be promoted by the teacher.

Science process approach is teaching strategies in which the abilities, potentials, and technical know-how can be developed by experience are used in carrying out mental operations and physical actions, (Ibe and Nwosu 2003). Science process skills therefore, are the processing strategies which scientists bring to bear in solving problems. According to Ivowi (2006), science process skills have the advantage of preparing pupils for future activities and contribution to national development. Similarly, Mei, Kaling, Xinyi, Sing and Khoon (2007) argued that acquisition of science process skills can help pupils do science on their own.

In a study conducted by Mari (2001) on science process skills at junior secondary schools, it was found that there is significant improvement in science process skills tasks as a result of the treatment, that the process based instruction is effective in stimulating cognitive growth in students. Also, Mei, et al (2007), supported the use of science process skills in primary schools as the skills enhance pupils' conceptual understanding, acquisition of skills which will make pupils relate science to their everyday life, and eventually make them to acquire the process skills and scientific attitudes.

1.3 Statement of the Problem

According to Atadoga and Onaolapo (2008) there is a quest for scientific knowledge all over the world, this quest for knowledge and everyone desiring to read and write, and making applications of acquired skills or knowledge pose challenges in the teaching and learning of primary science. The challenges are nationwide, which include; inadequate, competent, dedicated and qualified science

teachers to teach science as required in the National Policy on Education and the primary science core curriculum. One of the goals of Primary Education clearly stated in the National Policy on Education (FME, 2004), is to lay a sound basis for scientific and reflective thinking in the pupils. The attainment of the goal seems not to be realistic because of the way pupils are taught as observed by Hou (1994) and Usman (2001) in that pupils generally perform poorly in science, and a number of factors have been identified to influence pupils' poor performance in science. The factors include the use of inappropriate teaching methods. Poor performance in science among students in developing countries including Africa is caused by the absence of vocational incentives, lack of awareness of teachers and individual pupil's creativity (Emmanuel and Jonathan 1999).

The study on science process skills is not new. Mari (2001) worked on the effect of process skills instruction on formal reasoning ability among SSS students in Kaduna state and concludes that students perform better when taught using science process skills. Also Sani (2007) studied the effectiveness of science process skills approach on remedial science students' performance in Jigawa state, and concluded that students learn chemistry concepts better when they are taught using science process skills approach. Therefore, this study sought to investigate the effect of science process teaching approach on primary school pupils' achievement in basic science and technology in Katsina state, Nigeria.

1.4 Objectives of the Study

The objectives of the study are to;

1. determine the effectiveness of science process teaching approach on academic achievement in basic science and technology

2. investigate whether science process teaching approach can enhance academic achievement on male pupils.

3. determine the effect of science process teaching approach on female pupils' academic achievement in basic science and technology.

4. investigate the effect of science process skills approach on male and female pupils' academic achievement in basic science and technology science when exposed to science process teaching approach.

1.5 Research Questions

The study attempts to answer the following questions:

1. What is the effect of science process teaching approach on the pupils' academic achievement and those exposed to the conventional teaching method in basic science and technology?

2. What is the difference in academic achievement of male primary pupils taught using science process teaching approach and conventional teaching method in basic science and technology?

3. What is the difference in female pupils' academic achievement in basic science and technology taught using science process teaching approach and conventional teaching method?

4. What is the effect of exposing male and female pupils' to science process teaching approach on academic achievement in basic science and technology science?

1.6 Null Hypotheses

Based on the research questions stated, the following hypotheses are formulated.

Ho:1. There is no significant difference in the academic achievement of primary school pupils exposed to the science process teaching approach and those exposed to conventional teaching method.

Ho: 2. There is no significant difference in the academic achievement of male pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology.

Ho: 3. There is no significant difference in the academic achievement of female pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology.

Ho: 4. There is no significant difference in the academic achievement between male and female pupils when exposed to science process teaching approach in basic science and technology.

1.7 Significance of the Study

The research study will be useful to the upliftment of science education in the following ways:

- Sensitize science teachers on the effectiveness of science process teaching approach in basic science and technology teaching.
- Teachers will appreciate science process teaching approach in primary schools and hopefully use it to develop and improve the acquisition of science process skills of the pupils when teaching basic science and technology.
- School administrators will appreciate the science process teaching approach and provide the teachers with necessary materials required.

1.8. Scope of the Study

The study will be delimited to two randomly sampled primary schools in Katsina metropolis. There are thirty one public primary schools in the metropolis. The class to be used for the purpose of this study is primary six; one class will also be randomly sampled from each school. The pupils in this class are in the concrete operational stage which is characterized by the ability to solve problems involving concrete objects that can be observed and manipulated (Urevbu 1990). Science process skills according to Esomonu and Onunkwo (2004) are divided into basic and integrated skills, the basic process skills are – observing, classifying, communicating, using numbers, measuring, recognizing special relations, inferring, predicting, while the integrated process skills include: defining operationally, hypothesizing, identifying and controlling variables, interpreting data, experimenting, and using models. In view of their stage therefore, basic science process skills approach will be used in this study, to determine their effectiveness on academic achievement of primary six pupils in basic science and technology.

1.9 **Basic Assumptions**

This study is based on the following assumptions:

1. Schools in the study area are taught by qualified science teachers.
2. The schools are using the recommended basic science and technology curriculum for primary school.
3. The topics taught under the study are familiar to basic science and technology pupils.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

In this chapter, a critical review of relevant literature will enable the researcher to investigate what is known in the area of study so far in order to see where there is a gap in research that this study can fill. The review is organized into the following sub headings:

- National Policy on Education and Basic Science and Technology Teaching.
- Psychological Theories of Learning and Basic Science Teaching
- Problems Associated with Basic Science Teaching and Learning
- Science Teaching Methods.
- Concept of Science Process Skills Approach.
- Concept of Creativity and Academic Achievement in Science.
- Science Process Skills and Creativity in Science
- Studies on Basic Science and Technology Teaching and Learning.
- Studies on Gender-Related Issues and Academic Achievement in Basic Science.
- Overview of Similar Studies.
- Implications of Literature Reviewed on the Present Study.

2.2. National Policy on Education and Basic Science and Technology Teaching

The National Policy on Education (FME 2004) is a document that spells out clearly the philosophy and objectives of education in Nigeria. The government has stated that for the benefit of all citizens, the country's educational goals shall be clearly set out in term of their relevance to the needs of the individual and those of the society. The National Policy on Education came about as a result of the 1961 National Curriculum Conference.

The overall philosophy of Nigeria according to (FME 2004,) is to:

(a) live in unity and harmony as one indivisible, indissoluble, democratic and sovereign nation founded on the principles of freedom, equality justice;

(b) promote inter-African solidarity and world peace through understanding.

The five main national goals of Nigeria, which have been endorsed as the necessary foundation for the National Policy on Education, are the building of:-

(a) a free and democratic society;

(b) a just and egalitarian society;

(c) a united, strong and self-reliant nation;

(d) a great and dynamic economy;

(e) a land full of bright opportunities for all citizens.

The primary education according to National Policy on Education (FME 2004), is the education given in institutions for children aged 6 to 11 plus. Since the rest of the education system is built upon it, the primary level is the key to the success or failure of the whole system. The goals of primary education are to:-

(a) inculcate permanent literacy and numeracy, and ability to communicate effectively;

(b) lay a sound basis for scientific and reflective thinking;

(c) give citizenship education as a basis for effective participation in and contribution to the life of the society;

(d) mould the character and develop sound attitude and morals in the child;

(e) develop in the child the ability to adapt to the child's changing environment;

(f) give the child opportunities for developing manipulative skills that will enable the child function effectively in the society within the limit of the child's capacity;

(g) provide the child with basic tools for further educational development, including preparation for trades and crafts of the locality.

The National Policy on Education (FME 2004) stated that science education shall emphasize the teaching and learning of science processes and principles. This will lead to fundamental and applied research in the sciences at all levels of education. The goals of science education shall be to:

(a) cultivate inquiring, knowing and rational mind for the conduct of a good life and democracy;

(b) produce scientists for national development;

(c) service studies in technology and the cause of technological development; and

(d) provide knowledge and understanding of the complexity of the physical world, the for and conduct of life.

Also the National Policy on Education (FME 2004) stated that the minimum qualification into the teaching profession shall be the Nigeria Certificate in Education (NCE), with the aim of producing highly motivated, conscientious and efficient classroom teachers for all levels of our educational system.

The above policy is not without problems of implementation. For example, Ogunleye (1999) mentioned that majority of teachers in Nigeria have not attained the NCE qualification, despite the current government policy which stipulates that

no teacher with less than Grade 2 Teachers Certificate must be allowed to teach at the primary school level by 1995 and no teacher without a minimum of NCE must be allowed to teach from 1998. For instance, Ogunleye (1999) stated that by 1991 Katsina state has only 41.78% qualified primary school teachers. Other areas of concern according to Ogunleye (1999) are inadequate availability of school facilities like classrooms and furniture, inadequacy of laboratory, apparatus and equipment, lack of textbooks and so on. In this study therefore, the effects of science process teaching method on primary school pupils' academic achievement in basic science and technology will be investigated.

2.3. Psychological Theories and Basic Science and Technology Teaching

According to the behaviorist school of psychology, learning is an individual experience. Whenever an individual's behavior is modified, learning is said to have taken place: the individual can act or think differently, or acquire new knowledge or skill. The bulk of the problem of science teaching in Nigerian schools today according to Aina (2007) is attributed to the teachers' inability to help students learn science in a meaningful way especially in the absence of laboratories. Science teachers need to understand classroom practices that can facilitate processes leading to effective learning of science.

Therefore, theories on how students learn have implications in terms of the way a teacher selects his/her materials and decide on his/her instructional techniques. The learning theories that have had profound impact on the methodology of science teaching at primary level are those of Bruner (1963), Ausubel (1963), Piaget (1968) and Gagne (1970).

The work of Piaget (1968) in developmental psychology has become an important guide in the selection of science materials for pupils in basic science. The pioneering

study by Piaget on cognitive and mental development offer theoretical analysis of children's thought processes. According to Piaget (1968) at about the age of six or seven, a child enters the concrete operational stage and this stage lasts till age eleven or twelve. During this period, the child's mental process is limited to thinking about concrete things. The concepts of quantity, time, space, conservation and reversibility have developed. The child can also understand the relationship of classes, ratio and numbers. Logical processes such as observing, describing, classifying and measuring real objects can take place. A characteristic of this period is also the fact that children like to be active and desire to play with other children. They generally frown at being isolated or confined. They enjoy running around, playing games and do not like to be idle or bored.

The implication of this for the basic science class according to Aina (2007) is that the primary years should be viewed as a period of exploration and observation. This is a time for children to examine relationships between man and his physical and biological environment with basic senses of sight, smell, hearing, touch and taste. The emphasis is on hands-on science activities whereby the teacher acts as the facilitator while the pupils is the actor or doer. Thus, the pupils are actively involved in what is being taught, rather than being passive listeners. Young (1988) stated that primary school pupils learn science better if they are involved in their own learning activities, and explanations are given by their teachers using objects like pictures, models, diagrams and other instructional aids. The teacher should avoid complex verbalizations or abstractions.

In his contribution to the theory of learning Ausubel (1963) emphasizes meaningful learning as contrasted to rote learning, he maintains that meaningful learning can only occur when what is to be learnt is related to what is already

known. In other words, for a stimulus or concept to have meaning, there must be something in the learners' conscience, which is labeled as cognitive structure and can provide for interaction necessary for meaningful learning are called subsumers. If a learner does not have a previous subsumer for a new knowledge, Ausubel (1963) proposed that advance organizers may be used. Advance organizers are prior information or complex set of ideas or concepts that is given to the learners before materials to be learned is presented. An organizer is meant to provide stable cognitive structure to enhance meaningful learning and can also increases recall.

Bruner (1963) put forward solution to problems in education. This theory promotes the acquisition of knowledge through discovery by oneself through the use of mental processes. It takes place in two ways:

1. The learner encounters a new situation that is similar to one on the element in his existing structure of knowledge and assimilates it with ease.
2. When the learner encounters a new situation which is incompatible with his existing knowledge, he then restructures the existing knowledge in order to create a place in his mind for the new knowledge. Bruner believes that it is only through the exercise of problem solving and the effort of discovery that one learns the heuristic of discovery. Students assume more responsibility for their own learning.

Bruner (1963) described four major benefits derived by children when they learn how to investigate and discover for themselves:

1. An increase in intellectual potency.
2. A shift from self-reliance on extrinsic reward to a reliance on intrusive reinforcement, this is because the act of discovery is itself highly pleasant (interesting).
3. Learning the heuristics of discovery.

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

Gagne (1965) in his theory made two distinctions regarding the arrangement of learning situations involves the following:

1. Management of learning.
2. Conditions of learning.

Gagne (1965) implies that learning materials should be structured. He maintains that meaningful learning can only take place in gradual step from known to the unknown, it should be possible to break down into some steps, one step slightly higher or lower the preceding step. This he described as hierarchy of learning. The task of the teacher is to break down any information to its hierarchy and the process of breaking down any knowledge into specific knowledge is called task analysis.

From the above psychological theories therefore, the issue of pupils' need as well as their attitude are both beneficial for the basic science and technology teaching.

2.4. Problems Associated with Basic Science and Technology Teaching and Learning

Why teach science at the primary school level? The answer to this question is not far fetched according to Aina (2007), who stated that children are naturally inquisitive; they have a natural tendency to explore their environment. This leads to self experimentation and discovery of certain things. This trait is very instrumental in the study and learning of science. Primary school science thus links the child with his/her environment-both at school and at home, scientific knowledge gained by children is very useful for development in all aspects of life. Aina (2007) mentioned the following reasons for teaching science in the primary school:

- Application of scientific process skills by children to solve personal life problems.
- Scientific knowledge and attitude produce good citizenship in children and help to eliminate some unfounded fears and superstitions.
- Science teaches children how to think and reason logically.
- Science helps children develop their manipulative skills, through the proper handling of objects and equipment.
- Science enable children develop social skills through establishing friendship while working cooperatively in groups.
- Science helps to inculcate in the children the principle of sustainable development i.e. how to sustain resources in the environment.

According to Abdullahi (1982), science teachers should be aware of certain general rules which facilitate the selection of appropriate approaches of imparting knowledge or developing a particular skill in pupils. Although these rules are by no means peculiar to science teaching, nonetheless, they have been found to have instructional value for science teaching. In line with the above, Jegede and Brown (1980) stated that a teacher is not expected to know everything, but what is expected of him when teaching science is to present what he knows in a pleasant and interesting manner, capable of generating curiosity in the children. Thus in selecting methodology for science lesson Abdullahi (1982) suggested that, science teacher should consider the following:-

1. The pupils' age, their previous knowledge on the topic and their general ability. The method of instruction for a mixed ability class should be different from a method that is employed to teach pupils who are high achievers and homogeneous in ability.

2. The method should be suitable for the topic to be taught. For instance, in teaching the effect of dilute mineral acids on metals, it will be inappropriate to set up small group discussions. Rather, laboratory experiment or demonstrations will be more appropriate from learning point of view.
3. The science teacher should select the method that he/she can effectively handle. This means that if the teacher feels more competent in the lecture method, regardless of its limitations, that method should be used instead of employing another method which the teacher cannot use effectively.
4. The time the lesson will take place must be put into consideration. If a science lesson is to take place at noon time, it is advisable to select a method which requires students' participation. On the other hand, should a teacher select a method that makes the students sit passively, he should not expect to carry students along.
5. The size of the class is another factor to be taken into account. It is of no value instructionally if a discussion method or a demonstration method is used in a class consisting of over a hundred pupils, unless the class could be divided into smaller groups.
6. The resources that are at the disposal of the teacher should be an important guide in the choice of teaching methods. Where there are no materials and equipment for school laboratory experiments, individual laboratory experience or demonstration by the teacher cannot be expected to be effective. In other words, the selection of methods for science teaching should be based on the instructional

resources available for an effective use of the method. One cue that can be taken from the above guidelines is that science teachers should not be dogmatic in their choice of methods for class teaching, they should change or vary their methods as many times as the need arises. It is quite possible for a teacher to introduce his lesson with one method, and then goes on to change his method when the lesson is being developed. And, in ending his lesson, the teacher may use yet a different method. The frequency with which we change our method of teaching should depend on the concept or skill or attitude that is being developed in the pupils.

In addition to the above, Young (1988), stated that in science lessons, we can teach children some useful knowledge, but notice that this reason for teaching the subject is at the end of the list, for primary school we should be emphasizing the 'know how' of science rather than the 'knowing'. As indicated in most of the theories of learning by psychologists.

2.5. Science Teaching Methods

In education the word 'method' means the mode by which the material is communicated from the teacher to the pupil, it is the way teachers impart knowledge and skills while teaching, and pupils comprehend knowledge and acquire the skills in the process of teaching (Rao 2003).According Gbamanja (1991) there is no one method of good teaching. The method to be employed will depend on the subject matter, the students, the teacher and the environmental variables. Therefore, it is very important to know the prevailing conditions regarding time, place and human nature in the shape of learners, teachers, parents, and society generally. Science teachers must be concerned about those conditions and limitations that affect

effective teaching of science. Ogunneye (1992) mentioned that science teachers are to vary their teaching methods on the demands of the situation they may find themselves. A combination of two or more methods may better achieve the desired effect than a single method. Rao (2003) stated that there are many methods of teaching but science teacher selects a particular method based on the needs of the content, teaching facilities available, ability of the students and the philosophy of the teacher. Rao (2003) categorized teaching methods into three; namely oral methods include: narration, recitation, lecture and discussion method. Secondly, activity methods include: demonstration method, activity method, project method, laboratory method, heuristic method, discovery learning/inquiry approach, problem-solving method and supervised study. Third category is special methods which include: programmed learning, team teaching, computer assisted learning and personalized system of instruction. Some of the teaching methods will be studied as follows.

2.5.1. Lecture Method (Chalk and Talk)

This method according to NTI (2006) involved a one-way flow of information from the teacher to the pupils. The teacher does most of the activities while the pupils are expected to listen with little or no involvement; it is otherwise referred to as teacher-centered type of instruction. Atadoga and Anaolapo (2008) mentioned that lecture is used for elaborating, simplifying, clarifying and discussing new materials to learners, the material include facts or views on issues and problems related to the learners, which provide an aesthetically stimulating experience. Effectiveness of lecture method depends on the type of students, educational purposes and teacher's own characteristic and skills. FME (2004) stated that lecture method have two merits:

1. It is a cheap method to use as no apparatus is required.
2. It does not consume time therefore a lot can be covered in a short time.

And the following demerits:

1. It stifles creativity and development of scientific process skills by pupils.
2. It encourages memorization of facts.
3. It gives a wrong picture of science.

Another method of interest in the teaching of basic science and technology which is activity-based is inquiry/discovery method.

2.5.2. Inquiry Method (Discovery Method)

According to Abdullahi (1982) inquiry or discovery method is one of the strategies of science teaching. Many science educators have consistently advocated for this method as they believe that "science should not be taught to a child but that he should be left to discover it". Rao (2003) defined discovery or inquiry method as a process of self-learning whereby learners generate concepts and ideas with very little teacher intervention. The approach are used to discover new knowledge through experimentation, problem solving or project work. There are two types of inquiry approach according to Aina (2007), namely guided and unguided. The guided inquiry is recommended for basic science and technology class. In a guided inquiry class, the pupils tends to act more like maturing adult by originating problems, formulating hypotheses, designing investigative approaches, testing ideas by experimenting, synthesizing the knowledge gained and developing certain attitudes. These according to Aina (2007) are possible if provisions for a science room with special conference area and a discovery corner. Abdullahi (1982) proposed the following table of instructional modes of discovery method.

Table 2.1. Instructional Modes of Discovery Method.

	General Principle	Solution to a Scientific Problem	Teaching Strategy
a. When	Is given	Is given	Exposition(Lecture method).
b. When	Is given	Is not given	Deductive(guided inquiry).
c. When	Is not given	Is given	Inductive (guided inquiry).
d. When	Is not given	Is not given	Unguided inquiry (pure discovery).

*Source: Abdullahi (1982)

Another important basic science and technology teaching method which involves individuals or group of pupils to carry out is the project method.

2.5.3. Project Method

According to Ogunneye (1992) project method involves every member of the class, a learning task in science is sub-divided into some units and each unit is assigned to a group of learners to study and to report. Each group is expected to complete the unit of the project within a specified time. As each group is working on the unit assigned to it; teacher goes round to offer assistance where necessary. Aina (2007) stated that children are encouraged to investigate, collect specimens and analyze on their own. Each group later presents its report; all reports are collected by the teacher for an exhaustive discussion by the class. Discussion is another method of teaching basic science and technology in which teachers employ to teach science.

2.5.4. Discussion Method

A discussion according to Gbamanja (1991) occurs when two or more people interact verbally with each other. A discussion becomes more meaningful if the persons involved in a particular discussion see each others point of view and they are able to harmonize their ideas to arrive at a consensus. Gbamanja (1991) further stated that in teaching science therefore, the discussion method could be adopted

deliberately in a learning situation. But sometimes, it may occur spontaneously as a teacher uses one method of teaching or another. In fact, the discussion approach to teaching of science can enrich various types of teaching methods. Discussion at brief intervals to clarify certain points must be adopted during lecture, demonstration, inquiry, discovery, or even before and after excursions or laboratory exercises. Discussion could be considered as a technique within a method. It is therefore more of a technique in teaching used to enhance effectiveness of various teaching methods. Effective discussions involve questioning and developing interaction between the teacher and the learners. A good discussion allows the students to pursue the idea being discussed so that they are made to arrive at the objective being sort. For effective discussion to take place, the teacher should seek maximum participation from the learners. Students should be made to give their various points of view and the teacher should not communicate or dispense knowledge but act as a moderator. The teacher should not dictate or influence the view points of the students as he moderates the discussion. Rather he should guide the students as they present their various view points which should be harmonized and identified vividly with the teachers reference frame. In this way, the discussion technique is regarded as a student-centered approach to teaching of science.

Another very important method of teaching basic science and technology is demonstration.

2.5.5. Demonstration Method

Demonstration is a process or means of showing how something works or is used. It is an act to display working of some experiment. The demonstration method is 'natural' method of teaching and provides foundation for the initiative behavior through example. Similarly, demonstration provides foundation for apprenticeship training. When a chemistry teacher is showing the presence of carbohydrate in food materials, he is demonstrating. Thus, demonstration is one of the most common methods used by the science teachers. Science is based on sensory experience and in learning by observation and experimentation a student uses his sensory organs. Demonstration can contribute to both. When properly utilized, demonstration method can be effective as well as useful. In sciences demonstration is a significant method where students learn to do practical after the demonstrations are given by the teacher Rao (2003). Aina (2007) stated that demonstration involves carrying out science activities to illustrate science concepts or ideas, and that demonstration can be carried out by the teacher alone, the teacher with a child, the child who is knowledgeable in the activity and an invited guest.

In the teaching and learning of basic science and technology teachers employ field trip as very important method of teaching.

2.5.6. Field Trip (Excursion Method)

Field Trip involves taking the pupils out of the classroom so that they can learn some science concepts and themes as they occur in real-life situations. A possible site for field trip or excursion is school farm/garden; play ground and related science concepts that could be learnt include insects, living organisms, seeds and plant growth and types, food chain. Gbamanja (1991) sees field trips to include visits to various exciting places which can enrich learning. Field trips are meant to broaden

pupils' general knowledge. Pupils are supposed to observe the application of certain scientific concepts learnt in class or to examine some process or special material in its natural environment. Such observations provide primary experience to the learner and this is very crucial in science. During this process of primary experience the learner is kept observing, collecting, classifying, studying relationships and manipulating objects. This leads to the acquisition of science process skills and also to the scientific method of inquiry which should form the basis for science teaching. Various works have been done in basic science and technology teaching methods. Some of which include that of Aina (2007) who work on the 'Effective Teaching of Primary Science: Bedrock for Sustainable Development'. And that of Clark (2002) titled 'What is the Role of Practical Activities in Basic Science and Technology Teaching? The above methods of teaching basic science and technology do not fully integrated science process skills in their strategies as put forward by (Sani 2007). This work therefore, intends to study the effects of science process approach on primary pupils' academic achievement.

2.6. Science Process Skills Approach

The history of science process skills approach can be traced back to the successful launching of Sputnik 1 in 1957 by the former USSR prompted the United State of America (USA) to rapidly reform its science education policy and came up with programs such as Science- A Process Approach (SAPA), which was an experimental program in elementary school science, sponsored by the American Association for the Advancement of Science (AAAS). There are several basic assumptions underlying the SAPA program. The first is that science can be taught to young children in a way that is faithful to science as an intellectual approach to the world. The primary implication of this is that children should learn not so much

facts which are the outcome of scientific investigation, as the processes used by scientists. There are eight basic processes and five integrated processes taught in the program. The second assumption is that science is best learned by doing science. Hands-on learning should be emphasized. The third assumption is that the lessons must take into account the empirical findings of developmental psychology of the learner (Lawlor 2008).

Science process skills are defined by Esomonu and Onunkwo (2004) as the processing strategies which scientists bring to bear in solving problems. They are the fundamental capabilities or intellectual skills utilized in sciencing. The American Association for the Advancement of Science (AAAS) identified 14 process skills which hierarchically include observing, classifying, communicating, using numbers, measuring, recognizing spatial relations, inferring, predicting, defining operationally, hypothesizing, identifying and controlling variables, interpreting data, experimenting, and using models. Eight of these (i.e. from defining operationally to using models) fell under integrated skills. The distinction is that the integrated skills make higher cognitive demands than the basic ones (Adey and Harler, 1986).

2.7 The Process Skills in Sciencing.

Scientists engage in procedure, of investigation to gain knowledge of natural phenomena. These tactics and strategies, the skills scientists use in their pursuit of understanding are called science processes (Karen 1998). There is however general believe among science educators that the development of science process form part of attainment of the general objectives of education. This is because the acquisition of science processes plays a vital role in scientific activities (Akinmade 1992). They are often seen as the foundation of scientific inquiry since they can be generalized and are required for learning the facts, concepts and principles necessary for making valid inferences. Gagne (1968) a renown psychologist believed that a pre-requisite

knowledge of concepts and principles can be obtained only if the student has certain underlying capabilities, such as the science processes which are needed to practice and understand science.

Hence process skills are acquired capabilities which can be learned through experience and applied for the understanding of nature and problem-solving. They are categorised into basic and integrated process skill (Shaw 1983). The basic science processes include, observation, measuring inferring, predicting, classifying, collecting and recording data. The Integrated Science Processes or process skill is comprised of interpreting data, controlling variables, defining operationally, formulating hypothesis and experimenting. Observation is considered to be the fundamental skill by virtue of its position at the foundation of the skills needed to discover the broad knowledge required for inquiry. Shaibu and Mari (1997) share a similar view that the acquisition of science skills ought to be a major goal of education more so that the search for scientific knowledge is process-oriented.

Some of the major features of the processes of science as identified by Aktamis and Ergin (2008) include:

- Each process is generalizable (transferable) across content domains and contribute to rational thinking in everyday affair.
- Each process is an identifiable behaviour of scientist that can be learned by students.
- Each process is specific intellectual skill used by all scientists and applicable to understand any phenomena.

The processes are hierarchically organised with the ability to use each upper level process dependent on the ability to use the simpler underlying process (Ndukwe

1986). These science process skills have been identified as having the enduring quality of enabling the individual acquire and process information and solve problems even when the information base changes (Bybee 1989). This view apparently supports- Wuyep (1996) notion that concepts and contents of science will undoubtedly change, but the mental skills of the scientists or the students which are very vital in science and technology, do not.

The significance of the science process skill, maintained Nwosu (1994) has led to the expansion of the goal of science education to include an understanding and development of these process skills in the pupils. School therefore ought to emphasis the development of skills in all areas of curriculum, although the types and levels of skills acquisition will depend on learners' stage of development.

Possession of such skill according to Ekpo (1986) is apparent if pupils can take action to find appropriate information and techniques from the previous experience and bring them to bear on new problems and situations.

2.7.1 Process: Observing

This is the first stage in scientific inquiry. It is made on particular event and general principle is developed from a number of specific and consistent cases (Abdullahi 1982.) It is considered to be the fundamental skill by virtue of its position at the foundation of the hierarchy of skills needed to discover knowledge required to conduct inquiry. Eniajeju (1994) described it as the skill of looking and seeing which may be made directly or indirectly. Thus active use of the senses during the process of observation according to Ogunleye (1996) enables one to determine the quantity and quality of things and events. Observations are influenced by past experiences often involving instruments (microscopes, telescopes, etc) and requiring careful recording and description (Karen 1998).

However, Akpan (1992) identified three broad proficiencies that are logically necessary for achieving observational competence to include:

- Making observation well
- reporting observation well
- assessing report of observation.

The more precise an observation is according to Mari (1994) the more valid are the inferences based on it.

2.7.2 Process: Measuring

Measuring involves assigning numbers to objects or events that may be arranged in a continuum according to set of values and expression of observation in quantitative terms adds precision and permits more accurate descriptions (Karen 1998).

According to Eniajeju (1994) measuring employs the use of counting skills to man-made units of length, area, volume, weight and time. The units are initially those developed and applied by the pupil themselves. It is a process which involves the use of an instrument to determine the quantitative value associated with the properties of an object or event (Akinmade 1992, Ogunleye 1996).

Mari (1994) identified seven (7) sub-processes involved during the process of measuring. These are:

- Ordering object by inspection in terms of magnitude of selected common properties such as linear dimension area or volume.
- Comparing quantities such as length, area, volume and weight to arbitrary unit.

- Taking measurement using standard units.
- Taking measurement of quantities which depend upon more than one variable.
- Converting from one system of unit to another.
- Using and devising indirect means to measure quantities.

To be proficient in the use of the process of measurement according Akinmade (1992) student should be able to measure time, rate of change of a property of an object, represent an object by scale diagram, draw an accurate map and be aware of the limitations of the various measuring devices in use. In addition, student should be able to determine the area and value of one, two or three dimensional objects.

2.7.3. Process: Classifying

Classifying object according to Mari (1994) involves sorting and arranging objects according to their similarities and differences. During this process things or events are organised, categorised and grouped, based on observed or measured property to form an easily recognised pattern. Akinmade (1992) identifies six (6) characteristics of a child who attain certain level of competence in using the process of classifying. Thus the child is able to:

- categorize object or system of objects using a given property.
- determine with reason an appropriate property and categorise objects or systems of objects according to that property.
- classify object or systems of objects according to two or more given simultaneous properties.

- select and justify two or more appropriate simultaneous properties and group objects or systems of objects on the basis of those properties.
- identify the properties on which a given set of objects has been grouped; and
- regroup a given set of objects or systems of objects using a rational procedure.

Eniayeju (1994) sees classification as a process and skill of sorting, grouping and ordering objects by both their quality and quantity. The desired goal in this scientific process is for children to develop sensible reasons as bases of their grouping, sorting and ordering.

2.7.4. Process: Inferring

Inferring as perceived by Ogunleye (1996) is a skill of basing judgement on observed and measured event. Smith and Welliver (1990) sees it as an interpretation of one's direct observation; past experiences are generally used as a basis for interpretation. According to Eniayeju (1994) inference implies the cause and effect relationship which may be based on preliminary or sketch data or very well founded data from experiment.

Mari (1994) pointed out that inference is strongly made on the bases of inductive and deductive logic. Deductive inference involves reasoning from general premises to specific instance, while inductive inference involves deriving general preposition from the evidence of specific cases. The following sub processes are involved in the process of inferring as identified by Mari (1994) are:

- distinguishing pertinent observations upon which given inferences are based and are extraneous.
- drawing an inference from a set of related observations.

- stating cause and effect relationships from observations of related events.
- identifying and extending inferences to include discrepant event.
- modifying and extending inferences to include discrepant event.
- developing plans to test the validity of inferences.
- using inferences from one set of observations to suggest further observation.

2.7.5 Process: Predicting

Making prediction according to Akinmade (1992) involves figuring what future observation will be on the basis of available previous information. Identifying some proficiency associated to a person who achieves competence in using the process prediction, Akinmade (1992) suggests that such a person should be able to:

- find out and explain trends in a given set of data;
- device appropriate procedures for checking the correctness of the prediction made;
- present plausible arguments and evidence to justify his prediction;
- appreciate the importance of multiple observations in making predictions, and
- exercise restraint in making predictions in the absence of reliable and valid multiple observations.

Smith and Welliver (1990) see the skill of predicting as the process of determining or anticipating future events based on past observations and experience. To Eniayeju (1994), predicting is a scientific process which arises from a well

founded base of hypothesis, theory or even law. With regularly consistent data in hand, one can predict. According to Ogunleye (1996) and Mari (1994) predicting involves forecasting or extrapolating on the basis of past observation.

2.7.6 Process: Communicating

This is the process skill of transmitting acquired information from one person or group to another which may result in change in behaviour. A scientific experience in observation, data collection, discovery etc. according to Eniayeju (1994) need to be communicated to other people. This will give growth to knowledge, and it could be in written words, diagrams, graphs or models. However, the following sub processes are involved during the process of communicating (Mari 1994):

- describing observation verbally.
- describing conditions under which observations are made.
- recording observation in a systematic way.
- stating questions and hypothesis concisely
- using table and graphs to communicate data.
- planning for communication of procedures and result as an essential part of an experiment.
- reporting experimental procedures in a form so that other persons can replicate the

  experiment.
- using mathematical analysis to describe interpretation of data.

2.7.7 Process: Interpreting Data

According to Smith and Welliver (1990) interpreting is a process of identifying various forms of data to determine the validity of a hypothesis; to organise information derived from an experiment, and/or revise interpretation of data based on new information. When using the process of interpreting, students are required to determine the pattern or put meaning into it or as well as take meaning out of their experience. They are also expected to provide a justification for the meaning put into their experience, and to generalize to other situations on the basis of sufficient evidence (Akinmade 1992).

Mari (1994) viewed interpreting data as involving identifying changes in size, shape, position and judgement of validity and usefulness of data. However, Akinmade (1992) identified what a student should be able to do to demonstrate competence in the use of the skill as follows:

- make sound generalization from a set of data.
- identify cause and effect relationship
- provide reasonable justification for any generalization made.
- draw as many plausible inferences as are permitted by a given data set.
- test an inference by collecting more data and
- recognise which data lend support to an inference.

This skill answers the question, "what does a collection of data tells you?" It is much more than the collection and classification of data to provide possible generalization with which one may predict (Eniayeju 1994).

2.7.8. Process: Raising Questions and Formulating Hypothesis

Questions are raised as a result of observation. Hence observation provokes question in an attempt to provide answer to the problem under consideration. Mari (1994) sees hypothesis as a thoughtful educative "guess" as to what solution to a given problem might be. According to Mari (1994) hypothesis is an educative "guess" of answers to a question which is tentative until a real research is conducted.

2.7.9. Process: Making Operational Definitions

Here, pupils have the freedom to develop their own scientific vocabulary. Such words and terms describe their operation rather than conform to the standard of discipline of science. According to Ogunleye (1996) making operational definition ensures precision by providing situational definitions of concepts so as to focus attention on the phenomena being observed. Operational definitions according to Mari (1994) are important means of facilitating communication about the phenomena investigated as well as the materials and procedures of investigation. They are however made as precisely as possible and where feasible, mathematical relationship could be used as a way of enhancing precision.

2.5.10 Process: Experimenting

This is the testing of hypothesis to confirm our guess or disprove it. Initially it might be in the form of trial and error. According to Eniayeju (1994) experimenting involve chasing after answers along a path that appears fruitful. Designing experiment involves planning a series of data gathering operations which will eventually provide the bases for testing hypothesis or answering a research question. It may however involve the use of some of the other processes such as observing, comparing, interpreting, use of numbers and control of variables. It may also involve designing an investigation to find out the effect of independent variable on the dependent variable (Mari 1994, Ogunleye 1996).

The achievement of competence in the use of this process skill according to Akinmade (1992) implies that student is able to:

- choose, clarify and state the primary variable being investigated in a way that could be tested.
- confine the number of variable to a manageable number.
- competently control variable.
- differentiate between independent and dependent variable.
- select or design data gathering procedures that are appropriate to the investigation.
- use the processes of observing, classifying, comparing and measuring to gather relevant data.
- ensure the reliability and validity of data-gathering procedures employed.
- record and organise data using tables, graphics representations and models.
- use the processes of inferring and predicting to interpret the data collected.
- find a rational answer to the research question posed.
- raise new relevant question; and
- design new experiments to find rational answers or the new research question raised.

2.7.11. Process: Controlling Variables

This is the process of identifying the influential variable in a system, holding some constant and varying others to see how the system behaves (Eniayeju 1992). Thus the experiment will discover the real role of a variable or factor in a system.

2.7.12. Process: Formation of Mental Models

This is the ability to create a mental, physical or verbal representation of idea, object or event and use model to describe interrelationships of ideas, object or event (Smith and Welliver 1990). A mental model according Eniayeju (1994) is a tool for prediction. A model once formed, is continuously refined and modified in the light of new experience, evidence and discovery which may challenge some aspects of the initial model.

Models according to Mari (1994) make the abstract more concrete, enable the students to study interrelationships of objects and concepts or help them to make prediction. The following sub-processes are involved in the formulating of models (Mari 1994).

- differentiating between models and reality.
- explaining phenomena by using models devised by others.
- constructing a physical representation, a drawing or mental image to explain observed phenomena.
- extending physical or mental model to include related phenomena.

Table 2.2. Basic and Integrated Science Process Skills

PROCESS SKILLS	DEFINITION
A. Basic Skills	

Observing	Noting the properties of objects and situations using the five senses.
Classifying	Relating objects and events according to their properties or attributes.
Communicating	Ability to explain, writes a report of an experiment or demonstration, or evaluates a piece of work, scientific procedure or conclusion.
Using numbers	Using quantitative relationships
Measuring	Expressing the amount of an objects or substances in quantitative terms.
Recognizing partial relations	Visualizing and manipulating objects and events, dealing with shapes, time, distance and speed.
Inferring	Giving an explanation for a particular object or event.
Predicting	Forecasting a future occurrence based on past observation or the extension of data.
B. Integrated skills	
Defining operationally	Developing statements that present concrete descriptions of an object or events by telling one to do or observe.
Hypothesizing	Stating a tentative generalization of observations or inferences that may be used to explain a relative larger number of events but that is subject to immediate or

	eventual testing by one or more experiments.
Controlling variables	Manipulating and controlling properties that relate to situations or events for the purpose of determining causation.
Interpreting data	Arriving at explanations, inferences, or hypotheses from data that have been graphed or placed in a table.
Experimenting	Testing a hypothesis through the manipulation and control of independent variables and noting the effects on a dependent variable; interpreting and presenting results in the form of a report that others can follow to replicate the experiment.

*Source: Hamilton and Swortzel (2007)

In general, the science process skills are indispensable tools to scientists because they are the pre-requisites for understanding scientific concepts and principles (Opong, 1981; Ndukwe, 1986). In addition, Okebukola (1985) and Ali (1986) mentioned that technological breakthroughs are predicated on systematic and effective use of the process skills. Indeed, these explained why the Federal Government of Nigeria emphatically incorporated students' acquisition of the science process skills as objectives of the National Policy on Education (FME 2004).

According to Okoli (2006), science process skills are cognitive and psychomotor skills which scientists employ in problem identification, objective enquiry, data gathering, transformation, interpretation and communication. Harlen (1984) describes science process skills as abilities which can be developed by experience

and which are used in carrying out mental operations and physical actions. Studies by Okebukola and Ogunniyi (1984), Nwosu (1990), and Okoli (1998) assert that when one acquires the science process skills of observing, measuring, questioning, designing experiment, interpreting data etc, such a person becomes specially equipped with the tools required for scientific inquiry or problem-solving as well as ability to use these skills in all scientific fields.

According to Mei, Kaling, Xinyi, Sing, and Khoon (2007) maintain that science process skills is commonly used to describe a set of broadly transferable abilities that are reflective of what scientists do. These skills are grouped into two types - basic and integrated. Basic process skills provide foundation for learning the integrated skills, which are more complex skills for solving problems or doing science experiments. Mei et al (2007) also stated that some science educators have argued that teaching students science facts is not important as developing their science process skills so that they can learn this knowledge on their own. Mei et al (2007) reported that studies in the United States have shown that elementary school students who are taught process skills, not only learn to use those processes, but also retain them for future use. That in Singapore, the primary science syllabus also emphasizes the teaching of basic process skills and some integrated skills, while the lower secondary school syllabus emphasizes the use of process skills for planning investigations and problem solving.

In view of the above Okoli (2006) rounded it up by saying that the foundation for scientific literacy is laid in the primary schools and it is the same level which served as the beginning of future career in sciences and other science related professions. The scientific literacy is acquisition of scientific knowledge and skills that enables one to live successfully in this modern age of science and technology. It

enables one to take right decisions on scientific issues affecting ones personal and civic life. Scientific literacy is a necessary tool for everybody, from the individual to the government ministers and from the shop floor attendant to the boardroom director. Few work done on science process skills includes that of Mari (2001) who work on the 'effect of science process skills instruction on formal reasoning ability among senior secondary school students in Kaduna state' and Gumel (2007) who work on 'effectiveness of science process approach on remedial science students' performance in Jigawa state'. Teaching basic science and technology using science process skills method will bring up children with creative mind and interests in science subjects. In this study, the effects of science process teaching approach on primary school pupils' academic achievement in Katsina state will be investigated.

2.8. Academic Achievement in Science Education

Achievement is relatively defined in different ways by different authors depending on the issue at hand. Generally, achievement means accomplishment or proficiency of performance in a given skill or body of knowledge. Academic achievement according to Amuset (1994) is the knowledge attained or skill developed in the school subject, usually designated by test score or by means assigned by teacher. Bomide and Gyuse (1992) accept as evidence, if cognitive achievement such varied performances as recalling scientific information, demonstrating ability to comprehend, apply, analyse, synthesize and evaluate any given scientific information.

Achievement could be classified into either achiever or under-achiever. Under achievement is viewed as performance that is below an acceptable level (Okebukula & Jegede 1986). Under achievement according to Eke (1986) is a level of achievement below expected intelligent quotient (10) of an individual. He continues

to maintain that a student may be under-achiever even though he/she is performing as well as overachiever, whose average mental ability not withstanding has put up a relatively good show. Academic under-achievement therefore to Eke (1986) means the shortfall below expected level of attainment as predicted by the students known or measured intellectual ability and actual performance. However, Okebukula and Jegede (1986) subdivided achievement in to three categories:

- High achiever (top 75%)
- Medium achiever (middle 55%)
- Low achiever (bottom 25%)

Achievement in this research work is used in the context of performance with regards to the knowledge attained, not the proficiency of the knowledge or the skill attained by the student.

Contrastingly to all these views, academic performance according to Musa (2000) refers achievement as the quality of result produced by students as reflected in the quality of their examination scores.

According to Hamilton and Swortzel (2007) the process skills can each be defined in a tabular form.

2.9. Gender Related Studies in Primary School Science

Gender issues in the context of education refer to the differences, both real and perceived, between boys and girls, and their relative achievements and opportunities (Westminster Institute of Education 2006). Gender in science is the classification of the roles males and females play in science. This is the consequences of gender stereotyped which has classified different roles for male and female in the society.

Ogunleye (1999) stated that girls and women over the years have tended not to study science when compared to boys and men.

According to Ezirim (2006) girls' alienation from science subjects begins early. Even from the age of five, both girls and boys have views about what constitutes "male's work" and "female's work". With little variation across the social classes, girls and boys believe, for example, that car repairs and woodwork is exclusive province of men while mending and washing clothes are the province of women. More worrying is the stereotype of all occupations.

Comber and Reeves (1973), Kelly (1978) studied sex-differences in science achievement among 14 year olds. Nineteen countries were used and in each, the science test was used with 500-700 boys and girls, it was found that in all the subjects, Japanese girls did better than boys in other countries in the same test. Japanese and Hungarian girls achieved as well as boys even better than boys in the other countries. Shaibu and Ameh (1982), Mari and Ajagun (1998), in Mari (2001) revealed superiority in performance of female students over their male counterpart in task involving science process skills. The implication of these finding is obvious – under certain circumstances, girls can achieve well in science, even better than boys.

It has been suggested that boys are less well endowed than girls with verbal reasoning and analytical skills. Girls have been said to be more sensitive to sound and to be able to detect intonation patterns at an earlier stage, to the obvious advantage of the growth of their language skills. Another theory is that there may be differences in the development of the junctions of brain hemispheres, and that language development follows a biological maturation 'timetable' where girls have faster rate of progress than boys. There is a greater proportion of boys among

hyperactive children and among those with language difficulties. Boys who show behavior problems in the pre-school years have been observed to persist in them to a greater extent than is the case with girls (Westminster Institute of Education 2006).

Westminster Institute of Education (2006) argued that the extent to which teachers have different attitudes to boys and girls has attracted much attention. It has been argued that the messages conveyed by common stereotypes influence teachers in the way they respond to their pupils, and that this happens from an early stage in the progress of education. Njoku (2006) stated that science teachers are members of the gender-divided society, and hence they carry into their formal and informal science teaching activities their gender ideologies. Due to erroneous notion that science subjects are for males rather than for females, teachers of science subjects do not encourage them to improve, especially in physical sciences (Shapiro, Kramer and Hunerderg 1981, Njoku 1997).

More often than not science teachers use competitive approaches for teaching science subjects (Okebukola 1995). Njoku (2006) added that teachers' adoption of competitive approach is perhaps borne out of the traditional way results of students' assessment are processed and organized. Pedagogically, it is believed that academic competition among students would enhance achievement; hence teachers tend to sustain academic competition in their classrooms. However, it has been found through research that not all the learners benefit in a competitive learning environment (Okebukola 1985, and Okeke 2000).

Recent analysis of science curricular materials has shown that gender biases against females in favour of males is widespread in science text books used in Nigerian primary schools (Erinosho 1997, Njoku 2000). A situation where the contents of science books in term of language, illustrative pictures and diagrams,

and activities are slanted towards male interest and preferences may not be expected to enhance female confidence, interest, participation or achievement in science subjects. The gender bias in science books is believed to be a product of the masculine image of science whose root is the sex role stereotyping in the gender-dividing society (Njoku 2006).

It has been reported that school guidance counselors give boys and girls gender-biased counseling with regard to science subjects. Okeke (1996) stated that school guidance counselors encourage the boys to enroll and work hard in the physical sciences because of the relevance of the subjects to future studies in the disciplines of engineering, technology, basic sciences and mathematics. Conversely, the counselors discourage the girls by telling them that sciences are difficult and are meant for boys.

Thus male behaviors tend to dampen female motivation and interest in science subjects and careers. It is capable of forcing female students, some of whom are talented in science activities, to drop out of science subjects, in preference to less threatening subject areas (Njoku 2006).

Various work on gender-related issues on science education have been done, for example Akalonu (2006), wrote on Using an Instructional Approach to Break the Gender Barrier in Science Education. Njoku (2006) also wrote on School-Based Strategies for Improving the Interest, Achievement and Retention of Girls in Science and Technology Subjects. In this study, therefore, efforts will be made to find out the effect on academic achievement on gender when exposed to science process teaching method as compared to conventional teaching method in basic science and technology.

2.10. Overview of Similar Studies

The overview of similar studies focuses on earlier work done by some researchers on science process teaching approach.

Mari (1994) worked on "the understanding of science processes and its relationship to achievement in integrated science". The research was carried out using junior secondary school pupils in Zaria and Sabon-gari local government areas of Kaduna state as the population of the study. The samples were obtained by random sampling technique comprised 110 JSS I, 110 JSS II and 110 JSS III giving a total number of 330 junior secondary school students. Two instruments were used for the study i.e. TOPS and IOSP.

After administration of the instruments, the results obtained were analyzed using t-test. The results showed that:

- There was significant difference in the understanding of science processes as expressed by the various groups.
- There was a significant difference at $P \leq 0.05$ level of confidence in understanding of science processes between male and female students.
- Subjects from private and government owned schools were found to differ significantly in their understanding of science processes at $P \leq 0.05$ level of confidence.

Chukwuemeka and Nwosu (2008) worked on "the effect of mode of presentation of material resources on acquisition of science process skills among primary science pupils: implication for primary science curriculum delivery". They employed quasi experimental design, using pre and posttest. Using stratified random sampling techniques, six schools were selected, three each from urban and rural located schools. A total of one hundred and eighty pupils in six intact classes were used.

These classes were randomly assigned to two experimental and one control groups in each of rural and urban locations. ANOVA was used to analyze the results showed which showed that pupils whose teachers allowed manipulating materials by themselves and in groups (experimental group 2) performed significantly better than those pupils whose teacher manipulated the resources (demonstration) and this later group also performed significantly better than the control group taught conventionally.

Aktamis and Ergin (2008) worked on "the effect of scientific process skills education on students' scientific creativity, scientific attitudes and academic achievements." The study was quasi experimental-control involving pre and posttest design. 40 students from higher elementary school were randomly selected, 20 being experimental exposed to science process approach while 20 as control group were exposed to lecture method. After two weeks of instruction, a posttest was administered the results of which was analyzed using t-tests. High academic achievement was recorded in the experimental group exposed to science process approach than control group who were exposed to lecture method of instruction.

Sani (2007) worked on the effectiveness of science process approach on remedial science students' performance in Jigawa state. The major objective of the study was to determine whether or not exposure to science process approach promotes the acquisition of science process skills and performance in chemistry among students in Jigawa state. The study sample consisted of 78 students drown from two tertiary institutions using purposeful sampling technique. A pretest-posttest marched group experimental design was used. College of Education Gumel comprising of forty (40) students was randomly assigned as experimental group while College of Agric Hadejia comprising of 38 students was assigned as the control group. A pretest

using teacher made test was administered to the two groups to determined their equivalence before treatment, while the two tests was administered as posttest to the two groups after treatment to ascertain the effect of the instrument. The data obtained were analyzed and hypotheses stated were tested using t-test statistics at 0.05 level of significance. Major of the finding of the study revealed that: process approach does not seem to be more effective than lecture method in enhancing academic performance in science. Some of the conclusions are: process approach is gender friendly in enhancing process skills acquisition, that boys learn chemistry concepts better when they are taught either using process approach or lecture method.

Therefore, this study is to find the effects of science process teaching approach on primary school pupils' academic achievement in basic science and technology.

2.11. Implication of Literature Reviewed on the Present Study

The review of the related literature indicated that various researchers have worked and shown the effectiveness of science process teaching approach in teaching and learning of basic science and technology at various levels of education, and that science is introduced to the pupils and they should be given the basic acts about science. Pupils should be made to recognize the direct relevance and the application of science to everyday life.

The literature review also indicated that close relationship exist between science process teaching approach and academic achievement, that if science teachers are using science process skills to teach science then our students will be creative, which will subsequently lead to scientific and technological acquisitions. However, the review indicated that science process teaching approach is not gender friendly.

From the foregoing, most of the research works conducted on science process teaching approach has concerned with other variables but study on effects of science process teaching approach on academic achievement more especially at the primary school level is relatively new. This, however, implies that there is need to conduct a research on the effect of science process teaching approach on primary school pupils' academic achievement in basic science and technology.

CHAPTER THREE

METHODOLGY

3.1. Introduction

The study intends to find out the Effects of Science Process Teaching Approach on Primary School Pupil's Academic Achievement in Basic Science and Technology in Katsina State. In this chapter, the methodology is presented under the following sub-headings.

- Research Design
- Population of the Study
- Sample and Sampling Procedure
- Pilot Testing
- Instrumentation
- Validity and Reliability
- Item Analysis
- Data Collection Procedures
- Data Analysis

3.2. Research Design

In this study quasi-experimental-control group design involving pre and posttest was employed. The research design involved two intact classes as suggested by Akuezuilo (1993). There are two groups involved in the study, in which one group was assigned as experimental and they were taught using science process teaching approach method of instruction. The second group was the control group and exposed to the conventional method of instruction. A pretest was administered to the groups before the treatment, for determining the homogeneity of the ability level of the two groups.

After the treatment, both the experimental and the control groups were administered with a posttest that is Basic Science and Technology Achievement Test (BSTAT).

The illustration of the design is presented in figure 3.1.

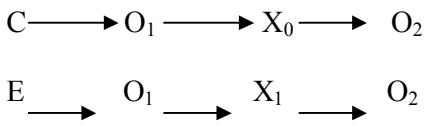


Figure 3.1 Research Design Illustrations.

Where:

C = Control group.

E = Experimental group.

O_1 = Pretest (Academic achievement, science process approach)

O_2 = Posttest (Academic achievement, science process approach).

X_0 = Conventional method of instruction.

X_1 = Science process teaching approach method (Treatment).

3.3. Population of the Study

The population of the study comprises all the primary six pupils of the five zones (A to E) which comprise thirty one (31) public primary schools in Katsina Metropolis. The schools are all coeducational. The study population is fifty seven thousand four hundred and two (57,402) pupils. The detail is presented in appendix N.

3.4. **Sample and Sampling Technique**

In selection of the four out of thirty one public primary schools in Katsina Metropolis, four zones were randomly sampled out of the five zones (A-E) by writing letters A-E on pieces of paper then squeezed them and a child was asked to pick four, in which zones B, C, D, and E were emerged. In sampling of the four schools out of the four sampled zones, stratified random sampling technique was employed, all the schools under each zone were listed serially, and the serial numbers of the schools as they appear on the list were written on pieces of paper and squeezed, using balloting method a child was asked to pick one paper for particular zone. This was repeated four times as per the number of zones. The sampled schools are , Rahamawa Primary School, zone 'B', Hassan Rafin-Dadi Primary School zone 'C', Sabuwar Unguwa Primary School, zone 'D' and Sabon-Gida Primary School, zone 'E'.

One arm of class six was randomly sampled using balloting in Hassan R/D. and S/Unguwa, these two schools have four arms of class six each. The classes sampled are; Hassan R/D. class 6D, S/Unguwa class 6C. The other two schools have only one arm of class six each, those arms were retained.

In each of the four schools, the sampled class was administered a pretest, the result of which was used to select two out of the four schools that shows

equivalence in their ability level. The schools are Sabon-Gida primary school and Sabuwar Unguwa primary school.

The details of the two primary schools selected as study sample after the pretest are shown in table 3.2.

Table 3.4. **Sample for the Study**

S/N	**Names Of Primary Schools**	**Location**	**Group**	**Sample**		**Total**
				Boys	**Girls**	
1.	S/Gida	Sabon-gida	Experimental	51	37	**88**
2.	S/Unguwa	S/Unguwa	Control	99	65	**164**
Total				**150**	**102**	**252**

Table 3.4. shows that there are a total of two hundred and fifty two pupils, one hundred and fifty are boys (150) while one hundred and two (102) are girls.

3.4. Selection of Topics for the Study

The topic selected is in the New 9- Year Basic Education curriculum, Basic Science and Technology for Primaries 4-6, theme 2:. The text book used is Longman Primary Science, pupils' book 6, by Asun P., Bajah S.T., Ndu F.O.C., Oguntonade C.B., Youdeowei A. (1999). The selection of the above text book is due to the fact that, it is one of the recommended text books primary schools in Katsina are using by the State Universal Basic Education Board Katsina.

Table 3.5**. Table of Specification on Topics**

Units	**Topics**	**No of items**	**Total**

1.	Observing the growth of crops	1,2,4,7	4
2.	Soils and crop growth	3,8,9,13,15	5
3.	Helping crops to grow well	5,6,10,11,12,14	6
	Total		**15**

NERDC (2007) reported that 'Growing Better Crops' represents part of the experience to which all learners in primary science must be exposed to, as a practical orientation, a solid foundation and the opportunities for further education in science and related discipline. The topics have a number of Science process skills relevant to the purpose of this study. These topics will be taught using science process teaching approach and conventional methods of instruction.

3.5. **Pilot -Testing**

For the purpose of this study, instrument i.e. Basic Science and Technology Achievement Test (BSTAT) was pilot tested using class six pupils of Talba Ibrahim Primary School Katsina. In the BSTAT Test the following was determined during pilot- testing:

1. The reliability of the instruments.

The method of reliability to be used is test-retest method, in this method a test was given to the pupils, after two weeks the pupils were retested. Tuckman (1975) suggested two weeks interval between first and second test, which after two weeks the items in the first test are forgotten. Pearson-Product-Moment Correlation Coefficient (PPMCC) was used to determine the reliability coefficient.

2. Items characteristics i.e. Discrimination index and Difficulty index will be determine.

3. The approximate time that will be required by the respondents to complete the test.

3.6. Instrumentation

This study investigates the effects of science process teaching approach on primary school pupils' academic achievement in basic science and technology. The instrument used for this study is Basic Science and Technology Achievement Test (BSTAT). The description of each of the instrument is presented as follows:-

3.6.1. Basic Science and Technology Achievement Test (BSTAT)

Basic Science and Technology Achievement Test (BSTAT) is designed by the researcher to measure pupils' academic achievement in the topics of basic science and technology taught. The purpose of this test is to find out how individuals can cope with the study of primary science. Test item was prepared involving fifteen (15) multiple choice items. Basic Science and Technology Achievement Test (BSTAT) was used for pre and posttest in the study.

3.6.2 Validity of the BSTAT

The instrument was submitted to two lecturers in the department of science education ABU Zaria as well as other two senior lecturers in the department of integrated science Federal College of Education, Katsina for validation.

The validators have been requested to critically examine and assess all the items of the instrument based on the following:

1. whether the test items test what they are meant to test;
2. whether the questions are clear, precise and free from ambiguity;
3. whether questions match the ability of the pupils and
4. whether the language of expression is simple and unambiguous.

The experts made constructive criticisms and corrections on the basis of content and face validity of the instrument.

3.6.3. **Reliability of the Instrument**

To determine the reliability of the instrument, a test-retest method was employed. The first test was given to the pupils of different school which are not part of this study. After two weeks interval, the second test was administered, in line with Tuckman (1975) recommendation of the use of two weeks interval for the test-retest procedure. Pearson Product-Moment Correlation Coefficient (PPMCC) statistic was used to analyze the reliability of the instrument.

On the basis of the data obtained from pilot testing of the BSTAT, reliability of the instrument used for this study was found to have a reliability coefficient of r=0.75. This shows that the instrument is reliable and could be used for the study.

3.6.4. **Difficulty Index of BSTSAT**

This is the percentage of the pupils who obtained the correct answer on items, in computing the difficulty index for each item in the test, the steps are as follows:

- Ranking – order of the scores on the test from highest to lowest.
- Identification of the high scoring group and low scoring group. The top scoring one third of the students and the bottom scoring one third.
- Determining the percentage of high scores and low scores passing an item.
- Computation of the item difficulty index by adding the percentage of those correct in the low scoring and high scoring and the divide by:

The formula is $P = \frac{U + L}{N}$

P = item difficulty

N = number of pupils involved in the analysis

U = number of pupils that got item right in the upper one third.

L = number of pupils that got the item right in the lower one third.

Difficulty index of 75% or higher is regarded as easy in terms of difficulty level. Where the index is 25% or less, the items is hard in terms of difficulty level (NTI 2006). The difficulty level of the test items ranges from 57% to 42% and therefore were retained and used.

3.6.5. **Discrimination Index of BSTAT**

This is used to identify high and low achieving pupils. This discrimination index of test items is its ability to separate or sort out high and low ranking pupils in a test. Items showing little or no difficulty or items that show a percentage of success in favour of the poor group should either be eliminated or re-examined for vagueness and ambiguity and such items were re-worded.

Discrimination index for each item is calculated by subtracting the number of pupils in the lower group who answer the item correctly from the number of pupils in the upper group who got the item right. The figure is divided by half the number of pupils in both groups or by the number of pupils in one of the groups.

The discrimination index of the Basic Science and Technology Achievement Test (BSTSAT) was determined using the formula given below.

Thus, $$D = \frac{U - L}{\frac{1}{2}N}$$

Where D = discrimination index

U = number of pupils that got the item correct in the upper of the group;

L = number of pupils that got the item correct in the lower of the group;

N = number of pupils actually involved in the items analysis (upper one third + lower one third) (NTI 2006).

The difficulty index according to Sambo (2008), any item whose difficulty index falls between 40% and 60% and for which the discrimination index exceeds 0.40 is ideal. For the purpose of this research, the difficulty index which falls between 40% and 70% and a discrimination index of 0.40 and above ware retained and used.

Table 3.6. **Table of Specification of the BSTAT Items**

S/N	Bloom's Taxonomy	No of Items	Total
1.	Remembering	1,2,4,8,10	5
2.	Understanding	5,6,7,11,12,14,15	7
3.	Applying	3,9,13	3
	Total		**15**

3.7. **Pretest Administration**

In the pretest administration, the classes selected in the four schools were presented with the test instrument. After marking, the result was analyzed using ANOVA and Post hoc Scheffe's test at $P \leq 0.05$. The analysis indicated that the result of S/Gida P.S. versus S/Unguwa shows the list F-ratio of .249 in BSTAT. The selection of these schools is in line with NOUN (2004), where it is mentioned that "as the differences between the mean squares increases, the F-ratio increases. When there is a genuine differences between the groups, the MSb or the variance estimate derived from the variance of group means around the grand mean is markedly

greater than the mean square within groups or the variance estimate derived from the variation of scores within each group, and F value will be considerably greater than 1." to find out therefore the classes in the two schools above show no significant difference in ability level and are selected as control and experimental groups respectively.

3.8. **Data Collection Procedures**

The data collection procedures were carried out as follows:

3.8.1. **Treatment Administration**

In the treatment administration, the researcher did all the teachings of both the experimental and control groups. The teaching was done in six weeks that is eighteen (18) periods was used in teaching both the experimental and control groups using science process approach and lecture method respectively. There are three periods allocated to primary science per week and each period is of thirty five minutes because of the age level of the pupils which is average of eleven years.

After six weeks of teaching the experimental and the control group by the researcher, before administering the tests, The researcher presented the test item i.e. BSTSAT to the teachers, who were teaching them basic science and technology for scrutiny of the test item. The teachers after scrutiny certify that the item was suitable.

The researcher solicited assistance from colleagues to help and administer the test same day same time in the two different schools under study. After the posttest administration, the scripts were marked BSTAT over fifteen.

3.9. **Data Analysis**

The statistical tool used in answering research questions 1-4 so as to determine their performances was the mean scores and standard deviation of the test, i.e.,

BSTAT. To test hypotheses 1-4 the significance differences in academic achievement of the pupils in the test was determine using t-test. The level of significance was $P \leq 0.05$ for retaining or rejecting the null hypotheses.

The data collected for the purpose of this study was analyzed as follows:

Ho:1. There is no significant difference in academic achievement of primary school pupils exposed to science process teaching approach and those exposed to conventional teaching method of instruction.

t-test statistics was used to test this hypothesis. $P \leq 0.05$ level of significance was set for retaining or rejecting the null hypothesis.

Ho: 2. There is no significant difference in academic achievement of male pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology.

t-test statistics was used to test this hypothesis. $P \leq 0.05$ level of significance was set for retaining or rejecting the null hypothesis.

Ho: 3. There is no significant difference in academic achievement of female pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology.

t-test statistics was used to test this hypothesis. $P \leq 0.05$ level of significance was set for retaining or rejecting the null hypothesis.

Ho: 4. There is no significant difference between male and female pupils' academic achievement when exposed to science process teaching approach in basic science and technology.

t-test statistics was used to test this hypothesis. $P \leq 0.05$ level of significance was set for retaining or rejecting the null hypothesis.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1. Introduction

In this chapter, data obtained from the result of the instrument (BSTAT) administered during the post-test were analysed using the Statistical Package for Social Science (SPSS) and presented. The analysis essentially involved statistical testing of the hypotheses stated in chapter one.

The level of significance adopted was $P \leq 0.05$ which formed basis for retaining or rejecting each of the null hypotheses stated. The t-test statistic was particularly used to test all the stated hypotheses. Each of the hypotheses is stated below along with description of the statistical tools used for testing each at $P \leq 0.05$ probability level.

4.2 Data Analysis

The result obtained from the test was used to answer the research questions re-stated that follow:

1. What is the effect of science process teaching approach on the pupils' academic achievement and those exposed to the conventional teaching method in basic science and technology?

Table 4.1. **Pupils' Mean Scores Difference in Basic Science and Technology Achievement Test (BSTAT) for Experimental and Control Group**

Groups	N	Mean	St. Dev.
Experimental	88	11.17	1.44
Control	164	9.72	1.85

From table 4.1. results shows that the experimental group performed higher than the control group. This means that science process approach enhance pupils academic achievement in basic science and technology. Therefore the research

question one above have been answered, that science process skills approach is more effective on pupils' academic achievement than conventional teaching method.

Table 4.2.**Males' Mean scores Difference in Basic Science and Technology Achievement Test (BSTAT) for Experimental and Control Group**

Groups	N	Mean	St. Dev.
Experimental	51	11.45	1.33
Control	99	9.83	1.81

From table 4.2 results shows that the experimental group performed higher than the control group. This means that science process approach enhance male academic achievement in basic science and technology. Therefore the research question three above have been answered, that science process skills approach is more effective on males' academic achievement than conventional teaching method.

4. What is the difference in female pupils' academic achievement in basic science and technology taught using science process teaching approach and conventional teaching method?

Table 4.3 **Females' Mean Scores Difference in Basic Science and Technology Achievement Test (BSTAT) for Experimental and Control Group**

Groups	N	Mean	St. Dev.
Experimental	37	10.92	1.50
Control	65	9.58	1.90

From table 4.3. results shows that the experimental group performed higher than the control group. This means that science process teaching approach enhance females' academic achievement in basic science and technology. Therefore the research question four above have been answered, that science process teaching approach is

more effective on females' academic achievement than conventional teaching method.

5. What is the effect of exposing male and female pupils to science process teaching approach academic achievement in basic science and technology?

Table 4.4. **Males and Females' Mean Scores Difference in Basic Science and Technology Achievement Test (BSTAT) for Experimental Group**

Groups	N	Mean	St. Dev.
Males	51	11.45	1.33
Females	37	10.92	1.50

From table 4.4. results shows that the experimental group performed higher than the control group. This means that science process teaching approach enhance male' academic achievement in basic science and technology. Therefore the research question five above have been answered, that science process skills approach is more effective on males' academic achievement than conventional teaching method.

The results obtained from the test conducted i.e. BSTAT analysed using t-test at $P \leq 0.05$ level of significant were also presented in the tables below along with the hypotheses re-stated.

Ho:1. There is no significant difference in academic achievement among primary school pupils exposed to science process teaching approach and those exposed to conventional teaching method of instruction.

Table 4.5. **t-test Analysis of Pupils' Mean Scores in Basic Science and Technology Achievement Test (BSTAT) for Experimental and Control Group.**

Groups	N	$\bar{X}$	sd	Df	t-value Cal.	P	Remark
Experimental	88	11.17	1.44				

				250	6.89	0.00	significant
Control	164	9.72	1.85				

* Significant at P ≤ 0.05

Since the P-value of 0.00 obtained as shown in Table 4.5. is less than 0.05 it means that there is significant difference. The null hypothesis is rejected. This means that there is statistically significant difference in the academic achievement among primary school pupils exposed to science process teaching approach and those exposed to conventional teaching method. The significant difference was in favour of the experimental group.

Ho: 2. There is no significant difference in performance and creativity attainment of male pupils taught using science process teaching approach and those taught with conventional teaching method in primary science.

This null hypothesis was used to compare the male mean scores in BSTAT for experimental and control group. The academic achievement of the male pupils was singled out and compared. The t-test statistic was used in the analysis and these were presented in table 4.3.1b.

Table 4.6. **t-test Analysis of Males' Mean Scores of Basic Science and Technology Achievement Test (BSTAT) for Experimental and Control Group**

Groups	N	$\bar{X}$	sd	Df	t-value Cal.	P	Remark
Experimental	51	11.45	1.33				
				148	6.22	0.00	significant
Control	99	9.83	1.81				

*Significant at P ≤ 0.05

The result from Table 4.6. revealed that there is significant difference in the academic achievement in basic science and technology between males that were taught using science process teaching approach and those taught using conventional teaching method. The P-value was found to be 0.00 at P≤ 0.05. The null hypothesis is therefore rejected. This shows significant difference in the performance of males exposed to science process approach as compared to those exposed to conventional teaching method.

Ho: 3. There is no significant difference in academic achievement of female pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology.

This null hypothesis was used to compare the mean scores of academic achievement of females in Basic Science and Technology Achievement Test (BSTAT) for the experimental and control group. Science process approach and conventional teaching method was used respectively.

Table 4.7. **t-test Analysis of Females' Mean Scores of Basic Science and Technology Achievement Test (BSTAT) for Experimental and Control Group**

Groups	N	$\bar{X}$	Sd	Df	t-value Cal.	P	Remark
Experimental	37	10.92	1.50				
				100	3.91	0.00	significant
Control	65	9.58	1.90				

*Significant at P ≤ 0.05

The result from the Table 4.7. revealed that there is significant difference in the academic achievement of females taught using science process approach and those

taught using conventional teaching method. The P-value was found to be 0.00 at P≤ 0.05 level of significance. The null hypothesis is therefore rejected.

Ho: 4. There is no significant difference between male and female pupils on academic achievement when exposed to science process teaching approach in basic science and technology.

The null hypothesis was used to determine the academic achievement in Basic Science and Technology Achievement Test (BSTAT) using science process approach. Scores of the males and females subjects in the experimental group was analysed using t-test statistics.

Table 4.8.**t-test Analysis of Males' and Females' Mean Scores of Basic Science and Technology Achievement Test (BSTAT) for Experimental Group**

Groups	N	$\bar{X}$	sd	Df	t-value Cal	P	Remark
Males	51	11.45	1.33				
				86	1.72	0.04	significant
Females	37	10.92	1.50				

*Significant at P ≤ 0.05

The result from Table 4.8. indicated that there was a significant difference between academic achievement of males and females when they are exposed to science teaching process approach. This is because the P-value of 0.04 obtained at P≤ 0.05 level of significance. Therefore, the null hypothesis is rejected. This result contradicts the earlier findings of Mari (2001) who revealed superiority in performance of females over their male counterpart.

4.3. Summary of Findings

The summaries of the findings are as follows.

- There is significant difference in the academic achievement of primary school pupils exposed to science process teaching approach and those exposed to conventional teaching method.

- There is significant difference in the academic achievement in basic science and technology between males that were taught using science process teaching approach and those taught using conventional teaching method.

- There is significant difference in the academic achievement of females taught using science process approach and those taught using conventional teaching method.

- There is significant difference between academic achievement of males and females when they are exposed to science process teaching approach.

4.4. **Discussion of the Results**

This research work was aimed at determining the effects of science process teaching approach on academic achievement among primary pupils in basic science and technology as compared with conventional method of instruction. Hypotheses were stated and tested based on the scores of the subjects obtained from BSTAT.

Analyses of the data obtained were presented in the tables 4.1 to 4.5.2. in accordance with the stated hypotheses. The findings from the analysis are discussed.

Hypothesis 1 states that there is no significant difference in performance among primary school pupils exposed to science process teaching approach and those exposed to conventional teaching method of instruction. The result presented in table 4.1 revealed there is significant difference in the academic achievement among

primary school pupils taught using science process approach and those taught using conventional teaching method. The experimental group performed better than control group, the mean scores of the groups is 11.17 and 9.72 respectively. This result is in conformity with the findings of Mari (2001) Chukwuemeka and Nwosu (2008), Aktamis and Ergin (2008). The result also disagrees with the result findings of Sani (2007) who discovered a significant difference in the performance of control group taught using conventional teaching method over the experimental group taught using science process approach. The result of this study therefore indicated that science process approach is better than conventional teaching method in improving pupils' performance in primary science.

Hypothesis 2 states that there is no significant difference in academic achievement of male pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology. From the result in table 4.3.1, it was discovered in the t-test results of the posttest that there was a significant difference in the performance of male experimental group in the BSTAT taught using science process teaching approach and the male control group taught using conventional method of instruction. The result agrees with the findings of Aktamis and Ergin (2008), where they discovered a significant difference in the performance of males treated with science process approach as compared with their males counterpart treated with conventional teaching method.

Hypothesis 3 states that there is no significant difference in academic achievement of female pupils taught using science process teaching approach and those taught with conventional teaching method in basic science and technology. From the result in table 4.4.1, it was discovered that there was a significant difference in the performance of female experimental group in the BSTAT taught

using science process teaching approach and the female control group taught using conventional teaching method of instruction. The result agrees with the findings and Chukwuemeka and Nwosu (2008) where they discovered a significant difference in the performance of females treated with science process approach as compared with their females counterpart treated with conventional teaching method.

Hypothesis 4 states that there is no significant difference between male and female pupils on academic achievement exposed to science process teaching approach in basic science and technology. Table 4.5.1 shows a comparison of male and female mean scores exposed to BSTAT within the experimental group. The result indicated a significant difference in favour of male. This result is in conformity with the findings of Gumel (2007), and disagrees with the findings of Mari (2001) who revealed superiority in the performance of females over males.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study deals with determining the effects of science process teaching approach on primary school pupils' academic achievement in basic science and technology. This chapter is presented in the following sub-headings:

- Summary
- Conclusion
- Recommendations and
- Limitation of the Study
- Suggestions

5.2 Summary

This study is aimed at determining the effects of science process teaching approach on primary school pupils' academic achievement in basic science and technology. The two primary schools were randomly sampled for the study. One arm of class six was selected randomly from the two schools for the study. The schools are Sabon-Gida primary school as experimental and Sabuwar Unguwa primary school as control. The experimental group was treated using science process teaching approach while the control group was treated using conventional teaching method. The area selected to teach during treatment was 'Growing Better Crops'. Four hypotheses were formulated and tested using t-test statistics at $P \leq 0.05$.

A pretest-posttest quasi experimental control group design was used for the purpose of data collection. A pretest was first administered before treatment was

given. After this, an intensive teaching session of six weeks, after which a posttest using instrument (i.e. BSTAT) was administered. Data collected from the posttest scores of the pupils in the two groups were analysed using t-test at the 0.05 level of significance.

Results of the data analysed revealed that:

1. science process teaching approach is more effective than conventional teaching method of instruction in enhancing academic achievement in basic science and technology.

2. males performed significantly better than female when exposed to science process teaching approach.

5.3. Summary of Major Findings

The summary of the findings are as follows.

- There is significant difference in the academic achievement of pupils taught using science process approach and those taught using conventional teaching method in favour of the experimental group. The experimental group also shows high mean scores than the control group.

- There is significant difference in the performance of males in BSTAT between experimental group treated with science process teaching approach and control group treated with conventional teaching method in favour of the experimental group, the experimental group also shows high mean scores than the control group.

- There is significant difference between the performance of females' experimental group in the BSTAT and the females control group, in favour

of the experimental group. The result indicated high mean scores in experimental group than the control group.

- Comparison of male and female exposed to BSTAT within the experimental group. The result indicated a significant difference in favour of male. The mean scores of the experimental group is higher than the that of control group.

5.4. **Conclusions**

From these revelations, the following conclusions are drawn:

When pupils are exposed to science process approach they achieved better academically than those exposed to conventional method of teaching in basic science and technology.

Males exposed to science process teaching approach performed better than females exposed to the same treatment. Science process approach of teaching is not gender friendly in academic achievement.

5.5. **Recommendations**

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

1. That effort should be made by all stakeholders to discourage gender stereotyping. In view of this therefore, the home, the school and the society at large should encourage females to participate fully in skill-based activities within and outside school.

2. Also enabling environment should be provided based on culture and believe of the society. No matter how effective certain method of teaching is, it may not yield the required result if the teachers are not properly and adequately equipped with the technical-know-how regarding the use of the method.

3. Government concerned with the responsibilities of managing the affairs of primary schools should design special training programs for basic science and technology teachers so as to keep them abreast with the current development in methodology of teaching and new innovation such as SAPA that are being invented by educational researchers.

5.6 **Limitations of the Study**

The following are the limitations of the study

1. The sample used in this study were limited to only primary six pupils of public schools own by Local Education Authority (L.E.A.) which is a government organ in Katsina Metropolis. Privately owned schools or by organizations or individual were not used. Also rural schools were left out in this study. An extension of the study to other classes, privately owned schools and rural schools should be carried out in order to be able to generalize the findings.

2. The concept taught was limited to growing better crops. Further studies can be carried out to cover other topics in basic science and technology.

5.7. **Suggestions for Further Studies**

Based on the findings of the study the following suggestions are made:

1. Similar study on Effects of Science Process Teaching Approach be conducted at tertiary institutions such as NCE, Polytechnics and undergraduates to see whether it will yield similar result with the present study.

2. The composition of the schools be changed to include privately owned and organizations' owned schools to see what the result will be.

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APPENDIX A

Date…….

LETTER OF INTRODUCTION

Sir,

The bearer IBRAHIM ABUBAKAR MED/EDUC/19643/2007-08 is a post-graduate student of Ahmadu Bello University, Zaria in the Department of Education (Science Education Section) currently undertaking a research on the Effects of Science Process Teaching Approach on Primary School Pupils' Academic Achievement in Basic Science and Technology in Katsina State . In view of the above therefore, you should kindly give him all the necessary assistance that he may require.

Thank you.

(…….)
Student's Supervisor
Dr. Alhaji Usman Isah

APPENDIX B
SCIENCE PROCESS TEACHING APPROACH LESSON PLAN ONE
(EXPERIMENTAL GROUP)

Subject: Basic Science and Technology

Topic : Observing Crops Growing

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Hoe and Container

Behavioural Objectives: By the end of the lesson pupils should be able to:

1. recognize that crops are planted and grow on the soil.
2. recognize that crop plants grow big and strong on rich soils.
3. recognize that on poor soils crop plants don't grow big and strong.
4. distinguish between rich and poor soils.

Previous knowledge: Pupils have been seeing plants growing on the school compound and other places within their environment.

Introduction: The lesson introduced by asking the pupils to come out gently and moved around the school compound and nearby places where plants are growing they were also asked to carry their note books and pencils.

Presentation Step 1: The lesson was presented by leading the pupils round the school environment and note areas where crop plants are growing well and where they are not. Pupils were asked to take note of the growth difference between the two areas.

Step 2: Pupils were asked to dig the soil from where the crops are growing well and where the crops are not growing well and compare the soils from the two areas.

Pupils' Activities – Pupils went round the school environment they observed and noted areas where crops are growing well and where crops are not growing well.

- Pupils dug and collected soils samples from the areas that support good growth and the areas where crops are grown poorly.

- Pupils examined the two soil samples collected and recorded the differences between the two soils.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. On what medium do crops grow?
2. On what kind of soil do crops grow well? And
3. What kind of soil do crops grow poorly?
4. List any two differences between the soil that crops grow well and where crops are not growing well.

Conclusion: The lesson was concluded by summarizing the main points that:

- Some crops in the farm grow well because they are growing in rich soils which contained all the things the crops need.
- Other crops do not grow well because they are growing in poor soils which have only few of the things crops need to grow well.
- Soil in the farm is not the same all over the farm.
- In some parts of the farm the soil is rich but in other parts it is poor.

Pupils were asked to come to school during next lesson with empty tins of Milo, bournvita or that of powdered milk.

APPENDIX C

SCIENCE PROCESS TEACHING APPROACH LESSON PLAN TWO (EXPERIMENTAL GROUP)

Subject : Basic Science and Technology

Topic : Growing Crops in Different Soils

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Soil Samples and Containers

Behavioural Objectives: By the end of the lesson pupils should be able to:

1. list the three different types of soil.

2. identify the three different types of soil.

3. mention at least two characteristics of each of the three types of soils.

Previous knowledge: Pupils have idea on soils found in the playground, in the farms, school garden e.t.c.

Introduction: The lesson was introduced by revising the previous lesson's activities carried out with the pupils, as soils are not of the same type anywhere, there are rich and poor soils, that rich soils encourages good growth of crops, while poor soils does not.

Presentation Step 1: The lesson was presented by grouping the pupils into ten groups. Then the teacher presented three buckets containing soil samples to the whole class. The three buckets was labelled A, B and C containing sand, clay and loam respectively.

Step 2: The groups were asked to carry three empty tins and labelled the three tins A, B, and C with the marker provided by the teacher. Under the guidance of the teacher the group leaders were asked to come out with their tins and collect the soil samples for their groups.

Step 3: Each group were instructed to use their fingers and rub the three soil samples and record the smoothness or otherwise of each sample. Pupils were asked to write down the sample that has larger particles and the sample that has very fine particles.

Step 4: Groups were then asked to put equal amount of water to each of the three soil sample and record which container its water drained first, second and last.

Step 5: Groups were also instructed to collect some part of the wetted three soil samples and mould it to form a ribbon or press it form any shape. They were also asked to record which among the 3 samples formed the ribbon.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. List the three types of soils.
2. How can you identify the following types of soils: sand, clay and loam?
3. mention any two characteristics of each of the three types of soils

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

1. There are three types of soils namely sand, loam and clay.
2. That sand particles are larger and loose, sand don't hold water.
3. Loam soils have moderately fine particles and hold water moderately, it has high humus content.
4. Clay soils have very fine particles, it holds water for longer period of time, it is stick and very hard when wet.

APPENDIX D

SCIENCE PROCESS TEACHING APPROACH LESSON PLAN THREE

(EXPERIMENTAL GROUP)

Subject: Basic Science and Technology

Topic : Growing Crops in Different Soils

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Soil Samples, Containers, water and Maize Seeds

Behavioural Objectives: By the end of the lesson pupils should be able to:

1. prepare soil and seed sowing

2. observe the level of growth of crops in three different soil types.

Previous knowledge: Pupils recognised the three types of soil and their characteristics from the previous lesson.

Introduction: The lesson was introduced by revising the previous lessons activities as soil being the medium in which crops grow, that there are 3 types of soils, that sand particles are larger while that of clay are fine and smooth, clay soils hold for longer period of time while sand soil drain water very quickly and that clay particles stick together when wet and can be moulded to form ribbon.

Presentation Step 1: Groups was instructed to come and fill their tins with the 3 soil samples and asked them to label them A, B, and C i.e. sand, clay and loam respectively. The Groups were then told to water their experiments adequately. Each group were given six maize seeds and asked them to sow two seeds per each soil sample, using the depth of the mark of their forefinger and cover the seeds gently.

Step 2: Each group was directed to carry their experiments to the school metrological garden and get a portion specifically for their respective group and keep. Pupils were instructed to be watering their experiments morning and evening daily. Each group was asked to keep records of their experiments by using ruler to measure the seedlings weekly.

Pupils' Activities – Pupils moved to their various groups, each group having 3 tins containing the 3 different soil samples. Members of each group under the supervision and guidance of the teacher were following the instructions given.

Evaluation: The lesson was evaluated by asking the pupils to go back to the class and asked them the following questions:

1. What is the medium in which farmers used to plants their crops?
2. What will happen if your experiments are not watered?

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

1. Crops are sown in the soil for them to grow.
2. There must be regular watering of the sown crops.

APPENDIX E

SCIENCE PROCESS TEACHING APPROACH LESSON PLAN FOUR (EXPERIMENTAL GROUP)

Subject: Basic Science and Technology

Topic : Helping Crops to Grow Well (Manure)

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Manure, Sandy soil, Beans seeds and Containers

Behavioural Objectives: By the end of the lesson pupils should be able:

1. identify manure.
2. recognized that manure make soil to become rich.

Previous knowledge: Pupils discovered that a rich soil encourages plants growth while sandy soil does not encourage good crop growth as experimented and that they were familiar with refuse in there homes.

Introduction: Pupils were asked to go to their respective groups. The groups were then called to come and collect manure, sand and bean seeds. Pupils were then to ask to identify what was given to them. Pupils were asked to specifically identify the composition of manure under the guidance of the teacher.

Presentation Step 1: Pupils were asked to suggest the cost of manure, and whether manure is sold at the market or not. Pupils were also guided to discover where manure was found and formed.

Step 2: Groups were instructed to fill their 2 tins with the sand provided and level the tins 1 and 2. Tin 1 were mix with manure and leave tin 2 without manure. Each

group were asked to water the tins and seeds were sown using the depth of the first mark of their forefinger and then cover the beans seeds gently.

Step 3: Groups were instructed to carry their experiment to metrological garden of the school where they were asked to continue watering twice daily. Pupils were guided how to measure the growth of the seedlings using ruler and record their readings as shown.

Pupils' Activities: Pupils were engaged doing the activities instructed and guided by the teacher in their respective groups, e.g. observing manure to explain what it constitute.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. List two things that decomposed and make up manure.
2. What do farmers use manure for?
3. If manure is applied to the soil, what ultimately use it at the end?

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

- Manure is the decomposed plants and animal waste.
- It is rich in things that crops need for good growth.
- It is applied to the soil in order for crops to grow well and to make soil very rich.
- Manure is cheaper thereby making farmers to produce and make profit.

APPENDIX F

SCIENCE PROCESS TEACHING APPROACH LESSON PLAN FIVE (EXPERIMENTAL GROUP)

Subject: Basic Science and Technology

Topic : Helping Crops to Grow Well (Fertilizers)

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Fertilizer, Sandy soil, Containers and Maize Seeds.

Behavioural Objectives: By the end of the lesson pupils should be able to:

1. identify fertilizers.
2. explain that fertilizers make soil to become rich.
3. explain the precaution measures in the use of fertilizers on our crops.

Previous knowledge: Pupils performed experiment using manure and were able to discover that manure increases soil fertility when added to the soil.

Introduction: The lesson was introduced by discussing the previous lesson that manure added to the poor soils and make rich and suitable for good growth of the crops and it also cheaper. The teacher asked the individual groups to give the record of their experiments after measuring for the week.

Presentation Step 1: The teacher then distributed the sample of NPK 15-15-15 or otherwise known as ‘compound fertilizer’ to each group and asked them to identify and how it is formed. The teacher facilitates the discussion in trying to explain how it formed.

Step 2: Teacher together with the pupils then discussed how much fertilizer cost, where it is being sold. Pupils were made to discover the price of fertilizer as compared to that of manure. Some other examples of fertilizer were discussed with the pupils e.g. SSP, CAN, UREA e.t.c.

Step 3: The teacher then instructed each group to fill their 2 tins with sandy soil provided, and then level the tins 1 and 2, they were then asked to water the tins and sow the maize seeds as they were instructed previously. Unlike experiments carried out using manure, this time around they were asked not to apply the fertilizer until after germination. The experiments were carried out side, and instructed the pupils to water them as usual.

Step 4: The teacher together with the pupils the discussed the reason for not mixing fertilizer with the sand as did with manure, fertilizers are not allowed to touch any part the crops when applying. That any part of the crop the fertilizer touches will burn the crop leading to its death. The methods used in fertilizer application include placement and band method. These methods were demonstrated with pupils.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. What are fertilizers.
2. List the any three types of fertilizers.
3. Why do farmers use fertilizers on their farms?
4. Why do farmers avoid fertilizers from touching the plants?

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

- Fertilizers are chemicals use by farmers to increase soil fertility for good crop growth.

- Fertilizers are expensive; some types of fertilizers are NPK, CAN, SSP, Urea e.t.c.
- That fertilizer application is done with caution; farmers should not allow the fertilizers to the body of the plants.

APPENDIX G

CONVENTIONAL TEACHING METHOD LESSON PLAN ONE

(CONTROL GROUP)

Subject: Basic Science and Technology

Topic : Observing Crops Growing

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Chart showing plants growing

Behavioral Objectives: By the end of the lesson pupils should be able to:

1. recognize that crops are planted and grow on the soil.
2. recognize that crop plants grow big and strong on rich soils.
3. recognize that on poor soils crop plants don't grow big and strong.
4. distinguish between rich and poor soils.

Previous knowledge: Pupils have been seeing plants growing on the school compound and other places within their environment.

Introduction: The lesson was introduced by explaining to the pupils that seeds of various plants are growing on soils that are exposed in the environment, e.g. in the farm, garden and other places.

Presentation Step 1: The lesson was presented by explaining to the pupils that crop plants like beans, maize, millet, groundnut e.t.c. are planted in the soils in the farm, and that some other plants such as grasses are growing on playground, bushes e.t.c. that soil in the farm may not be the same some parts the soil be may rich while the other part of the farm the soil may be poor.

Step 2: The teacher explained to the pupils that crop plants that grow on good and rich soil are bigger and stronger, the plants growing on such rich soils are also healthier with very greenish colour of the leaves.

Step 3: The teacher explained to the pupils that crop plants that are grown on poor soils will not grow bigger and stronger and the leaves will also not be very greenish in colour.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. On what medium do plants grow?
2. On what kind of soil do plants grow well? And
3. What kind of soil do plants grow poorly?
4. List any two differences between the soil that crops grow well and where crops are not growing well.

Conclusion: The lesson was concluded by summarizing the main points that:

- Some crop plants in the farm grow well because they are growing in rich soils which contained all the things the plants need.
- Other plants do not grow well because they are growing in poor soils which have only few of the things plants need to grow well.
- Soil in the farm is not the same all over the farm.

APPENDIX H

CONVENTIONAL TEACHING METHOD LESSON PLAN TWO

(CONTROL GROUP)

Subject: Basic Science and Technology

Topic : Growing Crops in Different Soils

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Samples of sand, loam and clay

Behavioral Objectives: By the end of the lesson pupils should be able to:

1. list the three different types of soil.
2. identify the three different types of soil.
3. mention at least two characteristics of each of the three types of soils.

Previous knowledge: Pupils have idea on soils found in the playground, in the farms, school garden e.t.c.

Introduction: The lesson was introduced by revising to the pupils what they were taught on previous lesson, that soils are not the same, there are rich and poor soils, that rich soils support plant growth while poor soils don't.

Presentation Step 1: The lesson was presented by explaining and listing the three types of soils on the board namely; sand, loam and clay and present the sample to the class.

Step 2: The teacher explained to the pupils the characteristics of the loam as it is the combination of sand and clay together with humus particles. Clay soils hold water

moderately for a while, the particles are relatively sticky and it is found mostly at the top soil.

Step 3: The teacher explained to the pupils the characteristics of the sand soil that it does not hold water, that it does not stick together when pressed with hand, that the sand particles are larger and loose and there is no much humus in it.

Step 4: The characteristics of clay soils was be explained to the pupils, that clay soils has very fine particles and it hold water for longer period of time than sand and loam. The clay particles stick and form ribbon when wet, it also become very hard when dry.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. List the three types of soils.
2. How can you identify the following types of soils: sand, clay and loam?
3. mention any two characteristics of each of the three types of soils

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

- There are three types of soils namely sand, loam and clay.
- That sand particles are larger and loose, sand don't hold water.
- Loam soils have moderately fine particles and hold water moderately, it has high humus content.
- Clay soils have very fine particles, it holds water for longer period of time, it is stick and very hard when wet.

APPENDIX I

CONVENTIONAL TEACHING METHOD LESSON PLAN THREE

(CONTROL GROUP)

Subject: Basic Science and Technology

Topic : Growing Crops in Different Soils

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Diagram Showing 3 group of crops growing at different rate.

Behavioral Objectives: By the end of the lesson pupils should be able to:

1. recognize the level of growth in three different soil types.
2. identify the three different types of soil.

Previous knowledge: Pupils were taught the three types of soil in the previous lesson

Introduction: The lesson was introduced by explaining the general functions of soil to plant as the medium by which farmers grow their crop plans.

Presentation Step 1: The lesson was presented by explaining and listing the three types of soils on the board namely; sand, loam and clay and present the sample to the class.

Step 2: The teacher explained to the pupils the characteristics of the sand soil that it does not hold water, that it does not stick together when pressed with hand, that the sand particles are larger and loose and there is no much humus in it.

Step 3: The teacher explained to the pupils the characteristics of the loam as it is the combination of sand and clay together with humus particles. Clay soils hold water

moderately for a while, the particles are relatively sticky and it is found mostly at the top soil.

Step 4: The characteristics of clay soils was be explained to the pupils, that clay soils has very fine particles and it hold water for longer period of time than sand and loam. The clay particles stick and form ribbon when wet, it also become very hard when dry.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. List the three types of soils.
2. How can you identify the following types of soils: sand, clay and loam?
3. Who can mention any two characteristics of the following types of soils?

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

- There are three types of soils namely sand, loam and clay.
- That sand particles are larger and loose, sand don't hold water.
- Loam soils have moderately fine particles and hold water moderately, it has high humus content.
- Clay soils have very fine particles, it holds water for longer period of time, it is stick and very hard when wet.

APPENDIX J

CONVENTIONAL TEACHING METHOD LESSON PLAN FOUR

(CONTROL GROUP)

Subject: Basic Science and Technology

Topic : Helping Crops to Grow Well (Manure)

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Manure and Soil Sample

Behavioral Objectives: By the end of the lesson pupils should be able to:

1. define manure.
2. recognized that manure make soil to become rich.

Previous knowledge: Pupils were taught that a rich soil encourages plants growth and that they were familiar with refuse in there homes.

Introduction: The lesson was introduced by reviewing the previous lesson that soils are of various types, some are fertile e.g. loam while others are not e.g. sand, so poor soils have to be helped.

Presentation Step 1: The lesson was presented by explaining the concept of manure as the decomposed remain of plants waste and animal dung. It is the cheapest and contains all the things that plants need for good growth.

Step 2: The teacher explained to the pupils that farmers whose farm have poor sandy soil they put manure to the soil so that it become rich and fertile and this will make the crops to grow bigger and healthy.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. List the any two things that decomposed and make up manure.
2. What do farmers use manure for?
3. If manure is applied to the soil, what ultimately use it at the end?

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

- Manure is the decomposed plants and animal waste.
- It is rich in things that plants need for good growth.
- It is applied to the soil in order for plants to use it and to make soil very rich.

APPENDIX K

CONVENTIONAL TEACHING METHOD LESSON PLAN FIVE

(CONTROL GROUP)

Subject: Basic Science and Technology

Topic : Helping Crops to Grow Well (Fertilizers)

Class : Primary Six

Average Age: Eleven years

Sex : Mixed

Duration: 35 minutes

Teaching Aid: Fertilizer and soil samples.

Behavioral Objectives: By the end of the lesson pupils should be able to:

1. define fertilizers.
2. explain that fertilizers make soil to become rich.
3. explain the precaution measures in the use of fertilizers on our crops.

Previous knowledge: Pupils were taught that manure increases soil fertility when added to the soil.

Introduction: The lesson was introduced by reviewing previous lesson to the pupils that manure added to the poor soils and make rich and suitable for good growth of the crops and it also cheaper.

Presentation Step 1: The lesson was presented by explaining the fertilizers as being made up from chemicals by industries and are sold to farmers in bags. There are various kinds of fertilizers; the commons ones are: NPK, CAN, SSP, Urea e.t.c.

Step 2: Teacher will explain to the pupils that fertilizers are sold to the farmers either in the market at higher price or at government subsidized price. Fertilizers are so expensive that many farmers cannot afford.

Step 3: The teacher then explained to the fertilizers like manure are applied to the soil in order to make it rich so that plants grow well.

Step 4: The teacher explained to the pupils that unlike manure, fertilizers are not allowed to touch any part the crops when applying. That any part of the plant the fertilizer touches will burn the crop leading to its death.

Evaluation: The lesson was evaluated by asking the pupils the following questions:

1. What are fertilizers.
2. List the any three types of fertilizers.
3. Why do farmers use fertilizers on their farms?
4. Why do farmers avoid fertilizers from touching the plants?

Conclusion: The lesson was concluded by summarizing the main points to the pupils that:

- Fertilizers are chemicals use by farmers to increase soil fertility for good plants growth.
- Fertilizers are expensive; some types of fertilizers are NPK, CAN, SSP, Urea e.t.c.
- That fertilizer application is done with caution; farmers should not allow the fertilizers to the body of the plants.

APPENDIX L

BASIC SCIENCE AND TECHNOLOGY ACHIEVEMENT TEST (BSTAT)

Instructions: Answer all questions. You are required to choose the letter A to D bearing the correct answer.

Name of your school ----------

Sex (tick as appropriate)

Male	Female

1. The medium in which plants germinate and grow is called:
   (a) water
   (b) air
   (c) sunlight
   (d) soil
2. Which of the following groups contain all the 3 types of soil?
   (a) clay, rock, sand
   (b) rock, granite, sand
   (c) loam, sand, clay
   (d) rock, granite, stones
3. One of the characteristics that enable farmer to identify clay soil is:
   (a) sticky when wet
   (b) loose when mix with water
   (c) larger particles
   (d) drain water quickly
4. Which type of soil best support good plant growth?
   (a) sand
   (b) loam
   (c) clay
   (d) stones
5. Why do local farmers used to prefer manure than fertilizer?
   (a) because it add nutrients to the soil
   (b) because it contains humus
   (c) because it is cheaper and affordable
   (d) because it is decomposed remains of plants waste
6. When applying fertilizer to the soil which method is most prefer among the following?
   (a) broadcasting
   (b) placement
   (c) mix with seeds when planting
   (d) mix with water then apply
7. If you are ask to collect loam soil in your school compound, the best portion to get it is to dig:
   (a) deep soil
   (b) sub soil
   (c) top soil
   (d) all of the above
8. What is in the loam soil that makes it to be richer than others?
   (a) humus
   (b) nitrogen

(c) air
(d) water

9. A farmer identify sand in terms of water holding capacity when water is:
(a) retained for longer period of time
(b) drained very fast
(c) waterlogged
(d) changing colour

10. The decomposed remain of plants waste and animal dung is called;
(a) manure
(b) manual
(c) fertilizer
(d) fertility

11. Farmers are applying manure on their farms because it is useful to:
(a) animals
(b) crops
(c) insects
(d) soil

12. Which of the following best describe fertilizer?
(a) chemically manufacture substance
(b) decomposed materials

(c) mixture of plants and animals waste

(d) boiled substance

13. A farmer rubs a soil sample between his fingers and feels that the particles are fine this indicate that the soil is a:
(a) clay
(b) sand
(c) stones
(d) loam

14. Why does a farmer used to apply fertilizer on the farm?
(a) to decorate the soil
(b) to make the soil richer
(c) to make the soil become loose
(d) to drain waterlogged

15. The type of soil that has larger particles is:
(a) silt (b) loam (c) sand (d) clay

APPENDIX M

BASIC SCIENCE AND TECHNOLOGY ACHIEVENMT TEST (BSTAT)

MARKING SCHEME

Section A (Multiple Choice)

1. D
2. C
3. A
4. B
5. C
6. B
7. C
8. A
9. B
10. A
11. B
12. A
13. A
14. B
15. C

Any 1x15=15 marks

APPENDIX N

LIST OF PUBLIC PRIMARY SCHOOLS IN KATSINA METROPOLIS

S/N	Names Of Primary Schools	Location	Zone	Pupils' Enrolment		Total
				BOYS	GIRLS	
1	A. Kumasi Sci.	Kayalwa	A	1851	1657	3510
2	Dan Marna	Dan Marna	A	470	423	893
3	Dikko Memorial	Iyatanci	A	876	867	1743
4	Dr. Kabir Usman	S/ Unguwa	A	3049	2816	5865
5	Estate Islamiyya	D/ S. L. cost	A	993	892	1885
6	Farin Yaro	Farin Yaro	A	879	831	1710
7	Filin Polo	Filin polo	A	669	654	1323
8	Garba Kaita	Yammawa	B	466	400	866
9	Gidado	Rafukka	B	575	504	1079
10	Gobarau	Gobarau	B	907	857	1764
11	H. Fatima Shema	K/ Yandaka	B	103	62	165
12	Hassan Rafindadi	Gafai	B	1646	1677	3323
13	Hassan Usman Sc.	Modoji	B	767	681	1448
14	Isa Kaita	K/ Kaura	C	1288	1221	2509
15	Jabiru Abdullahi	Garama	C	1874	1841	3715
16	Kofar Sauri	Kofar Sauri	C	737	873	1610
17	Mamman Barda	D/Amare	C	1835	1808	3646

18	Muhammad Dodo	K/K. Lay out	C	514	556	1070
19	Musa Yar'adua	Ambuttai	D	893	868	1761
20	Nagogo Memorial	Kofar keke	D	585	325	910
21	Rahamawa	Abattoir	D	749	672	1421
22	Sabon Gida	Sabon Gida	D	279	325	604
23	Sabuwar Unguwa	Kofar Kaura	D	519	591	1010
24	S. Noma Bala	Kofar Guga	D	534	485	1019
25	Sararin Kuka	Sarari Kuka	E	570	575	1145
26	Sandan Bale	Filin Samji	E	518	511	1029
27	Sen. Ibrahim Ida	Abattoir	E	1121	1060	2181
28	Talba Ibrahim	K/ Marusa	E	1102	990	2092
29	Tudun Muntsira	T/ Muntsira	E	454	461	915
30	Tudun Yanlihidda	T/Yan'lihidda	E	211	218	429
31	Waziri Zayyana	Rafindadi	E	2470	2292	4762
TOTAL				**29507**	**27895**	**57402**

*Source: Katsina L.E.A. (2010)