IMPACT OF PROCESS-BASED INSTRUCTION ON ACQUISITION OF SCIENCE SKILLS, PERFORMANCE AND RETENTION AMONG BASIC SCIENCE STUDENTS IN ZARIA EDUCATIONAL ZONE, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY ZARLA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN SCIENCE EDUCATION

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APRIL, 2019

DECLARATION

I declare that this thesis entitled: ‘‘Impact of Process-Based Instruction on Acquisition of Science Skills Performance and Retention among Basic Science Students in Zaria Educational Zone, Nigeria” has been carried out by Christiana, ADANYI with registration number P16EDSC9059 in the Department of Science Education, Faculty of Education, Ahmadu Bello University, Zaria, Nigeria. The thesis is a record of my own research work and no part of this thesis was previously presented for another degree or Diploma at this or any other institution. All quotations and information derived from the literature have been duly acknowledged in the list of references provided.

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Christiana, ADANYI Date

CERTIFICATION

This thesis entitled ‘‘IMPACT OF PROCESS-BASED INSTRUCTION ON ACQUISITION OF SCIENCE SKILLS PERFORMANCE AND RETENTION AMONG BASIC SCIENCE STUDENTS IN ZARIA EDUCATIONAL ZONE, NIGERIA” has been carried out by Christiana, ADANYI with registration number P16EDSC9059 meets the regulations governing the award of the degree of Doctor of Philosophy (PhD) in Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my beloved husband David Mson Adanyi for his love and support throughout this work.

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LIST OF ABBREVIATIONS

STAN: Science Teachers Association of Nigeria

PPSSC: Physical Science Study Committee

BSPS: Basic Science Process Skills

SAPA: Science- A Process Approach

NABTEB: National Business and Technical Education Board

UBE: Universal Basic Education

EFA: Education for All

NEEDS: National Economic Empowerment and Development Strategy

BPSP: Bendel Primary Science Project

NSSSP: Nigerian Secondary School Science Project

NBSP: Nigerian Basic Science Project

NISP: Nigerian Integrated Science Project

MDGs: Millennium Development Goals

ISPS: Integrated Science Process Skills

PBI: Process-Based Instruction

PBIS: Process-Based Instruction Strategy

BSPT: Basic Science Performance Test

SPSAT: Science Process Skills Acquisition Test

AAAS: American Association for the Advancement of Science

PBIP: Process-Basic Instructional Package

CESAC: Comparative Education Study and Adaptation Centre

NERDC: Nigerian Educational Research and Development Council

PEIP: Primary Education Improvement Project

USSR: Union of Soviet Socialist Republic

OPERATIONAL DEFINITION OF TERMS

Lecture Method: A teaching strategy involving students sitting before the teacher, watching and listening passively with minimal chance of participation. It can be in a verbal or non-verbal form.

Process-Based Instruction: Procedural skills used to produce and use scientific information to perform scientific research and to solve problems.

Basic Science Concepts: Concepts taught and learnt at the last/upper level under the Universal Basic Education Scheme (UBES) which corresponds to the Junior Secondary School (JSS).

Academic Performance: An attainment skills scores after exposure to learning activities

Retention: Ability to recall, remember and recollect a body of knowledge after passing through instruction.

Impact: An impression expressed by individuals as a result of exposure to a pedagogical.

Science Process Skills Acquisition: Is the development of procedural skills use to produce and use scientific information to perform scientific research and to solve problems.

ABSTRACT

The persistent poor performance of students in the Junior Secondary School Certificate Examination by Basic Science students is causing concern and poses a problem in subsequent learning of science related courses. This study investigated the impact of Process-Based Instruction on science skills acquisition, performance and retention among Basic Science students in Zaria Educational Zone, Kaduna, Nigeria. The research was quasi-experimental control group design that employed pre-test, post-test and post-posttest. The study population comprised 4,157 (2,615 males and 1,542 females) students from twenty five co-education schools. Two schools comprising 75 students (44 males and 31 females) were randomly selected for the study, one was randomly assigned as experimental group while the other served as control group. The experimental group was taught using PBI while the control group was taught by LM. Both groups underwent pre-test treatment and post-test. Two instruments were used for gathering data, Basic Science Performance Test (BSPT) with reliability co-efficient of r=0.76 and Science Process skills Acquisition Test (SPSAT) with reliability co-efficient of r=0.71. The data obtained were analyzed using t-test statistic at $p \leq 0.05$ level of significance. Findings revealed that students taught by PBIS performed better and retained Basic Science concept learnt than those taught by LM. There was also difference in the academic performance and process skills acquired by male and female students exposed to PBIS in favour of male. There was difference in observation, classification, measurement and experimentation skills in favour of female students while interpretation of Data was in favour of males. All the subjects however, performed the same in inferring skills. Among recommendation given was that PBIS be incorporated in science teacher training curriculum by the Ministry of Education in order to produce teachers who would handle PBIS technique effectively. Also PBIS should be introduced in the first year of the secondary schools as means to reduce the gender related differences in science process skills acquisition between male and female students in schools.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science education is an indispensable tool for national development because of the important position it occupies in the development and growth of all nations. The economic and political strength of a nation is globally assessed in terms of her achievement in science and technological advancement. All nations including Nigeria are struggling to improve on their science by laying more emphasis on the proper implementations of science and technology. The emphasis placed on science alongside with the important role it plays towards national development, makes it pertinent, practically necessary for science to be taught in an organized and well-structured pattern involving activities for students. On the contrary, before the mid-1950s science teaching was geared towards memorization and regurgitation of scientific knowledge. Ajayi, (2009) observed that, most elementary science teachers spend most of their time in the class teaching for memory and comprehension as opposed to teaching for development of positive thinking skills and acquisition of science process 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 necessitated 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. These include among others the Physical Science Study Committee (PSSC) and the Science-A Process Approach (SAPA).In these programmes, emphasis was shifted from the acquisition of academic knowledge in science through memorization of facts to acquisition of science skills, through inquiry and problem solving. SAPA was created to teach students scientific investigation methods and to provide teachers guidance on which practices students should learn during the elementary years. Jadrich & Bruxvoort, (2011) also stated that, the idea students should learn and engage in some of the processes of science has been an element of science instruction for so many years. Eze, (2010) is of the same view that most science educators recommend that students practice how to acquire science process skills while solving problems rather than simply learning the processes.

In Nigeria, curriculum changes were stimulated by individuals, professional bodies and institutions. Both individual, professional bodies and institutions advocated for changes in Nigeria educational system that would reflect peculiar circumstances and what the nation required of an individual to make him useful to his community. Such institutions and professional bodies according to Ajayi, (2009) include the Science Teachers Associations of Nigeria(STAN) who develop the Integrated Science Project and the Comparative Educational Study and Adoption Center (CESAC) now Nigeria Research and Development Council (NERDC) who developed the Nigerian Secondary School Project (NSSP). Emphasis in these curriculum materials was placed on promotion of acquisition of science skills and problem solving. This could be achieved through hand-on activities which would assist students learn skills scientists use in solving scientific problems and acquiring the processes involved. This is in line with Al-R abaani, (2014) who opined that teachers cannot teach science effectively without employing the process of science, neither can students learn science effectively without process of science.

One of the aims of the National Policy on Education (FME, 2013) concerning science education as stated in Basic Science curriculum is to equip students to live effectively in modern age of science and technology. In line with this objective, science subjects are among the core subjects that are being taught in secondary schools, Nigerian Colleges of Education, Polytechnics and University as well. At the junior secondary level, Basic Science is introduced for the purpose of laying solid foundation for subsequent science studies at the higher level. Basic Science lays emphasis on both contents and teaching methods. Kasim, (2007) described Basic Science as a course devised and presented to students in such a way that students gain the concepts of the fundamental unity of science, the commonality of approach to problem of scientific nature and students are helped to gain an understanding of the role, function of science in everyday life and the world in which they live. Basic Science being the foundation of science at Junior Secondary School (JSS) for advancement in science and technology was introduced for the purpose of giving solid foundation for subsequent science studies at the higher level. However, presently there has been a growing public anxiety over the poor instructional strategies used for instruction, low level learning and high massive failure rates in science subjects in the West African Examination Council results obtained from 2011-2013 among the science students (Adrian & Robert, 2016). Other evidence of poor performance in science include a studies by Usman, (2007) and Nzewi, (2011) which show that, leaning of science tends to be by rote and students find it very difficult to understand. Also the report of the second international science competition in which Nigerian students came last in primary science and second to last junior and senior secondary science among the participating countries of the world (Akiri & Nkechi, 2013). A number of bodies some of which are STAN, Nigeria Education

Research Development Council (NERDC) and Ministry of Education have advanced towards addressing the issue of concern (quality of science being taught). The bodies have been involved in conducting of researches on instructional strategies in teaching science, training and organization of workshops for science teachers. In spite of the efforts made by these bodies, the teaching of science has continually been criticized.

A number of factors also have been identified by Osuji(2009) such as shortage of qualified teachers, the perception of science by learners as very difficult subject, inability of teachers to teach some Basic Science concepts, lack of opportunities for learners to have direct experience with learning materials and large class- size. Others include inability of teachers to use appropriate instructional strategies that involved the use of hands-on- activities, instead resort to lecture methods that lead to poor academic performance and low acquisition science skills. Osuji, (2009) observed also that, students are still not involved in the doing of science but are predominantly made to learn Basic Science by copying and memorizing learning materials provided by the teachers. This is responsible for poor performance and process skills acquisition in Basic Science because the students lack the ability to develop science skills and understand scientific concepts both practically and theoretically while learning Basic Science. Proficiency is acquired by practice; inability of students to practice the use of process skills has led to poor science skills acquisition, a very weak foundation for future science and technological careers. Also, students' poor performance in Basic Science and acquisition of science skills is attributed to inadequate use of Process-Based Instructional materials and strategies in teaching Basic Science concepts. This has made Basic Science teachers to turn experiments into demonstration for students to observe and copy notes rather than practically handling the materials in order to acquire the desired process skills.

Another factor that can affect poor performance of students in Basic Science concepts could be as a result of some perceived difficulty of some concepts. Some studies conducted by Duwan,(2011), Nzewi, (2011), Ugwu, Ofuebe and Efiubon (2011) differently, reveals that students have difficulties in coping with certain concepts like habitat and adaptation of organisms, kinetic theory of matter and thermal energy. The difficulty according to them is as a result of the frequent use of lecture method in teaching Basic Science at the Junior Secondary School levels. Most junior secondary school teachers spend most of their time in class teaching for memory and comprehension as opposed to teaching for the development of process skills. Osuji, (2009) notes that experiences for science students in schools where the students are adequately guided promote acquisition of skills, such as measuring, observing, classifying, predicting to mention but a few. These skills are critical for the development of a worthwhile and fruitful understanding by students of Basic Science concepts. Observing, measuring, identifying, inferring and classifying experiences are also critical for achieving expertise in the meaningful use of scientific procedures for problem-solving and for applying scientific understanding to one's own life. Yuguda (2008) was of the opinion that, successful use of science process skills in class lessons will make learning richer and more meaningful to students learning Basic Science. Ajilege, (2006) maintains that, expertise in science process skills is a basic and integral part of having effective science teaching and learning skills. Such expertise obviously is not innate. Employing Process-Based Instruction Strategy involves activities to engage the students and such activities create meaningful learning experience. Abdullahi (2007) states that, activities have been found to enhance the quality and the extent of scientific understanding and process skills that are achieved by students. Based on the merits of using Process-Basic Instruction in enhancing academic performance of students and process skills acquisition, this study sought to use Process –Based Instruction to find out if it will improve the academic performance, process skills acquisition and retention of Basic Science concepts.

Basic science curriculum (FME, 2013) advocates the acquisition of science process-skills through the use of instructional strategies that allow students acquire and practice science process skills. Process-Based instruction is an activity oriented method that capitalizes on getting students to practice science process-skills. Students engage in activities intended to make them practice science skills as they are being taught using this instructional strategy. The recognition of Process-Based Instructional methods over the other methods like demonstration and discussion has resulted in its recommendation as it enhances acquisition of skills, used to produce scientific information, to perform scientific research and to solve problems. Many innovative science courses developed for Nigerian schools over the years according to Osuji, (2009) include the Nigeria Integrated Science Project (NISP), (now Basic Science) put emphasis on teaching and learning by inquiry and added that the Process-Based Instruction is meant to foster inquiry, skills acquisitions in students and discourages rote learning. The Process-Based Instruction is a strategy used in learning science which gained prominence during the late 1950's and early 1960's. Scientists use process skills in solving problems and if students are to learn science effectively, they must be allowed to acquire those skills used by scientists in scientific investigation, hence science is a participatory subject and not spectator art. Also, scientists continue to urge that science teaching and learning cannot be done by reading and listening alone, rather students should be involved in meaningful activities during which, they have ample opportunity to use the functional intellectual skills called the science processes to solve problem and be creative. Jadrich and Bruxvoort, (2011) identified the following skill; observation, inferring, measuring, communicating, classification and prediction to mention but a few. The researches posited that when students use science processes to solve problem like scientists they experience science and become creative rather than just learn about science. They engage in the development of principles and generalization rather than merely learning by rote. Research has also pointed out that when students learn science using the process of science with practical approaches, they acquire science process skills to improve their ability to apply the skills to solve problem and become more creative.

In spite of the recognition of the Process-Based Instructional Strategy to science teaching, according to Usman, (2007) and Osuji, (2009), results of some studies still indicated continuous poor performance and acquisition of adequate science skills by science students in solving problem. Most of the topics taught in Basic Science emphasize activity-centered learning. Therefore students should be involved in considerable hands-on activities during Basic Science lessons in order to develop the appropriate process skills. Teaching and learning of Basic Science concept requires according to Gagne, (1965) and Finley, (1983) that; students have certain underlying capabilities such as science process skills which are needed to practice and understand science. The science skills (process skills) are structurally organized with the ability to use each upper level process (integrated science process skills) such as, controlling variables, hypothesizing, experimentation and interpretation dependent on the ability to use the simpler underlying process (Basic process skills) such as observation ,measurement ,inferring and classifying. The science process skills have been identified as having the enduring quality of enabling the individual acquire process information and solve problems even when the information base changes particularly when Process-Based Instruction is used. According to Karamustafaoglu, (2011) and Mari,(2012) that, learning by listening can never be as effective as learning by doing. They explained that, the new science programme at all levels of education no longer see the students as the subject to be filled with facts. Efforts are being made to help the learners develop an understanding and appreciation of the world through practical experiences by acquiring science process skills.

Abdulrauf, Abdulrasul, Mansor and Lyndo, (2013) reported that Process-Based Instruction improves science skills acquisition and knowledge of content among junior and senior secondary students (SSS). The use of Process-Based Instruction helps the students to develop responsibility in their own learning, increased permanency of learning as well as teach them to investigate scientifically. In this study therefore, an attempt was made to use Process-Based Instruction in Basic Science to see its impact on acquisition of science process skills, performance and retention of Basic Science concepts.

Basic Science curriculum places a paramount emphasis on the teaching and acquisition of science process skills. Science process skills are broadly transferable abilities or skills appropriate to many science disciplines and are reflective of the behaviour of a scientist. American Association for the Advancement of Science, (1967) classified them as basic and integrated due to their usage according to the students' progression phases. The Basic Science Process Skills (BSPS) include observation, measurement, inferring, classifying, prediction and communication. Integrated Science Process Skills (ISPS) include controlling variables, hypothesizing, experimentation and date interpretation. Sevilay (2011) stated that, Basic Science Process Skills (BSPS) such as observation using numbers and classification are the foundation for the acquisition of Integrated Science Process Skills (ISPS). Both basic and integrated scientific skills are important in scientific investigation such as conducting and carrying out experiments.

Besides promoting the acquisition of the process skills, Karamustafaoglu, (2011) is of the opinion that activity oriented environment works in science facilitate the necessary learning environments such as active participation, integration to life and meaningful learning. There is quite a number of science process skills provided for in the secondary school Basic Science syllabus. However, this paper focused on six selected process skills commonly practiced in the Basic Science lessons namely, observation, inferring, measurement, classification, experimentation and interpretation of Data. According to Aktamis and Ergin, (2008) these skills are the foundational skills used at the Junior Secondary Schools for scientific enquiries. The first four are Basic Skills while the last two are Integrated Skills. In teaching and acquiring process skill of observation for instance involves the use of ones senses to perceive objects and events; their properties and behaviour. It requires that the students pay close attention to some aspects of what is being observed.

Using Process-Based Instructional Strategy for science skill acquisition, the learner according to AI-Rabaani, (2014) need to engage in scientific investigation so as to acquire scientific knowledge and skills. Science process skills are activities oriented and when Process-Based Instruction is used in teaching and learning Basic Science to acquire the processes, the students are able to become competent and experience in its application to solving problems or observing desire end results as scientists. Science process skills enable students experience hands-on engagement with science materials when solving problems using meaningful activities. The emphasis on process-based activities in science lessons cannot be doubted, as this is clearly evident in the objectives and instructional programmes in science subjects at the secondary schools. The proponents of Process-Based Strategy uphold the teaching of process-skills and advocate for the skills to be developed through experimenting (Adrian & Robert, 2016). The interaction with process-skills is evident throughout the students' daily lives and also in science lessons when they engage in activities. The activities carried out by the students under this framework will enable them to practice and utilize process-skills. It is obvious that what so ever the student sees and handles while teaching and learning Basic Science aids retention (Bentley, Ebert & Ebert, 2007; Abungu, Okere & Wachange, 2014). In this study therefore, an attempt is made to see if Basic Science students could acquire science process skills when taught using Process –Based Instruction and be able to retain its applications.

Retention is the ability to remember things or it is a form of reaction to what has been presented in the past. According to Bichi, (2002) Students retention is very important in teaching and learning interactions. Permanent and meaningful learning is the ultimate target of our educational endeavor. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students. Retention is the ability to remember things experienced or learned by an individual at the later time. It takes place when learning is coded in memory. Thus, appropriate coding of incoming information provides the index that may be consulted so that retention takes place without elaborate search in the memory lane. Lakpini, (2006) defined retention as the ability of a learner to recall, remember or recollect a body of knowledge after instruction. However, Veselinovska, (2011) defined retention as the ability of the learner to remember and recall not only a body of knowledge but be able to recall and apply any acquired skills after engaging practically on learnt materials. Bichi, (2002); Opara, (2011) and Omar, (2012) also reported that anything which aids meaningful learning improves retention while things that lead to interference among learned materials decrease the speed, efficiency of learning and accelerates forgetfulness. Materials are related to the quality of retention in terms of their meaningfulness, familiarity, concreteness and image evolving characteristics. Studies on retention and instructional strategy have attracted the attention of many researchers in the recent years. For instance, Ezenwe, (2005) compared the effectiveness of concept mapping and guided discovery teaching strategies on students' retention of some chemistry concepts. Analysis of the results showed a significant different between the concept mapping and guided discovery posttest scores in favour of concept mapping. It follows the concept mapping method enables students to have better understanding of the concepts taught and retain more knowledge of the chemistry concepts than guided discovery method. Mari, (2001) pointed how science processes and product or concepts are interrelated, that students cannot learn science meaningfully without comprehending the process used in generating such concepts. Science process skills have also been established to relate highly with achievement of science concepts. As acquisition of science process skills relate with achievement, is an indication that it could enhance meaningful learning and retention of the concepts with the skills acquired. The acquisition of these skills enables learners both male and female to understand how science knowledge is generated, see relationships among concepts learnt. These factors enhance retention and seem to suggest that Process-Based Instruction could enhance retention of science concepts. This study seeks to establish if teaching science process skills could enhance retention and achievement of Basic Science concepts in male and female or not.

The importance of gender to science learning cannot be overemphasized. One major goal for reform in science education is to evolve a science oriented programme for every child to participate actively and learn maximally irrespective of sex, social background and ability levels. Males and females varied in physical appearance; the question raised is what about their abilities in perceiving science process skills? Males had better performances than females when the Process–Based Instructional strategy is used (Dokme &Aydinli, 2009). Abungu, Okere and Wachange (2014) attribute the differences in the learning ability levels of males and females due to socialization processes that take place at home and the society around them. Osuji, (2009) attributes the differences in the learning abilities of gender to social, educational, role model, orientation and stereotyping. The researcher has endeavored to find out if there may be a link between Process-Based Instructional Strategy and lecture method in gender related differences in science process skills acquisition, academic performance and retention of Basic Science concepts.

1.1.1 Theoretical Framework

The essence of teaching science is to enable students acquire the process skills and the product of science, so as to apply them in their everyday life. Also to enable the students achieve national educational goals (scientific and technological development) .To achieve these goals as desired, it is highly needed for students to acquire certain science skills at all levels of education to have high sense of confidence for the enhancement of teaching and learning scientific concepts and principles that can lead to positive scientific and technological development. To advance such move, a body called American Association for the Advancement of Science (AAAS). (AAAS, 1967) and Finley, (1983) advocated the use of Process-Based Instruction to promote acquisition of science process skills and academic achievement. AAAS developed Science-A Process Approach (SAPA) in 1967 based on the learning theory of psychologist Robert Gagne (1965). Robert Gagne (1965) theory of hierarchy of learning states that learning materials be structured. He maintains that meaningful learning can only take place in gradual step from unknown to the known, that it should be possible to break down into some steps, one step slightly higher or lower the proceeding step. This implies that the students need to acquire process skills for example Basic and Integrated process skills which are hierarchically organized with the ability to use the simpler underlying process. Observation is considered to be the fundamental skill by virtue of its position as the foundation of the hierarchy of skills needed to discover the broad knowledge required to conduct enquiry. By so doing the students are involved in meaningful activity that leads to acquisition of science skills through inquiry and problem solving. The basic premise of SAPA according to AAAS (1967) was that, the first hand central purpose of science education is to awaken in the child whether or not he/she will become a professional scientist, a sense of the Joy, the excitements and the intellectual power of science. The basic notion was to give students a variety of hands- on experiment based on hierarchy of skills (called process skills) that scientists were seen to use regularly. AAAS, (1967) studied scientists at work and identify process skills in teaching science which science learners would use various tools, procedures to better understand and engage in activities in science skill acquisition in learning science concepts as the way scientist do. Finley, (1983) on the other hand states that the prerequisite knowledge of concept and principles that can be obtained only if students have certain underlying capabilities, the science processes which are needed to practice and understand science. According to Gagne, (1965), AAAS, (1967) and Finley,(1983) those tools and underlying capabilities are the science process skills which (stated from simple to complex) are divided into two groups, Basic Science Process Skills (BSPS) and Integrated Science Process Skills (ISPS). The BSPS includes observing, measurement, inferring, classifying, predicting and communicating. ISPS include controlling variables, hypothesizing, experimentation and data interpretation to mention a few. Both AAAS and Finley explained that, studying and acquiring science process skills will give students both male and female opportunity to carry out science investigations and thus perform operations like scientists. Since Process-Based instructional activities are designed to enable students practice science skills and thus acquire proficiency through those skills. Process- Based Instructional Strategy according AAAS, (1967) originated in 1960s. This strategy assumes that, children even in the primary level will derive more from the study of science if they learn the behaviour of scientists. Al-Rabaani,(2014) pointed out that, although behaviour of scientists are complex, they have been classified in number of process skills, some simple and others complex as mentioned earlier on. The acquisition of these intellectual activities of the scientist, the process skills form the goal of science instruction.

From the above explanations, one may deduce that, in the teaching of Basic Science using Process- Based Instructions for science skills acquisition, a set of activities characterize by those process skills must be put in place. To ensure effectiveness, students are to handle, observe and experiment using different types of materials. By so doing, the students are able to acquire or develop some levels of science skills that would enable them tackle some scientific problems as scientists and subsequently enhance their retentive memory. Al-Rabaani, (2014) noted that, when these process skills are acquired, intellectual ability of both the male and female students are widened and this could be used for life in the understanding of nature and problem solving. This is true and as rightly observed by a chinese slogan in Usman, (2007) that says ‘Give a man a fish and he eats for a day, teach a man to fish and he eats for a life’ time. This implies that the process skills are tools for learning and problem solving to facilitate academic achievement and acquisition of process skills for Basic Science concepts. It then means, they should not only be acquired at all levels of our schools but should also be acquired to a reasonable extent.

The need to find solution to students’ poor science skills acquisition, performance and retention in learning Basic Science concept not using Process-Based instructional strategy is very vital. Sevilay, (2011) pointed out that science curricular which emphasize the development of process skills were evolved with the assumption that these skills can be acquired by all students when exposed to instruction that are based on such science process skills. Therefore, this study is set to look into the impact of Process-Based Instruction on acquisition of science skills, performance and retention among Basic Science student which will hinge on AAAS and Finley’s work.

1.2 Statement of the Problem

Basic Science according to FME,(2013) is the basic foundation for the separate science subjects taught at the senior secondary school level. The syllabus of Basic Science emphasizes the acquisition of science process skills and the processes scientists used in enhancing the acquisition of science skills and knowledge. Little attention has so far been paid to ascertaining whether or not teaching and learning Basic Science has any influence on students' academic performance and science skill acquisition. Unfortunately, as reported by researchers such as Lakpini (2006), Opara (2011), Ameh and Dantani (2012) teachers shy away from Process-Based Instructional strategy which enhances the acquisition of science skills and rely on methods such as lecture method that is easy but most often in adequate and in appropriate for skill acquisition . This had led to inability of students to be creative in acquiring skills for scientific enquiry, as Basic Science learners. Table 1.1 is a reflection of poor performance of JSS3 certificate examination results in Basic Science as recorded by Ministry of Education, Zonal office, Zaria, (2013-2017) of schools in Zaria for the period of five years. The analysis indicated low performance in four years; in percentage pass and credit level between 38% to 47% in 2013, 2015, 2016 and 2017 under review. A fairly good percentage of 64% was recorded at credit level in 2014.

Table 1.1: Students Performance in JSSCE (Basic Science, 2013-2017) in Zaria Educational Zone

Year	No. of Registered Students	No. of students with pass and credit in %		No of students with failure (F grade)	
2013	3,097	1,211	39%	1,886	61%
2014	2,968	1,904	64%	1,064	36%
2015	2,864	1,094	38%	1,770	62%
2016	3,116	1,460	47%	1,656	53%
2017	3,940	1,720	44%	1,656	56%

Source: Ministry of Education, Zonal Office Zaria (2017)

This persistent poor performance of students in Junior Secondary School Certificate Examination by Basic Science students is causing concern and poses a problem in subsequent learning of science related courses. Researchers like Duwan, (2011), Nzewi, (2011), Ugwu, Ofuebe and Efiubon (2011) in their separate studies, attributed poor performance in Basic Science to students having difficulties in coping with certain concepts like habitat and adaptation of organisms ,kinetic theory of matter and thermal energy among others. The poor performance is also attributed to the use of inappropriate instructional strategies by teachers but often resulted to lecture method that has been shown to lead to poor academic performance, retention of concepts learnt and science skills acquisition in Basic Science among Junior Secondary Schools students. In teaching Basic Science memorization of facts is discouraged. Activities that foster process skills acquisition and retention of concepts are to be promoted. Exposing students to Process-Based Instructional Strategy has the ability to enhance learning because what students learned through doing increases their ability to retain the concepts learnt. A call by scholars for the use of effective teaching strategy however, has been made in order to make learning more meaningful. Research conducted by Mari, (2001), Sani, (2007) and Al-Rabaani, (2014) showed that Process-Based Instructional Strategy enhances acquisition of science skills and performance in senior secondary school students. Mari, (2001) and Al-Rabaani (2014) observe that proficiency in the use of skills is acquired through practice as Process-Based Instruction avail students' opportunity to practice process skills; participation in it is expected to promote acquisition of science process skill. As the goal of instructional strategy is to promote acquisition of science process skills, the level to which it enhances the acquisition of science skills should be determined.

A strong correlation has also been established between acquisition of science process skills and performance among Basic Science students, (Duwan, 2011). This is an indication that exposure to the use of instructional strategies that promote acquisition of science process skills could enhance students' performance. This study therefore, was to determine if exposure to Process-Based Instruction will enhance academic performance and science skills acquisition and retention among Basic Science students or not. Also, if gender was a factor in the understanding of Basic Science concept and science skills acquisition when Process-Based Instruction was used.

1.3 Objectives of the Study

The study has the following objectives which are to:

i determine the impact of Process-Based Instruction on JSS11 students' academic performance in selected Basic Science concepts.

ii determine the impact of Process-Based Instruction on academic performance of male and female in Basic Science concepts

iii. examine the impact of Process-Based Instruction on acquisition of science process skills in Basic Science concepts.

iv. investigate the impact of Process -Based Instruction on retention abilities of students in Basic Science concepts.

v. ascertain the impact of Process-Based skills acquisition of male and female students in Basic Science concepts.

1.4 Research Questions

The following research questions are put forward for answering which are:

i What is the difference between the mean academic performance scores of students taught Basic Science concepts using Process-Based Instruction and lecture method?

ii What is the difference between the mean academic performance scores of male and female students taught Basic Science concepts using Process-Based Instruction ?

iii. What is the difference between the mean score of students exposed to Science Process-Skills Instruction and those taught using lecture method?

iv. What is the difference between the retention abilities mean score of students taught Basic Science concepts using Process-Based Instruction and lecture method?

v. What is the difference between the mean academic performance score of male and female students in each process skill?

1.5 Null Hypotheses

Based on the research questions stated the following null hypotheses (HO) are formulated and tested at p ≤ 0.05 level of significance

HO_1**:** There is no significant difference between the mean academic performance scores of students taught Basic Science concepts using Process-Based Instruction and those taught the same concepts using lecture method.

HO_2**:** There is no significant difference between the mean academic performance scores of male and female students taught Basic Science concepts using Process–Based Instruction and those taught the same concepts using lecture method

HO_3**:** There is no significantly difference in the mean scores of students exposed to Science Process-Skills Instruction and those taught the same concepts using lecture method.

HO_4**:** There is no significant difference between the retention abilities mean scores of students taught Basic Science concepts using Process-Based Instruction and those taught the same concepts using lecture method.

HO_5**:** There is no significant difference between the mean academic performance scores of male and female students in each process skill.

1.6 Significance of the Study

The findings from this study would hopefully be significant to the following:

Basic Science Teachers: It will provide model for lesson plans for science teachers to adapt or adopt. The research findings also would hopefully benefit Junior Secondary School Basic Science teachers towards using more effective teachings strategies for effective learning of Basic Science concepts such as Process-Based Instructional Strategy.

Basic Science Students: It would be of benefit to the students as the findings may lead to an improvement in their science skills, academic performance and retention through the use of Process-Based Instructional Strategy of teaching Basic Science concepts, that is concepts of habitat and adaptation of organisms, kinetic theory of matter and thermal energy among others.

Textbooks Publishers: The textbooks publishers will find this work useful as it will assist in selecting materials and exercises to be incorporated in it, making reference to Process-Based Instructional Strategy used in this study.

Researchers: The findings will also provide new information to the existing literature in Basic Science and it will also serve as a foundation for the further similar studies. **Professional Bodies:** The findings will be useful to various professional agencies and association such as Science Teachers' Association (STAN) and Nigerian Education Research Development Council (NERDC) to organize workshop or seminars for teachers especially on using activity- oriented methods of instruction such as Process-Based Instruction to teach Basic Science concepts.

Curriculum Developers: The findings will be useful to curriculum developers in reviewing Junior Secondary Schools curriculum with particular reference to the inclusion of strategy like Process-Based Instruction in the teaching and learning of Basic Science concepts

1.7 Scope of the Study

The study was carried out among Junior Secondary School Two (JSS2) students of public schools in Zaria Educational Zone. JSS 2 was chosen for the study because the JSS1 may not have covered more contents and they are yet to adjust to the school environment while JSS 3 are busy preparing for the Junior Certificate Examination (JSCE).

The six Science Process Skills that were examined were Observation, Inferring, Classification, Measurement, Experimentation and Data Interpretation. These skills were selected because according to Aktamis and Ergin (2008) they are foundational skills used as basis for scientific inquiries at the Junior Secondary School level. The first four, observation, inferring, classification and measurement are Basic Science Process Skills (BSPS) while the last two, experimentation and interpretation of Data are Integrated Science Process Skills (ISPS).

The topics taught were, habitat and adaptation of organisms, kinetic theory of matter and thermal energy. These topics were selected because according to some studies conducted by Duwan, (2011), Nzewi, (2011), Ugwu, Ofuebe and Efiubon (2011) reveals that, students have difficulties in coping up at junior secondary school Basic Science. The skills are outlined in the curriculum as emphasized in the recommended text books by Ehindero, Arubayi, Dibu-Ojerinder and Aladeyaria, (2010). Comprehensive Basic Science for Junior Secondary Schools book Two. Lantern books Lanteramed Publications Nigerian Limited and Akintelure, Kuku, Ohiro and Mahmud, (2014). Classic Basic Science for Junior

Secondary Schools, Book Two. Thursmay Education Services Limited. The study comprises of Process-Based Instruction as the Independent variable, acquisition of science process skills, academic performance and retention as the dependent variables. These instruments were used to generate date for the study. They are Basic Science Performance Test (BSPT) Science Process Skills Acquisition Test (SPSAT) made up of 40 items each and Process-Based Instructional Package used as method of teaching. All the data collected through the aforementioned instruments were analyzed using t-test.

1.8 Basic Assumptions

The study had the following basic assumptions:

(1) The subjects for the study are familiar with the use of activity- based teaching strategies such as Process-Based Instruction.

(2) Basic Science teachers are familiar with the teaching of Basic Science concepts using appropriate teaching strategies such as Process-Based Instruction

(3) The schools are exposed to same academic environment.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

The main aim of this study is to investigate the Impact of Process-Based Instruction on Acquisition of Skills, Performance, and Retention of Basic Science among Basic Science students in Zaria Educational Zone. In this chapter, literature for the study was reviewed and presented under the following sub-headings:

2.2 Evolution of Basic Science.

2.3 Academic Achievement in Basic Science

2.4 Teaching of Basic Science at Junior Secondary School Level

2.4.1 Significance of Teaching Basic Science.

2.4.2 Challenges of Teaching Basic Science.

2.5 Basic Science Teaching Methods

2.5.1 Lecture Method.

2.5.2 Process-Based Instructional Strategy.

2.5.3 Concept of Science Process Skills.

2.5.4 Acquisition of Process skills and Achievement in Basic Science

2 .5.5 Gender and Science Process Skills Acquisition

2.6 Gender and Academic Achievement in Science

2.7 Retention and Achievement in Basic Science

2.8 Overview of Similar Studies

2.9 Implication of Reviewed Literature for the Present Study

2.2 Evolution of Basic Science in Primary School.

The history of curriculum reforms in science education could be traced back to the late 195Os, triggered off by the launching of Sputnik 1 In 1957 by the then Soviet Union now Russia. These years according to Duwan, (2011), were relatively crowded once in the history of the development of science education in Nigeria. He stated some major events that could have adduced as responsible for promoting science education at all levels such as, the experiences of the civil war in Nigeria which ended in 1970, provided the opportunity for the rethinking of the Nigerian Educational System. Hence the phrase “Federal Unity” was emphasized in virtually all government measures and activities including educational programmes, the establishment of the National Youth Service Corps (NYSC) programme launched in 1973 with objectives among which are to inculcate discipline in Nigerian youths by instilling in them a tradition of industry at work, of patriotic and loyal service to the nation in any situation they may find themselves. Also the unprecedented explosion of students enrolment in various institution of learning as well as expansion in terms of the number of such institutions, as a result of the launching by the Federal Government of the Universal Free Primary Education (UPE) scheme throughout the federation in 1976.And the introduction of free education at all levels by the then political parties which encouraged increased enrolment in primary and secondary schools and so on.

Many other bodies according to Ogunmade, (2006) and Ajayi, (2009), led to the relatively large number of curriculum innovations carried out in science education. In the forefront of these reforms were the following bodies such as, the Comparative Education Study and Adaptation Centre (CESAC), Nigerian Education Research and Development Council

(NERDC), Science Teachers Association of Nigeria (STAN), West African Examination Council (WAEC), National Examination Council (NECO), National Business and Technical Examination Board (NABTEB) and so on. In their various efforts at reforming the science curriculum, these bodies carried out major modifications of existing science curriculum, the result of which various teachers and pupil materials were produced. The National Curriculum Conference of 1969 made efforts to modernize science content and instruction and also provided an impetus for curriculum designers in Nigeria to pursue a pragmatic goal oriented approach at various level of education in the country. Such attempts according to Bitrus, (2012) have been made through programmes like the Bendel Primary Science project (BPSP), the Nigeria Secondary School Science Project (NSSSP), the Nigeria Integrated Science Project (NISP). As far as the philosophy and objectives of Basic science teaching is concerned, STAN (2010) took an initiative in the science curriculum development by setting up a working cooperation with the Federal Ministry of Education and Centre for Comparative and Adaptation Study (CESAC). The result of this working committee led to the introduction of a course integrated science for the junior forms of the secondary schools. (Bena & Chikwenze, 2012).

Formally, general science was taught in schools before Science Teachers Association (STAN) set up a three member committee to look into science curriculum under the three respective disciplines of biology, chemistry and physic. The committee came out with a unified discipline called integrated science between late sixties and early seventies, (Foley & McPhee, 2008). Integrated science existed for over forty years as a course that stipulated the use of integrating principle in science which should, be relevant to students needs and experiences, stress the fundamental unity of science, lay adequate foundation for subsequent subject specialist and add cultural dimension to science education. The change from integrated science to Basic science came in 2007 when the Nigerian Educational Research and Development Council (NERDC) was mandated to develop curricula for use at all levels of the education system in Nigeria. In line with government declaration for a 9 year- Basic education programme, the (NERDC) was directed by the National Council on Education (NCE) to restructure and re-align the existing primary and Junior Secondary School curricula. This is to meet the targets of the 9-year basic education in the context of National Economic Empowerment and Development strategy (NEEDS) and the Sustainable Development Goals (SDGS). There came Basic science that was formally called Integrated Science as stated by Obioma, (2008) and Ndu and Somoye, (2008), According to Labo-Popoola, Atanda and Bello (2009), the Basic science education as a policy in Nigerian education system pronounces that the 6 years primary and 3 years Junior Secondary School should be offered in primary school in 9 years. Thus, 6-3-3-4 system will be 9-3-4 as a policy. This was intended to reduce drastically the incidence of drop out from the formal school and also ensuring the acquisition of appropriate levels of literacy, numeracy, manipulative, communicative and life–long skills for laying a solid educational foundation. Basic science curriculum is a revised curriculum of the former primary and junior secondary integrated science which was spiral in nature and thematic in approach with themes cutting across all the sciences. Danmole, (2011) stressed that “you” and “your” home is one of the six themes. The contents now include the issues of shaping the development of the nation identified as globalization, Information Communication Technology (ICT) and entrepreneurship. Therefore, four areas of curriculum innovations were refused in the Basic science curriculum which were, Environmental Education

(EE),Drug Abuse Education (DAE), Population and family life Education (POP/FLE) and Sexual transmitted infection (STI, HIV/AIDS). Thus Basic Science as a subject had its initial pace through curriculum review on sciences by STAN and is offered in Junior Secondary Schools. Its curriculum is aimed at exploring and acquainting the young child with the environment. Also to widens the child's power of thinking, reasoning for further scientific study, and provides the trained manpower in applied sciences to the nation, (FME, 2013). Thus, the course plays a vital role in preparing young pupils for higher scientific study and appropriate choice of science related careers and profession. The National Policy on Education (2013) stated quite clearly the new structure of 6-3-3-4 system of education. Based on the structure, the Federal Ministry of Education set about developing what is described as core curriculum and so far it has successfully guided and produced two important documents, Core curriculum for primary science published 1980 and Core curriculum for integrated science for junior secondary schools published 1981. Several years in the use of the 6-3-3-4-system, the Federal Government of Nigeria introduced the Universal Basic Education (UBE) programme in 1999 to ensure unfettered access and equity to education for the total development of the individual. Through the UBE programme, the international goals of Education for All (EAF), as well as the Sustainable Development Goals (SDGs) was proposed to be achieved.

In 2004, Nigeria adopted the home-grown National Economic Empowerment and Development Strategy (NEEDS) as a response to global reforms in the social and economic context. Among the core elements of NEEDS is using education to empower the people. In December 2005, the National Council on Education (NCE) directed NERDC to develop a school curriculum for the implementation of the effective UBE programme. NERDC has developed a high quality 9-year Basic Education Curriculum that will not only facilitate the attainment of the core elements of NEEDS but also the goals of EAF and SDGS. Danmole, (2011). The high points of the new curriculum include the introduction of Basic Science and Technology and Information and Communication Technology (ICT). As envisaged by the Federal Government in the NEEDS document, a progressive Science and Technology policy, can transform Nigeria to one of the twenty foremost nations of the world by 2020. Realizing the vision of NEEDS has numerous imperatives for the way science and technology is presented in schools. It has implications for: inclusive education, curriculum reforms, text book reviews, improving teacher effectiveness, provision of adequate resources for teaching science and technology, maintaining equity and learner friendly environment. With respect to Science and Technology, the NERDC developed two curricula namely; Basic Science and Technology Curriculum for years 1-6 and Basic Science Curriculum for years 7-9. The last three years of this basic education programme (7-9) correspond to the former JSS1-3 that has been the domain of the popular STAN Nigerian Integrated Science Project (NISP) series. The NERDC curriculum review, necessitated the review of both in name and content of the (NISP) of (STAN) to the Nigerian Basic Science Project (NBSP).

The Basic Science curriculum, attempt at presenting topics, performance objectives, contents and activities in a structural teaching manner. Furthermore, the core curriculum is developed around themes which feature throughout the basic school years in what is described as SPIRAL or CONCENTRIC. The topics discussed under each theme gets increasingly more detailed and complex as the year progresses. This curriculum design approach is sometimes referred to as the THEMATIC APPROACH so as to achieve a holistic representation of science and technology contents to learners. Knowledge, skills and attitudinal requirements addressed under these themes (FGN, 2007 & Danmole, 2011)

- You and your environment
- Living and non-living things
- You and energy

At the Upper Basic level however, “You and Technology” (theme 3) was changed to Science and Development. The essence of bringing in Science and Development is to expose students to development in science and technology alongside skills that will enable them to face challenges, make informed decisions, develop survival strategies, and learn to live effectively within the global community. The topics under each theme were sequenced in spiral form with the simple to complex across the nine (9) years of Basic Education in order to sustain the interest of learners and promote meaningful learning. The curriculum offering at the lower, middle and upper levels are shown:

- Basic Science and Technology (Lower Basic, which is Primary 1-3)
- Basic Science and Technology (Lower Basic Level, which is Primary 4-6)
- Basic Science (Upper Basic Level 7-9,which is JS1-3)

In the new Basic Science curriculum, the use of Process-Based Instruction method teaching and learning is implied in the activities prescribed under each topic in order to promote learning by doing and skills development. In other word, the activities prescribed for each topic in the teaching and learning process imply full participation of pupils and students. Thus, encouraging a child-centered teaching and activity oriented learning (FME,2008 & Danmole, 2011). The core curriculum presumes a partially terminal formal learning of science for the one who uses the programme up to the end of basic school. This important assumption has influenced designer of the core curriculum to include science and technology topics that are relevant in present day Nigeria. This study would investigate the Basic Science curriculum contents through the use of Process-Based Instruction to find out its' impact on acquisition of skills, retention ability and performance of JSS students in Basic Science.

2.3 Academic Achievement in Basic Science

The good use of teaching method and innovative technique has an impact on the academic achievement of students in science subjects with Basic science inclusive. The decline in the academic achievement of students particularly in Basic Science has been of great concern as it has a direct link with students' future and subsequent performance in major science subjects and their choice in careers and other science related disciplines. Academic achievement refers to the quality of results of students that is reflected in their examination scores. The quality of scores on the part of students' academic achievement on sciences is influenced by a number of factors which raise it to fall or improving it to the desired level or standard. In recent times, related literature in science education revealed that students generally performed poorly in all science subjects especially at the secondary school level reported by Bilgin, (2009), Ofuebe (2009) & Adunola (2011). This poor achievement in science is attributed to poor instructional strategies, lack of instructional materials, non-use of materials or lack of knowledge and skills required to out such resources into productive use. (Usman, 2007), Ogunmade, (2006). Bitrus, (2010) and Usman, (2010) added that the consistent poor achievement in science subjects with Basic Science inclusive attests to the fact that science teaching has not been properly done and that is why concepts being taught are not properly understood. This however, reveal that there are quite a great number of factors that have a great influence on teaching and learning process of science that consequently affect students' performance.

It was viewed by Padilla, (2004), VanDriel and Abell, (2010) and Agharuwhu and Nkechi, (2013) that certain factors have been found to affect performance of students in their learning subjects including Basic Science. He summarized those factors as follows; antecedents, developmental factors and training factors. By antecedent factor he explains as those factors as the backing factors which occurred in the child's experience that may affect his learning and understanding of concepts. While developmental factor refers to the age of the learners that has a significant role on the type of concept he/she can capture and retain. But training factor refers to the amount of teaching instruction and strategy a child was exposed to. The fact that, students' academic achievement in science is influenced by so many factors, It is however of paramount importance to check those factors in order to revert the situation thereby improving the performance of our students in science which is the driving force of any societal growth and national development. Mari (2001) and Diyel, (2011) have been a call for a drastic revolution of the attitude of science and method of teaching science in order to check the problem of poor achievement of students in science. They however, added that teachers should employ those instructional strategies which are activity-oriented that will enhance students' understanding and retention of concepts. Similarly, Ward, Roden, Howlett and Formen, (2008) and Barineka, (2011) pointed out that failure to use appropriate teaching method/technique in teaching learning process will lead to the decline in the student's attitude and performance in science. Thus, the use of appropriate teaching method will take care of differences that affect our learners psychologically, sociologically, emotionally and mentally. Idowu and Bukunola, (2012) pointed out factors such as lack of facilities, shortage of qualified teachers and inappropriate choices of teaching technique which are responsible for poor achievement of Basic Science Students. Additionally, effective learning, retention of concepts and improvement in academic achievement of students as well as Basic Science can be achieved when more senses are involved: that is seeing, touching and hearing. In recent times, innovations which involve both senses of hearings, touching and seeing have been developed to make learning meaningful. All affirms that increasing sophistication in technology applications enable the exploration of diverse learning approaches providing versatile multi-sensory science education intervention programme. However, Mari (2001) also asserts that many technological innovation of the 21^{st} century have promised breakthrough in methods of effective and learning process among which Process-Based Instructional Strategy is inclusive for improvement in students' academic achievement. Moreover, some factors such as poor teaching methods/strategy, inappropriate choice of methods/techniques in science teaching, lack of facilities, shortage of qualified science teachers, poor attitudes to science to mention but a few have been shown to affect students' academic achievement. Many studies have been carried out to investigate students' academic achievements in science using different teaching strategies. Idowu and Bukunola, (2012) investigated the effects of learning cycle on students' achievement. They found that the learning cycle teaching strategy significantly improves teachers' performance and enhance students' intellectual achievement. In a similar investigation, Mari (1994) worked on the understanding of Science processes and its relationship to achievement in integrated science on junior secondary schools Students. Finding revealed a significant difference in the understanding of science processes as expressed by the various groups.

Iwuju (2011) on the other hand examined the effect of Activity Based Teaching Strategy (ABTS) on academic achievement in Basic Science among Junior Secondary two students. Findings revealed a significant difference in the academic achievement of students taught using ABTS and those taught using lecture method. Olorukooba and Lawal, (2010) investigated effect of Technology and Society (STS) approach and lecture method on academic achievement and development of creative traits of JSS 3 integrated science students. These result indicated an improvement in academic achievement compared to lecture method .According to Idowu and Bukunola, (2012), appropriate research have revealed that only instructional method that, directly involved the students in the learning process can achieve this feat and promote academic excellence. Instructional method that treats students simply as .passive receptors or cast in passive role does only allow student take little responsibility for their own education. Nwagbo, (2008) explains that, lack of involvement tends to undermine the drive for students to think for themselves. Also it discourages them from developing the capacity to learn by themselves because they are structured in such a way as to make them dependent on teachers. Good instructional methods will emphasis learning process as what students do to and for themselves under teachers' assistance. This way, students will "find out" things for themselves, by identifying a problem and seek solution to them. They will be encouraged to make inquiries, investigations, predictions, description, explanation, evaluation and draw meaningful conclusion. Instructional experiences thus learnt will be significantly retained with a significant achievement in student performance (Bichi, 2002; Usman, 2010 & Obeke, 2010).

The Process-Based Instructional Strategy therefore offers a value-neutral strategy for understanding the learners' needs. The assumption is that everyone can learn and achieve academically as shown by Adunola, (2011) that "all students are capable of learning" teachers' should respond appropriately to individual learning needs – using appropriate instructional method. Akiri and Ugborugbo, (2009) observed that, professional success in teaching can therefore be defined in terms of effective application of necessary and appropriate specific instructional approach to achieve greater academic successes among students in the classrooms. Ugwu, Ofuebe and Etiubon, (2011) sees instructional techniques as an attempt at making instructional methodologies problem-centered and an integrative strategy which provides an interactive opportunity for skill acquisition, capacity building and academic performance. To the author, there is an acceptable correlation between academic achievement and instructional methodologies, on one hand, professional skill in its application, on the other hand to bring about learning and thus improve academic achievement among students. This study is therefore conceived to investigate the impact of Process-Based Instructional Strategy on acquisition of science process skills, performance and retention among Basic Science students.

2.4 Teaching of Basic Science at Junior Secondary School

The concept 'Basic science', simply and in general terms means teaching science in such a way as to present scientific ideas as a unified whole. Science itself has been defined as a process of description and classification of all forms and processes of life and matter (Ezeliora, 2008). A combination of these two words 'Basic' and 'Science' has produced what is generally known as 'Basic science'. Kasim, (2007) suggested four broad groupings of Basic science;

i. Unity of all knowledge (holistic view, that is, knowledge is essentially one and united).

ii. The conceptual nature of science (that is, various concepts or conceptual units are merged together to make up the framework and later identified as a single concept).

iii. A unified process of scientific inquiry that emphasizes the integration on the methodology which brought together similarities among the scientist example, conceptualization, definition of a problem, statement of hypothesis, data collection, experimentation, data analysis and making generalizations.

iv. An inter-disciplinary study which emphasizes the collaborative venture between subjects and viewing it as topical or theme level from logically different viewpoints where the learner is left to synthesize it in any way he chooses.

According to Atadoga & Onoalapo, (2008), Basic science teaching covers approaches to the teaching and learning of science in the following aspects;

a. Fundamental unity of scientific thought

b. Strategies and processes of scientific enterprise

c. Scientific study of the environment requirement of day-to-day life.

Atadoga & Onoalapo, (2008) further stressed that Basic science is a fundamental science which cuts across subject's boundaries that provides meaningful work for the learners that give 'birth' to chemical and physical science, technology and other related disciplines. The emphasis placed on integration of science underscores both the social context of science and the processes of science. From the above definitions, Basic science can be regarded as a science in an undifferentiated form which not only makes learner gain more knowledge of science but more experience that aspires to inculcate the process of science in him/her.

Basic science can therefore be viewed as an amalgamated course designed to show the utility, wideness and interrelationship of the distinct discipline that makes up science. The philosophy and objectives of Basic science according to Apata, (2007) and Mustapha, (2012) is based primarily on the philosophy and objectives of the National Policy on Education (NPE) as they affect science education in general and Basic science in particular. Based on the NPE, FME, (2013) secondary school is expected among others to prepare the children to become useful to themselves, their society and for higher education. In specific terms, secondary education according to Mustapha, (2012) aim at providing an increasing number of primary school pupils with the opportunities for education of higher quality irrespective of sex or social, religious and ethnic background. Also to diversify its curriculum to cater for differences in talents, opportunities and roles possess by or open to students after secondary school course to mention but a few. Therefore, secondary education if properly handled, will lead to the attainment of aims and objectives. And also yield products that are capable and willing to function, relate well in the society and acquire a high potential for higher education. It is also a foundation for higher education. Basic science is a foundation for science at junior secondary school to the field of science and technology.

Therefore, Basic science as a course gently and slowly introduces learners to what science is all about and how scientists work. Thus the principles for teaching Basic Science are based on fundamental unity of science, common approach to problems of scientific nature, understanding the role and functions of science in everyday life and the world one lives. Based on these principles, there are reasons for Basic science teaching. Some of these reasons are short terms such as acquiring Basic knowledge in science, developing attitudes of scientist and so on. While long term reasons are preparing for career in science and technology. However, the objectives of Basic science among other things include, helping learners solve problems arising from observation of their immediate environment and contributing, meaningfully to the development of their society.

Therefore these objectives are geared towards equipping the learner to inculcate the skill of observing carefully and thoroughly, reporting completely and accurately what is observed and organizing carefully information observed and so on. Due to problems of teaching Basic science such as poor teaching methodology, curriculum reforms were initiated for the purpose of effective implementation of the curriculum. Hence an attempt is made at using Process-Based Instruction in teaching Basic science concepts to observe it impact on acquisition of process skills, retention ability and performance in this study.

2.4.1 Significance of Teaching Basic Science

A number of reasons have been stated for teaching of Basic Science as a school subject. National Teachers Institute (NTI, 2012). Some of the reasons are as follows:

i. Basic Science as a school subject helps to prepare students for useful living in the society.

ii. It helps students learn what science is and how scientist work.

iii. It makes students scientifically literate

iv. It serves as gateway to separate science subjects and a foundation of science Learning in schools

v. Basic Science, among other benefits as stated, prepares the students for higher education at both the senior secondary and tertiary levels, as stipulated by National Policy on Education (FME, 2009). In favour of teaching of Basic Science, Osuji,(2009) pointed out that, African child like any other child should be helped right from the beginning to start to develop basic scientific skills, abilities such as curiosity, manipulative ability and experimentation among others. Basic Science, if properly taught, is aimed at developing in learners all round abilities that fosters citizens who are potential leaders of tomorrow. In this vein, Ogunleye (2008) gave three practical reasons for teaching Basic Science such as, to ease the pressure of time-table, for instance, one subject instead of three, to yield coherent of time and to minimize the economy of time.

2.4.2 Challenges of the Teaching of Basic Science

The teaching of Basic Science as an innovation in the country's educational system is expected to face one problem or another. There are series of problems that beset the teaching of Basic Sciences. In his presidential address at 24^{th} Annual conferences of STAN in Jos, Akpan, (2010) mentioned that most of the problems arise as a result of the inappropriate training background of science teachers which is adequate for teaching Basic Science. Some of the challenges are as follows:

i. Lack of understanding the concept of integration in Basic Science by the teachers themselves: Teachers who are not well familiar with the concept of integration in Basic Science find it difficult to teach science in a unified way making use of irrelevant concepts from the various disciplines.

ii. Lack of understanding the philosophy and methodology: Today most science teachers do not fully understand the philosophy and methodology of Basic Science. Basic Science project is pupil-centered, activity-oriented, and above all it unites all the science disciplines. But most teachers do not have the requisite skills to put these characteristic into practice.

iii. Large class size: Basic Science like any other child-centered course is best taught in small class sizes. But most classes in our schools today are overcrowded. This makes classroom control and management difficult thereby affecting the teaching of Basic Science.

iv. Lack of equipment and materials: Lack of inadequate equipment and materials required for activities is another problem facing Basic Science teaching in Nigeria. Although this problem can be solved or minimized through improvisation, most of the teachers do not have skills needed for improvisation.

v. Insufficient quality teachers: There is inadequate supply of teachers to teach Basic Science in all schools. In some schools, where there are no teachers, students are denied the knowledge, skills and attitudes that they are expected to acquire.

vi. Inadequate qualified teachers: Most of the teachers handling Basic Science in our schools do not have the necessary training in teaching Basic Science. National Teachers Institute (NTI) (2012).

vii. Allotted Time: Two double periods of 40 minutes per period per week are recommended in the Federal Ministry of Education (2009) core curriculum for Basic Science at junior secondary level. But, unfortunately, many schools allocate only three periods and in some cases two periods for Basic Science on the time table. These are single periods. The effect is that teachers can hardly engaged students in meaningful activities (NTI,2012)

Therefore, in attempt to rush and cover the syllabus teachers might tend to use lecture method instead of the recommended Process- Based Instruction. The effect is that students might perform poorly in the subject due to using inappropriate method of teaching. This study therefore is aim at investigating the impact of Process- Based Instruction on acquisition of science process skills, retention and academic performance of students in Basic Science.

2.5 Basic Science Teaching Methods

The art of teaching lies in creating good learning situations and responding creatively to situations as they develop. Strategies to be adopted for teaching Basic science are similar to those normally adopted for teaching other science subjects. However, the role of a Basic science teacher should be clarified within the whole contest of teaching science. By far the most important thing to bear in mind is the fact that the teacher's role is one of a facilitator of learning experience Eze, (2010). Educational researchers have shown that teachers who are able to guide their students through learning situations by using activity oriented methods , rather than by direct teaching, informing or explaining produce. Their students are less dependent and in general learn more effectively. While it is true that the classroom teacher is the best judge of what method to adopt in teaching any aspect of the Basic science course, it is important for him to know of other possible options.

Some methods that could be used for teaching that aspect of Basic science include;

a. Demonstration Method: Simply means to display something Ameh and Dantani (2012). Generally in science acquisition of skills for tackling life's problem is highly valued. One of the ways of introducing various skills to the pupils is through demonstration (Atadoga & Onolapo, 2008). Demonstration involves the introduction of new skills.

Usually it is accompanied with a lot of explanation and showing how something works or is done. It can be employed in finding facts; identifying problems and displaying materials under demonstration, a range of activities can be planned starting from showing the correct use of science apparatus, illustrating a technique to planning a manipulation of equipment and material in order for the pupils to observe a scientific phenomenon. The demonstration method is a versatile method for teaching certain concept and techniques in science. It is a useful addition during a lecture method. A combination of demonstration and lecture should be used by teachers of Basic science. They (teachers) should remember that planning an effective demonstration requires organization and should always seek to provide positive answers which will enhance their demonstration. However demonstration method limits the students from developing manipulative skill and may not be satisfied psychologically. It also emphasizes sight alone which is not sufficient to provide the scientific information the students require. Investigation carried out has revealed that if well planned, demonstration method can also be more efficacious than the traditional. (Igboegwu, 2012)

b. Laboratory Activity Method: According to Ezeliora, (2008) class activity is an experimental subject. Most science educators believe that science is not really science unless it is accompanied by experimentation and laboratory work. For most science subjects therefore, the laboratory is seen as a focal point for the study of science. He further went on to say that for Basic science however, the concept of the laboratory has been extended to include any place in which the learning of science can take place. Experimentation is so much a part of science that it is difficult to conceive of a science programme without an experimental activity. Basic science like all other sciences stresses the role of laboratory work as an integral part of the science lessons. Teachers of Basic science should stress the procedures now generally known as the experimental method. Applied to most of the experiment in Basic science, the methods consist of Identification of a problem, formulation of hypotheses and so on.

The experimental method when properly applied is flexible and readily adapted to all types of situations even outside science. The experimental method sometimes also called the scientific method is no more than the application of common sense to the solution of everyday problems (Ajayi, 2009). Laboratory experiments and exercise are often used interchangeably. Many activities carried out in science laboratories are designed to either demonstrate certain principles or familiarize students with certain pieces of apparatus or skill. However, laboratory experiment differs from exercise in the information given to students in an experiment; a student does not generally know what the results of investigation will be. In an exercise the student is told what the outcome of his work should be and how to attain them. In effect then, the laboratory exercise is very highly structured while a laboratory experiment is less structured. It is important for a Basic science teacher to bear both approaches in mind in order to attain the objectives of teaching science. To conduct a good Basic science class activity, the teacher should bear the following in mind, among others are selecting laboratory activities, giving directions for laboratory activities, providing materials for laboratory activities and use of data collected during laboratory activities. Studies conducted on the efficacy of laboratory method have shown that it can enhance students 'academic performance in science being it indoor or outdoor laboratory instruction, (Ogunleye, 2006 & Usman, 2010).

c. Individualized Instructional Method: Individualized instructional method involves the teacher and the student directly in a one to one basis as Ogunleye, (2008) and Mutazu,(2009) rightly pointed out that learning is an individual thing, no matter how many students are in a class. The teacher first recognizes the individual needs of a student and thus devices special instructional packages to meet the students' needs. As far as the teaching of Basic science is concerned, working within the constraints of large classes and increased contact hour of the teacher, individualized instruction will stretch the school resources- teacher, material and time. A teacher must therefore assess the available resources before embarking on individualized instruction. As far as laboratory activities are concerned, Basic Science provides opportunities for individualized experiments. But teachers who embark on laboratory activities based on individualization must know their students well (Ogunleye, 2007 & Duwan, 2011). Individualization of Basic science curriculum for teaching demands of the teacher a certain flexibility of thinking. The teacher must abandon the concept of uniform out comes and redesign instructional objectives to permit one student in learning a second set of facts. To guide the teacher of Basic science who might want to introduce the individualized instructional methods the following tips are recommended such as, individualized instruction requires a large selection of suitable activities, closely related and needed materials should be readily procured .Also the techniques required for the activities should lie within the capabilities of the student. Shortcomings of this method of instruction according to Duwan, (2011) are that, it emphasizes only on the cognitive and psychomotor domains of knowledge and also cuts down interpersonal relationship because students work individually.

d. Field Trip Method: field trip usually takes place outside the classroom in form of excursion for the purpose of making relevant observations and for obtaining specific firsthand experience. Field trip is believed to be an important part of an effective science instruction if well planned. Field trip helps the student to observe, classify, collect data, study relationship and manipulate objects. Field trip plays the same role as laboratory experiments and demonstrations because first hand experiences are gained in the process. One major shortcoming of field trip is that even with careful and arduous preparation, there is danger of accidents (Ayua, 2011 & Borich, 2011).

e. Project Method: The project method is employed by science teachers to individualized instructions. The method is meant to provide for the needs of individual students or sometimes small groups so that those with special abilities have opportunities to fulfill themselves. Educationist believes that the best instruction is to meet individual need and in science, the projects work whether group or individual helps the teacher to do this (Akpan, 2010). Unlike verification experiments in science, project work requires bit of originality, which is students are given a free hand to look for problems which are of special interests to them and the solution to the problems which must also be unknown to the students. The students obtain for themselves, through the guidance of the teacher, topic for the project work from many sources include, interaction with their colleagues, reading in the scientific journals, Abstracts from papers by scientists reports on science seminars and workshops and so on. Kasim, (2007), reported that, project method appeared to improve the academic achievements of different ability groups.

f. Discovery Method: 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. A modem science curriculum stresses students' involvement in science activities through discovery experience. Akpan, (2010) defined discovery method as an unstructured exploration in the laboratory in which student, through his mental processes such as observing, measuring and classifying can draw valid conclusions from data which he has gathered. Two types of discovery method are recognized;

* Guided inquiry which consists of an instructional mode which can be inductive or deductive in nature. When the general principle is given and the students require using the principle in order to discover the solution to a specific problem, the guided inquiry is employed through deductive method. On the other hand, when the solution to a specific problem is given and the student is required to discover the general principle on which the solution is based, the guided inquiry is adopted through inductive reasoning.
* Unguided inquiry- this is however, when neither the general principle nor the solution is given and the student is required to discover both principle and the solutions, the teacher in this particular instance employs unguided inquiry which is also known as "pure discovery".

As guided inquiry and unguided inquiry involves finding out, they both employ discovery method. These two types of discovery method require student to engage in relatively sophisticated mental processes including, formulating problems for investigation and formulating hypotheses to guide investigation, designing experiment to collect data and so on. An investigation conducted by Bakke and Igharo, (2013) showed that guided discovery enhanced students' academic performance in learning. Obeka, (2010) opined that discovery/inquiry method of instruction had a significant effect on students' academic achievement. In this study therefore Process-Based Instructional Strategy is used in teaching some selected upper Basic Science to observe the outcome.

2.5.1 Lecture Method

Sometimes known as the expository or lecture method, according to Ameh and Dantani, (2012) the main pre occupation of the teacher who adopts this method is talking, giving facts, asking or answering questions and writing either on the chalk or pen board or on transparencies. Adopting this method presupposes that the teacher is the main repository of the knowledge to be transmitted and the students are the recipients. It does not carter for individual learners needs, it may be suitable for the fast or high ability learners but not for every learner in the classroom. Besides, there are objections by science educators to the use of this method in the secondary school level especially in the science which require the use of instructional aides to be enable to relate facts, after all they are not trained to follow chains of reasoning (Ameh and Dantani 2012). This method is unacceptable for learners at the secondary school level who find abstract thinking not only laborious but objectionable as they will not be able to relate facts adequately and will certainly be left out of the lesson. It is also apparent that scientific inquiry that would have led to science process skill acquisition is denied of science students; hence students are passive listener and give the impression that the teacher has monopoly of knowledge. According to Akpan, (2010), if used effectively, this method provides an opportunity for the teacher to demonstrate his mastery of the subject being discussed.

Effectiveness of lecture method depends on the types of student, circumstance of the class, the subject, educational purposes and teacher's own characteristics and skills Nnabuuo and Asodike, (2013). At least eighty percent (80%) of scientific information are passed on to students through lecture method stated by Akpan,(2010). According to Rupani and Bhutto, (2011) many academics have accepted lecture method as the proper way of imparting a body of knowledge since our educational system puts so much premium on external examinations. Lecture method helps science teacher cover a large amount of syllabus to a large class size in a very short period. This is however detriment to students learning, is theoretical, extremely, didactic and teacher centered instead of being experimental or activity based. But the teacher may not have a choice being driven by the pressure to cover the syllabus and thus prepare the students for the external examination which is the only qualifying measure to the next level or employment. A study of teaching behavior and student achievement by Ofuebe (2011) shows that students activities are better than teachers activities in promoting authentic learning and science skill acquisition at least in Junior Secondary School classroom. Research conducted by Rupani and Bhutto (2011) revealed that almost all teachers use traditional teaching methods at Junior Secondary Schools. Instead of allowing learners to work independently, teachers dictated or wrote on the board the answers to the question of the comprehension exercises listed at the end of each section meant for students to solve independently. Also, revealed by the research was that no single teacher followed lesson planning, their teaching lacked proper motivation of the students and evaluation techniques. Students remain passive instead of active, teacher did not allow questions to hide their inefficient skills, they mostly encourage students to concentrate on memorizing the definition and answers of the text or exercise questions, teaching evaluation supported memorization, teachers do not bother to unlock the doors of science laboratories and this resulted in materials of science to be highly utilized. Opateye (2012) further noted that the lecture method has some basic common problems which are;

i) The teacher's disposition: Since the teacher is the authority of subject matter as well as controller of student's behavior, the communication is only one way. The students have limited opportunities to express their problems and needs. It is difficult to know if the teacher is being understood, there is little chance of correcting students' misgivings and thus students are alienated.

ii) Communication problems: Delivery is the most personal problem in lecture method due to individual differences. For effective teaching, good communication must be maintained between the teacher and the students. This will inculcate clarity of voice, simple and understandable language style, monitoring the students by pausing regularly to explain and ask questions.

iii) The preparation, organization and presentation: This has to do with clear aims and objectives of the course and the student's previous knowledge will enhance good preparation, lecture materials should be put together ahead of lessons, updating it as necessary. The teacher's presentation should be such as well aid students to develop and maintain interest in the subject. Studies conducted on this method shows that the lecture method can promote meaningful learning if properly employed (Hijaz & Naqir, 2006).While others such as Osuji, (2009) and Remziye, (2011) argued that lecture method does not promote meaningful learning of science and that differences in students' science skills acquisition are not considered because it cannot satisfy the difference in individuals science skills acquired. Some studies conducted by Duwan,(2011), Nzewi, (2011), Ugwu, Ofuebe and Efiubon (2011) differently also reveals, that students have difficulties in coping with certain concepts like habitat and adaptation of organisms ,kinetic theory of matter and thermal energy (topics selected for this study). The difficulty according to them was as a result of the frequent use of lecture method in teaching Basic Science at the Junior Secondary School levels. They argued that, most junior secondary school teachers spend most of their time in class teaching for memory and comprehension as opposed to teaching for the development of science process skills. Lecture method was therefore used as a control in this study to see whether the result is the same or different.

2.5.2 Process-Based Instructional Strategy

Since the mid-fifties, revolutionary changes have been taking place in the teaching of science. Teams of scientists and teachers have attempted to bring about far reaching improvement in Science Education at all levels, including the elementary school levels. The commission of Science Education of the American Association for the Advancement of Science (AAAS) with financial support from the national science foundation embarks upon the preparation of science program for the elementary school. Materials were first written during the summer of 1963 and in each of the subsequent summers through 1967.This effort gave birth to a new curriculum called Science-A Process Approach (SAPA) in August, 1969.This curriculum considered Process- Based Instruction (Process Approach) as its main instructional strategy for teaching and learning of science. According to Ugwu , Ofuebe and Efiubon (2011), learning science and teaching students about science means more than just scientific knowledge. They also claimed that the science process skills form the bases for the Process-Based Instructional Strategy and that there are three dimensions of science that are very important. The first of these is the content of science, the basic concepts, and our scientific knowledge. To Ugwu, Ofuebe and Efiubon (2011), this is the dimension of science that most people first think about, and it is certainly very important they stated. The second dimensions of science in addition to science knowledge are processes of doing science and scientific attitudes that actually facilitates achievements. The processes of doing science are the science process skills that scientist employ in scientific investigation. Hence science is about asking questions and finding answers to questions, these are actually the same skills in science that are used daily to fathom everyday questions. So, when students are taught to use these skills in science, they are also being taught these skills to enhance/improve their quality of performance and for use in the future in every area of their lives, (Duwan, 2011). The third dimension focuses on the characteristic attitudes and dispositions of science. These include such things as being as curious and imaginative, as well as being enthusiastic about asking questions and solving problems. Another desirable scientific attitude is a respect for the methods and values of science. These scientific methods and values include seeking to answer questions using some kind of evidence, recognizing the importance of rechecking data, and understanding that scientific knowledge and theories change over time as more information is gathered (Ugwu, Ofuebe & Etiubon,2011).

Process-Based Instruction (PBI) is procedural skills used to produced and used scientific information to perform scientific research to solve problem. Is an instructional strategy that capitalizes on getting students to work on that which they are learning. Is also a method of teaching that involves students constructing their own conceptualization and solution to problems through ample opportunity to use the functional skills called science processes.

PBI uses Science-A Process Approach (SAPA) in teaching scientific knowledge and in acquiring of science process skills in solving problems. SAPA originated as a result of curriculum reform that took place in Science Education in America in 1967. It was an experimental program in elementary school science sponsored by the America Association for the Advancement of Science (AAAS). SAPA specified the particular behavioural objective and the competency measure for each lesson to be taught. This represents a very specific way of teaching science and unique contribution to the teaching of Basic Science.

In Process-Based Instructional strategy, the ability to read is not as essential as it is in many traditional curricular. Thus inquiry into circular can begin as early as kindergarten. Success does not depend on reading skills, but on the ability to use the process of science. The implication of this according to Opateye, (2012), lies in the provision of equal opportunity to children from low socio-economic backgrounds (Many of whom may have reading problems) and those children from higher socio-economic strata. The strategy is based on the notion that, children undergoing very active processes during their growth and development, be allowed to acquire those skills used by scientists in scientific investigation hence science is a participatory subject and not a spectator art. Science teaching cannot be done by listening and reading alone. Students should be involved in meaningful activities during which they have ample opportunity to use a functional intellectual skills called the science process to solve problems and be creative

In Nigeria, it was after 1969 (The year in which the first National curriculum was organized) there were increased conscious efforts by Nigerian Education sector to modernize science and technology content and instruction to achieve its vision of becoming a developed nation by the year 2020 (Matazu,2009). Such efforts according to Matazu,

(2009) have been made through programmes like the Bendel Primary Science Project (BPSP), Primary Education Improvement Project (PEIP) of the Institute of Education (IOE) Ahmadu Bello University Zaria, Nigerian Integrated Science Project (NIPS) by the Science Teachers Association of Nigeria now Nigerian Basic Science Project(NBSP) and the Nigerian Secondary School Science Project which was a project of the comparative Educations Study Adaptation Centre (CESAC) now Nigerian Educational Research and Development Council(NERDC).These projects have been designed to be student centered with an overall aim of making science interesting to the students and broad principles used in making the valid inductive inferences.

Process-Based Instruction (PBI) relies on the ability to use the process of science which was based on some basic assumptions as stated by Finley, (1983); that science can be taught to young children in a meaningful way. This implies that children should learn scientific investigation as a process used by scientists, that scientists can learn best by doing and that lessons must take into consideration the empirical findings of developmental psychology. Process-Based Instruction adopted the theory of the psychologist of Piaget, (1961), Bruner (1963), Gagne, (1965) and Finley (1983) as a guide in the programme design being a cognitive constructivism. Bruner, (1963) put forward solution to problem in education. This theory promotes the acquisition of knowledge through discovery by oneself through the use of mental processes. It takes places in two ways: the learner encounters a new situation that is similar to one element in his existing structure of knowledge and assimilates it with ease. Secondly, when the learner encounters a new situation, is incompatible with his existing knowledge in order to create a place in mind for new knowledge. Bruner believes that it is only through the exercise of problem solving effort of discovery that one learns the heuristic discovery. Students assume more responsibility for their own learning.

Bruner (1963) described four major benefits derived by students when they learn how to investigate and discover for themselves which are, an increase in intellectual potency, a shift from self-reliance on extrinsic reward to reliance on instructive reinforcement, this is because the act of discovery is itself highly pleasant (interesting) and learning the heuristic of discovery. Also discovery facilitates transfer of 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 involves the management and Conditions of learning. Gagne (1968) 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 .Finley (1983) identified some major features of processes of science which stated that, each process is generalizable (transferable) across content domains and contribute to rational thinking in everyday affair, is identifiable behavior of scientist that can be learned by student, is specific intellectual skill used by all scientists and applicable to understand any phenomena. The processes are hierarchically organized with the ability to use each upper level process dependent on the ability to use the simpler underlying process (Sevilay, 2011). 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 information base changes. From the above psychological theories therefore, the issue of students need as well as science skills to be acquired are both beneficial for Basic Science and technology teaching, hence the need to use the AAAS,(1967) based on learning theory of Robert Gagne,(1965) and Finley, (1983) being the basic premises for science skills acquisition.

Several researches have been conducted on the effectiveness of using the Process-Based-Instructional Strategy (PBIS) in teaching science. Opateye, (2012) found that Process – Based Instructional Strategy (science process approach) improves students' ability to apply intellectual skill to solve problems. Akinbobola and Afolabi, (2010) reported that science students cannot learn effectively without the use of the process of science which is ensured by the Process-Based Instruction (process approach). Sani, (2007) reported that the Process-Based Instructional approach programmes like Elementary Science Study (ESS) and PBIS were more effective in raising students' performance than the traditional reading based programmes. Nzewi (2011) also stated that some additional skills are attainable from the Process-Based Instructional Strategy which include; creativity, questioning manipulating, organizational and acquisitive skills, controlling variables and counting number relationship. In an attempt to meet the instructional demand of the new 9-3-4 system of education in Nigeria, it is observed that a greater concern is given on how to organize science lessons in line with the demand of the Process-Based Instruction. Therefore in this study, Process-Based Instructional strategy was used to teach Basic science concepts for science skills acquisition, performance and retention among Basic Science students in Junior Secondary Schools to see which of the method is impactful.

2.5.3 Concept of Science Process Skills

Science education is an indispensable tool for national development because of the position it occupies in the advancement of all nations. The pursuit of science education as an imperative effort for achieving prosperity and advancement is conspicuous in many development plans in both developing and developed countries. Mutazu, 2009; Akinbobola and Afolabi (2010) 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 in Nigeria emphasis is placed on the provision of science education at all levels. Science education enables Nigerian child to do the following among others, Observe and explore the environment, develop Basic Science process skills including; observing using sense organs, manipulating, communicating, develop trial knowledge of science that is, conception of principles, curiosity, objectivity, skepticism, perseverance, critical reflection and so on.

In order to achieve these objectives, emphasis was placed on learning science through the process of science. The development and use of process skills would enable student to bring logic and available evidence to bear on their ideas, attitudes and action so that they can pursue better practical skill at all levels of learning science in school. Science process skills are cognitive and psychomotor skills which scientists employ in problem identification, objective inquiring, data collection, analysis, interpretation and communication. Ozgelen, (2012) described science process skills as abilities which can be developed by experience and are used in carrying out mental operations and physical actions. Ibrahim, (2012) opined that when one acquires science process skills of observing, measuring, questioning, designing, experimenting, interpreting data among others, 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 the laboratory for a variety of investigations. According to Sevilay, (2011) science process skills are commonly used to describe a set of broadly transferable abilities that are reflective of what scientists do. These skills are grouped into two which are basic and integrated. The Basic Science Process Skills (BSPS) include observation, measuring, inferring, recording data, classifying, collecting and predicting. The Integrated Science Process Skills (ISPS) include interpreting data, controlling variables, defining operationally, formulating hypothesis and experimenting. Observation is considered to be the fundamental skill needed to discover the broad knowledge required for inquiry. Some of the major features of the processes of science as identified by Finley, (1983), Mari, (2002), Aktamis and Ergin, (2008) include, generalizable (transferable) across content domains and contribute to rational thinking in everyday affair, an identifiable behavior of scientist that can be learned by students, specific intellectual skill used by all scientists are applicable to understand any phenomena. The processes are hierarchically organized with the ability to use each upper level process dependent on the ability to use the simpler underlying process (Sani, 2007). 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. This view apparently supports Aktamis and Ergin, (2008) notion that concepts and contents of science will undoubtedly change, but the mental skills of the scientist or students which are very vital in science and technology do not.

Abungu, Okere and Wachanga, (2014) posited that, expertise in science process skills is a basic and integral part of having effective teaching skills. Such expertise obviously is not innate. One is not born with it. To become an expert, one must receive guidance in the way of scientific inquiry and must conduct extensive guided appropriate practice in the use of the skills of scientific inquiry. The development of skills of scientific inquiry requires that students of science be provided with appropriate and adequate guidance in their study of science. This guidance is to be found in the instructional programs provided by schools, colleges and universities. Competent, adequate guidance must meet a number of conditions. These include guidance in practical work which enhances the quality of a teachers learning. Science process skills are critical for the development of a worthwhile and fruitful understanding by both, teachers and students of scientific concept and propositions. These experiences are also critical for achieving expertise on the meaningful use of scientific procedures for problem solving and for applying scientific understanding to one's own life. (AbdulRauf, Rasul, Mansor, Othman and Lyndo, 2013)

The Basic and Integrated science process skills are explained as follows:

Observation Skills: According to Bilgin, (2006) observation is the first stage in scientific inquiry. It is made on a particular event and general principles are developed from a number of specific and consistent cases. 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. Aktamis and Ergin, (2008) described it as the skill of looking and seeing which may be made directly or indirectly. Thus an active use of the senses during the process of observation enables one, to determine the quality and quantity of things and events. Observations according to Fayzioglu, (2009) influenced by past experiences often involving instruments (microscopes, telescopes) and requiring careful recording and description. However, Sani, (2007) identified three broad proficiencies that are logically necessary for achieving observational competence to include, making, reporting and assessing report of observation. The more precise an observation is, the more valid are the inferences based on it (Mari, 2002; Bilgin, 2006).

Skill of Measuring: this 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, precision and permits more accurate descriptions Ikwuanusi, (2007).

Sani, (2007) said that 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 student 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. Bikpo, Lawal, Ekpunobi and Bukar, (2012) identified five sub- processes involved during the process of measuring among others 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 and so on..

To be proficient in the use of the process of measurement, students 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 (Zeidan and Joyosi, 2015).

Skill of Classifying: classifying objects according to Mari, (2001) and Ikwuanusi, (2007) involves sorting and arranging objects according to their similarities and differences. During this process things or events are organized, categorized and grouped based on observed or measured property to form an easily recognized pattern. Akinoglu and

Tandogau, (2007) identified six characteristics of a child who attain certain level of competence in using the process given classifying. Thus the child is able to, categorize object or system of objects using a given property, determine with reason an appropriate property and categorize objects or systems of objects according to that property to mention but a few. Aktamis and Ergin, (2008) defined classification as a process and skill of sorting, grouping, ordering objects by both their quality and quantity. The desired goal in this scientific process is for children to develop sensible reasons as a basis of their grouping, sorting and ordering.

Skill of Inferring: inferring as perceived by Kim, (2007) is a skill of basing judgment on observed and measured event. Baker and Peterson, (2007) viewed inferring as an interpretation of one's direct observation; past experiences are generally used as a basis for interpretation. According to Sani, (2007), inference implies the cause and effect relationship which may be based on preliminary or sketch data or very well founded data from experiments. Mari, (2001) and Ogunmade, (2006) pointed out that inference is strongly made on the basis of inductive and deductive logic. Deductive inference involves reasoning from general premise to specific instance, while inductive inference involves deriving preposition from the evidence of specific cases. The following sub-processes are involved in the process of infer ration as identified by Mari, (2001) and Ogunmade, (2006) such as distinguishing pertinent observations upon which given inferences are based and extraneous, drawing an inference from a set of related observation, stating cause and effect relationships from observations of related events to mention but a few.

Skill of Predicting: making predictions involves figuring what future observation will be on the basis of available previous information (Mohd Al-Junaid and Ong, 2012).

Identifying some proficiencies associated to a person who achieves competence in using the process prediction suggest 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 argument and evidence to justify his prediction. Sani, (2007) is of the opinion that the skill of predicting as the process is determine or anticipating future events based on past experience and observations. He viewed prediction as a scientific process which arises from a well-founded bases hypothesis, theory or law. With regularly consistent data in hand, one can predict. Mari, (2001) and Ikwuanusi, (2007) is of the view that predicting involves forecasting or extrapolating on the basis of past observation.

Skill of Communicating: - this is the process skill of transmitting acquired information from one person or group to another which may result in change in behavior. A scientific experience in observation, data collection and discovery needs to be communicated to other people. (Sani 2007). This will give growth to knowledge and it could be in written words, diagrams graphs or models. However, according, Mari, (2001) and Wheeler, (2007) the following sub processes are involved during the process of communication among others are describing observation verbally, describing conditions under which observations are made and recording observations in a systematic way.

Skill of Interpreting Data: -Baker and Peterson (2007) defined interpreting as a process of using various forms of data to determine the validity of a hypothesis, to organize information derived from an experiment and / or revise interpretation of data base on new information. When using the process of interpretation, 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. Kim,(2007),Coffey, Douglas and Steams, (208) viewed interpreting data as involving identifying changes in size, shape, position and judgment of validity and usefulness of data. However, Nwafor, (2007) identified what a student should be able to do to demonstrate competence in the use of the skill such as making sound generalization from a set of data, identifying cause and effect relationship and providing reasonable justification for any generalization made to mention but a few. 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.

Skill of Raising Questions and Formulating Hypothesis:-in an attempt to provide answer to the problem under consideration. Mari, (2001) and Ajayi, (2009) viewed hypothesis as a thoughtful educative ‘guess’, as to what a solution to given problem might be. Hypothesis according to Ajayi, (2009) can be regarded as an educative ‘guess ‘of answers to a question which is tentative until a real research is conducted.

Skill of Making Operational Definitions: - here, students 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. Sani, (2007) asserted that 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, (2001) and Ajayi, (2009) are important means of facilitating communication about the phenomena investigated as well as the materia1s 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.

Skill of Experimenting: This is the testing of hypothesis to confirm or disconfirm if initially it might be in the form of trial an error. Sani, (2007) reported that experimenting involves chasing after answers along a path that appear fruitful. Designing experiment involves planning a series of data gathering operations which will eventually provide the basis for testing hypothesis or answering a research question. It may however involve the use of some of the other skills such as observing, comparing, interpreting, use of numbers and controlling variables. It may also involve designing an investigation to find out the effect of the independent on the dependent variable. Sani, (2007) asserted that the achievement of competence in the use of this process skill implies that, the student is able to among others, choose, clarify and state the primary variable being investigated in a way that could be tested, confine the number of variables to a manageable number and competently control variable.

Skill of Controlling Variables: This is the process of identifying the influential in a system, holding some constant and varying others to see how the system behaves (Aktamius and Ergin, (2008). Thus the experiment will discover the real role of a variable or factor in a system. Yadav and Mishara, (2013) and Atadoga & Onoalapo (2008), observed that, in recent years, of all the methods of teaching the Process-Based Instructional Strategy is considered to be one of most suitable for learning science. This is because it allows students to think with their minds and work with their hands. Atadoga & Onaolapo, (2008) asserted that the main business of science teachers is to promote the learning of the fundamental facts and principles of science and to develop in students' activities and skills needed to engage in scientific process. Yuguda, (2008) is of the opinion that, successful use of Process –Based Instructional Strategy in classroom lessons will make learning richer and more meaningful to students learning Basic science. This study therefore, examines the impact of Process-Based Instructional Strategy on acquisition of science process skills, performance and retention among Basic Science students.

2.5.4 Acquisition of Process Skill and Achievement in Basic Science

One of the objectives of teaching Basic Science according to National Policy on Education (2013) is to help learners solve problems arising from observation of their immediate environment and equipping the learners to choose careers in science and technology. To achieve the above goals, the learners need to acquire necessary skills for scientific investigation in order to solve problems. Skill acquisition according to Usman, (2012) is a special ability acquired or develop as a result of training to do something well. Oburu, (2007) however defined skill acquisition as a process of learning skills, be able to became competent and be experienced in its application to solving problems or achieving desired end result. Science Process skills Acquisition are sets of broadly transferable abilities that are reflective of what scientists do that the learners needs to acquire to carry out mental and physical operation in science. In teaching and learning Basic Science, the acquisitions of science process skills are the bases for scientific investigation. Nwagbo (2008) and AI-Swidi, (2010) asserted that science process skills are abilities which can be developed by experience and used in carrying out mental and physical operations. According to Sevilay, (2011), the American Association for the Advancement of Science (AAAS) developed a programme known as Science A- Process Approach (SAPA). This programme sees science processes as true essence of science. The programme was designed to improve students' skills in the process of science. This is done through involving students in meaningful activities in the use of functional intellectual skills called the science process to solve scientific problem and be creative. A flowchart of Process-Based Instruction Adapted from the AAAS (1967) in fig.3.2 showed clearly step by steps the activities the students are to engage in to acquire science process skills and below is the Process-Based Instructional learning strategy as follows:

Step 1: **Information**

These include a space for the name of student and gender. There is indication of Class, subject, duration, topic and behavioural objectives are stated to be achieved at the end of the activities.

Step 2: **Instruction/ Introduction**

The students are shared into seven groups of five each to work on the activities. New words are stated and explained. Students are to use their sense organs in working out the skills in the activities. The place for the activities are indicated, which was either in the laboratory / outside the laboratory for the students to carry out the activities.

Step 3: **Students Activities**

List of materials are provided for the students to work with the skills to be acquired on each activity. Methods for each activity are stated and spaces indicated for answering the questions. The teacher guides the students on how to carry out the activities while students make use of their sense organs to work.

Step 4: Evaluation and Conclusion

Teacher evaluates the students work by selecting three students with their packages to read some areas of their work in front of the class. Corrections are made and students' packages were collected for marking.

The acquisition of science process skills is enhanced by Process-Based Instruction in oriented activities as scientists. This is because, when students are engaged actively in carrying out activities in teaching and learning Basic Science concepts are provided with the opportunities to actually do science as opposed to learning about science. This is an indication according Dash & Dadhi, (2016) that students are working like scientists. Nzewi, (2008), Osun and Ekpem, (2010) asserted that, for science process skills acquisition, Process-Based Instruction is regarded as a strategy that is to make the task of a teacher (teaching) more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subjects matter. Nzewi (2008), Chukwuemeka and Nwaso (2008) maintained that, the activities involved in the Process-Based Instructional Strategy engages the students in hand-on activities, using varieties of instructional materials for the effectiveness of the lesson hence improve academic performance and science skills acquisition. Nwagbo, (2008) and Okonkwo, (2009) stated that, the use of Process-Based Instructional Strategy in the teaching of Basic Science concepts could produce students that would acquire the necessary knowledge, skills and competence needed to meet the scientific demands of the nation. The importance of science process skills is identified as solution to scientific problems stated in the National Policy on Education, (FME, 2013) in Basic Science Curriculum on Education. Among others things, is one of the national goals of education in Nigeria that, "education should aim at helping the students in the acquisition of appropriate skills, abilities and competencies, both mental and physical as equipment for the individual to live in and contribute to the development of the society". In order to realize this goal, association such as Science Teachers Association of Nigeria (STAN) and Nigerian Educational Research and Development Council (NERDC) were set up by the government to look into various curricular developments, have their objectives which have to be achieved for successful science education, attainment of the national goals and aspiration. Of course, the goals are to be realized by effective effort of the classroom teacher. The teacher will play an important role in engaging students on activities involving science process skills in a class through planning; arranging learning activities and teaching that could lead to acquisition of science process skills.

Researchers conducted on process skill acquisition on students' performance, has shown that acquisition of science skills has helped in improving the ability to solve problems and be creative. Aktamis and Ergin (2008) carried out a study to investigate the effect of science process skills with the effect of school students on scientific activities in chemistry. The results shows that the science process skills acquired enhanced their performance in chemistry. Feyzioglu (2009) carried out a study at the university level and the outcome indicated positive relationship between science process skills and students achievement. Wambugu and Changeiywo, (2008) in the study on achievement in physic found out that, students who learned through Process-Based Instruction acquired the skills and attained high mean scores in physic than those who learned through traditional instructional approach. Oleyede, (2012) in the study conducted on the relationship between acquisition of science process skills on formal reasoning ability and Chemistry achievement. The result shows positive relationship between formal reasoning ability, acquisition of science process skill and achievement in chemistry.

Omole, (2012) in the other hand carried out a study in Nigerian Science, Technology Engineering and Mathematics Education and Basic Skill Acquisition in the 21st century, and found out that a wide body of researches suggests that learning to solve problems in various contexts fosters the development of a general problem solving ability. And this is practically applicable with science skills acquisition hence such is transferable in solving day to day life activities. To help a teacher create enabling environment in which students make connections between learning science skills in school and applying them is daily life activities. Basic science emphasizes science skill acquisition to make individual self-reliant economically as provided in the National Policy of Education (FME, 2013). In this research therefore an attempt was made in assessing the impact of Process-Based Instruction on acquisition of science process skills and performance in Basic Science with regards to gender.

2.5.5 Gender and Science Process Skills Acquisition

For science teaching and learning to be interesting and meaningful, the development of science skills in children becomes a necessary and an integral part of school science curriculum. Ongowo and Indoshi, (2013) observed that any meaningful learning of science by students in Nigerian schools must include the acquisition of the science process skills and the science curricula were modified to reflect this emphasis. When these process skills are acquired, intellectual ability of the students is widened and this could be used for life in the understanding of nature and problem solving. This is true and as rightly observed by Usman, (2007) that “Give a man a fish and he eats for a day, teach a man to fish and he eats for a life time”. The process skills are the tools for learning and problem solving. They should not only be acquired at all levels of our school, but should also be acquired to a reasonable extent (Sevilay, 2011), even though literature on the acquisition of these important process skills in relation to gender is deficient (Akinbobola and Afolabi, 2010).

Bang and Baker, (2013) reporting data collected from the Assessment of Performance Unit (APU) in the United Kingdom (UK) who indicated that girls show superior performance in observational skill at all ages tested (11, 13 and 15 years). The report suggests that girls outperformed boys with respect to questions that require objects or features to be compared and contrasted, but that the reverse trend is seen with respect to questions where scientific explanation of observation are required. Girls were however found to outperformed boys in relation to reporting observations of color changes in Chemistry context (Abungu, Okere & Wachange, (2014). On interpretation of Data, Bang and Baker, (2013) reported boys show significantly superior performance to girls among the Scottish school students. Data collected from low achievers aged 15-16 years in Scottish schools on the skill of measuring Bang and Bakers, (2013) indicated that no gender related differences were found for using lenses or stop clock but those girls were better at focusing of microscope than boys. Report on the skill of interpreting data (Al-Rabaani,2014) indicated that at age 11, there are no gender-related differences in performance on interpretation but that at age 13, boys’ slight superiority is evident, but by age 15 these differences reach statistical significance which they said may be related to the greater proportion of coordinate graphs used with these ages Research conducted by Olufunke and Adebayo (2014) on gender and practical skill performance on science indicated that there is no gender difference in observation, reporting, or planning skill, and there was no differential performance in the use of scientific language. The report also indicated that boys performed better in interpretation than girls. However, report by Shaibu and Mari, (2003);Mari, (2012) revealed that there was significant difference between the male and female subjects in their ability to solve problem requiring their understanding of the process skill as pre-requisites but the female subjects were significantly better in their understanding of science process skills than their male counterparts.

A study conducted by Ekon and Eni, (2015) to determine the influence of sex upon the acquisition of science process skills revealed that boys were better at using numbers, measuring and experimenting than girls, while girls performed better in the process of observing and inferring. However, the overall mean score of girls in both Integrated and Basic science process was found to be higher than that of the boys. Similar result was obtained by Akani, (2015), Bassey and Amanso (2017). Mohd Al-Junadi and Ong, (2012) in the study revealed that exposure to science process skill based learning involving activities for both girls and boys (experiment group) yield a more effective learning irrespective of gender and ability level. Report by Olufunke and Adebayo (2014) also revealed no significant difference in achievement between girls and boys on task involving process skill acquisition. There is thus, the need to use Process- Base Instruction, an activity-based learning in schools to help learners especially girls who are denied these opportunities at home to acquire the process skills. Raji and Devi, (2014) suggests that gender stereotyping has to be discouraged in the homes; school and societies to enable girls participate freely in skills-based activities. Process- Based Instruction is therefore used in this study to see if the result is the same or not.

2.6 Gender and Academic Achievement in science

Erinosho, (2008) notes that, the main concern in the field of science education is the biases and misconception about women and science, that science is a male enterprise. In Nigeria and Africa, gender bias is still very prevalent. This is a view to which Dokme and Aydinli, (2009) alludes by pointing out that "sex roles are somewhat rigid in Africa, particularly in Nigeria, gender as a factor in learning science education is emphasized". Bichi (2002) explains the concept 'gender which refers to the content of masculinity and femininity found in an individual. While there are mixtures of the two traits in human beings, the normal man has a preponderance of the masculinity and the normal female has a preponderance of femininity, (Mohd Al-Junaidi and Ong, 2012).

Gender-related issues have attracted the attention of many researchers in science education for males and females in the secondary schools. Many studies have investigated the influence of gender on academic achievement or performance. Studies in Singapore suggested that males' achieved better than females in Mathematics, (Essien, 2009). Similarly in West Indies, Afewape and Oludipe, (2008) reports superior performance of females in mathematics and physical sciences to that of males. In Great Britain, Wheeler, (2007) observes that males tend to have far more out of schools experience of scientifically based activities than girls. Esu, Anuah and Danso (2013) reveals that males have a head start advantage over females in opting for science related careers. In the same vein, studies of Mari, (2002) and Nworgun, (2005), reveal that, females are more prone than males to exhibiting fret and anxiety that are related to science tasks. This is particularly so in the academic situation. A number of researchers have come up with reasons for gender-related differences in science achievement. Jack, (2013) observes that teachers spoke more frequently to males, asked the males more questions, Praise males for quality work and females for neatness. Usman, (2010) reveal that male students received more praise and criticism from teachers than the female students during teaching and learning situations.

As it was reported that, there is a low participation of females in high school courses in science and technology as well as the low numbers of women who hold professional careers in science or technology, Ekon and Eni, (2015). However, data collected by Bassey and Amanso, (2017) also reveals that males are more oriented towards “hard” course like science subjects (chemistry and physics). Females prefer the “soft” subjects such as a human physiology, plant life, Zoology, Biology. Bang and Baker, (2013) report that gender differences in integrated science occurs as a result of a number of social factors both at home and at school, and that gender as a factor in learning science education appear to be greater in some schools, than others, although statistically achievement were also found among SS II chemistry students favouring males (Oloyede, 2012).

A study conducted by Duwan, (2011) on gender and practical skill performance on integrated science indicated that, there is no gender difference in observation, reporting, or planning skills and there was no differential performance in the use of scientific knowledge. The report also indicated that males performed better in interpretation than girls. However, report by Mari (1994), Shaibu and Mari, (2003) and Mari,(2012) reveals that there was significant difference between the male and female subjects. In their ability to solve problem requiring their understanding of science process skills as a pre-requisites but the female subjects were significantly better in their understanding of science process skills than their male counterparts.

A study conducted by Abdullahi, (2007) determine the influence of sex upon the acquisition of science process skills revealed that males were better at using numbers, measuring and experimenting than girls. While females performed better in the process of observing and inferring. However, the overall mean score of females in both integrated and basic science process skills was found to be higher than that of the males. Similar results obtained by Ongowo and Indoshi. (2013), Bang and Baker, (2013) reveal that exposure to science process skills based learning involving activities for both females and males (experimental group) yielded a more effective learning irrespective of gender and ability level. Report by Balanay and Roe (2013) also reveals that there is no significant difference in achievement between females and males on task involving science process skill acquisition. Esu, Anuah and Danso, (2013) suggests that gender stereotyping has to be discouraged in the homes; schools and societies to enable females participate freely in skills based activities. It is also important to note that integrated science is the grass root subject that introduces children into the field of sciences. If equal opportunity to education has been taken care of at this level, it thus provides sound bases for reducing gender biases and misconceptions. This study desired to find out if gender as a factor affect learning science taught using Process-Based Instructional Strategy and whether such instructional strategy could impact the students academically in Basic Science.

2.7 Retention and Achievement in Basic Science

Engagement in meaningful learning is a universal theme advanced in literature on student's achievement and retention. What students learn is greatly influenced by how they are taught. Several science educators have defined retention in several ways; Bichi, (2002), Horby, (2006), Roediger and Karpicko, (2006), view retention as the ability to retain and later remember information or knowledge gained after learning. It takes place when learning is coded into memory. Retention is the ability to accept information process it and store for future retrieval in response to situations demanding the applications. The concept of retention sometimes brings up the idea of memorization and rote learning. It is referred to what is learnt minus what is forgotten (Young & Albert, 2009). The theories of forgetting make it clear that it takes place as a result of passage of time. This however has the implication of making Basic Science and other science teachers to be in the position of urging and encouraging learners to engage in constant practice of what have been taught. Students could strengthen retention ability of the learned materials through practice and activity oriented strategy.

Research studies have shown that improved instructional strategies, improve students retention. To determine this, two fundamental assumptions were made by Iwuju, (2011) that underline formal education systems (a) that students retain knowledge and skills they require in school, (b) can apply them in situation outside the classroom. Research study to determine the accuracy of the assumptions has discovered that even when reports indicated that students were not using the knowledge acquired in school, a considerable portion is retained for many years and long-term retention is strongly dependent on the initial level of mastery. A study conducted by Iwuju, (2011) revealed that university students who took a child development course and attained high grades scores of about 80%, whereas those who obtained moderate or lower grades showed average consensus on the crucial question. Of how much knowledge acquired in school transfers to task encountered outside formal educational settings, and how much transfer occurs. Lakpini (2006) studied the effect of conceptual change instruction on retention of some biology concepts, and came out with the following results, the subjects taught using conceptual change instruction strategy retained more genetics concept learned than subjects taught using traditional method. She explained that the instructional strategy enables students discuss among one another, modifying their preconceptions, that members of a given group are able to freely express themselves, verbalize and organize their taught**.** Also resolve conflicts in their ideas and construct knowledge based on collective mentoring. She further stated that the activity oriented and student centered strategy has proved to be a better instructional method which significantly improves the level of retention and performance.

Udogu and Njelita, (2010) study on the efficacy of conceptual change strategy in remediating identified misconceptions in biology revealed a high correlation between performance and retention scores of the experimental group and a low correlation was recorded for control group. Bilgin, (2006) recorded significant retention from her study employing concept mapping, when compared with those exposed to guided-discovery. She explained that improved retention recorded by the group taught using concept mapping may be due to the fact that the strategy enables the students to have concepts organized and summarized in such a way that they are easily remembered at a later time as well as makes knowledge of concepts clear and meaningful to the students. From the review of the above literature, it is apparent that improved instruction could certainly enhance retention. This study intends therefore to facilitate active participation of the subjects in the learning process. Because the method that permitted the learner to interact directly with the learning material and making use of the Process-Based Instruction Strategy employing the processes skills could facilitate the mastery and retention of science concepts, than the condition where subjects are passive listeners to the teacher. The study therefore investigated the impact of Process-Based Instructional Strategy on retention span among sciences.

Goldstein, (2010) associated retention, span with Long-term memory, it is so defined to focus not only on its functionality but on its duration as well because Long-term memory is involved with the long storage of, manipulation and efficient processing of information. Nonye, (2009) conceived retention span; as a process, in which information is encoded, saved and retrieved. Encoding or registration allows information that is from the outside world to reach our senses in the form of chemical and physical stimuli, it involves receiving, processing and combining of received information. Storage entails the maintenance of information over a period of time; it is the creation of a permanent record of the encoded information. While retrieval is the process of recall or recollection of information that was stored in response to some cue for use in a process or activity. It is the ability to locate the desired information and return it to our consciousness that is significant to achievement in the cognitive domain.

Retention span as seen by Beer, (2010) is a tool employed by learners to assist them performs efficiently and effectively in all aspects of lives and particularly in the school. This essential tool is needed by learners to maintain and manipulate information in the mind for a brief and long period of time. Roediger and Karpicko, (2006) posit that it is the ability to actively hold information in the mind needed to do complex tasks such as active thinking, comprehension and learning. Goldstein, (2010) believe that it is responsible for maintaining and manipulating information during cognitive activity and that it is related to a wide range of cognitive abilities such as thinking skills, problem-solving, and learning. The cognitive processes involved provide for the integration, processing, disposal, and retrieval of learned material for higher order cognitive processes. Veselinovska, (2011) suggests that retention span is related to academic performance in the domain of the physical sciences, and that it (academic achievement) is enhanced by a number of abilities, storage capacities, processing efficiency, the ability to combine storage and processing, the ability to inhibit irrelevant information, the quality of knowledge representations, and the ability to use efficient strategies in the face of interfering processes and distractions. Thus, appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory (Bichi, 2002).Teaching students to use memory strategies by employing appropriate teaching strategy will not only improve students thinking skills on complex tasks (of prediction, modeling, experimentation, evaluation) but will also assist learners to attain a deep understanding of conceptual knowledge and will result in developing cognitive facilities to explore objects, phenomena and events in line 'with educational objectives in the cognitive domain, (Auwal, 2013). This study therefore intended to employ the use of the Process-Based Instruction Strategy to determine its impact on student's retention span and academic achievement in Basic science.

Williams and McClure, (2010) explained also that retention has to do with memory, that the memory stores information or activities learnt and the storage could be in form of sensory short term or long term. It was further explained that messages received through sensory memory using one or more of the sense organs are not easily recalled, unless they are stored in the short term memory. Also that short term memory last only for about 20 seconds and has the capacity to hold only about seven separate pieces of information at a time. The long-term memory however, they opined is a relatively permanent store house of knowledge which has the capacity to store enormous amount of information for over a long period of time even as long as a life time. Information stored in the long term memory can be described as information retained. Williams and McClure, (2010) suggested techniques to help students retain information in long-term memory among others are, beginning lessons with activities that require students to draw upon existing knowledge, ensure clarification of relationships between concepts. If students understand how concepts are related, they can conceptualize information in meaningful ways and may not have to rely on memorization. Also review previous taught topics often to ensure that students have not forgotten what they learnt previously to mention but a few.

Studies on retention and performance have attracted attention of many researchers which include: Anaso, (2008) in a study titled effect of class-size on academic achievement and retention of different ability groups among chemistry students reported that, students in the class size of 25 achieved higher retention ability than their counterparts in class-size 50 and 70s. Veselinovska, (2011) carried out study to determine the effects of usage of Sequential Teaching Method on academic achievement and retention level of second year students. The teaching methods were Laboratory method (student experiment), slide demonstration and lecture method. The result revealed that laboratory and demonstration methods improved the retention level of students in Biological science concepts than the lecture method. Iwuju, (2011) also reported a significant difference between retention levels of students taught Basic science using activity based teaching strategy than those taught using lecture method in a study titled effects of activity based teaching strategy on academic achievement in Basic science among students.

Kurumeh, Onah and Mohammed, (2012) reported among others that the ethno-mathematics teaching approach was more effective in facilitating and improving students' retention in statistics than the conventional approach using 248 junior secondary school students and Statistics Retention Test (SRT) with the reliability coefficient of 0.80 and ANCOVA statistical analysis in the study. Several factors are known to influence retention Bichi, (2002), Mari, (2002) and Auwal, (2013) reported that anything that aids learning will improve retention while things that leads to confusion or interfere among learned materials decreases the speed and efficacy of learning and accelerate forgetfulness. Retention is the ability to remember things or a reaction of what have been presented in the past. Active participation of the student in the class aids retention and makes the lesson more meaningful. This is because, as students participates and manipulate equipment or materials, they apply their five senses and other skills (science process skills) to their lessons more than when they would have learnt in abstraction or remain less active in the class. Students also learned better and achieve academically when they are involved in activity oriented method hence, improve their retentive memory of Basic Science Concept. According to Al-Rabaani, (2011) and Veselinovska, (2011) involving the students in activity oriented method, shows that people remember 10% of what they read, 20% of what they heard, 30% of what they see and 90% of what they had-on experience. It is because of the significance of retention in learning science that this study measured how much knowledge is retained by the learner, after introducing the instructional method which is structured to improve on scientific conception. In this study therefore, an investigation is made on the impact of PBI on retention ability of JSS students in Basic Science.

2.8 Overview of Similar Studies

Numerous studies reveal mixed results with regard to instructional methods, students' acquisition of science process skills, retention and academic achievement in Basic Science and science in general as they relates with gap. Such studies include the following among others:

Bassey and Amanso (2017) assessed the influence of gender and school type on science process skills acquisition among chemistry two students in Calabar Education Zone of Cross River State, Nigeria. Two hypotheses were formulated to guide the study. Survey research design was adopted for the study using stratified random sampling technique a sample of 413 science student was drawn from a population of 4212 for the study. The sample comprised 203 male and 210 female with 189 from private schools and 224 from public schools. A 32 items questionnaire was the instrument for data collection. The instrument was duly validated and the reliability estimated for the instrument was established through Cronbach alpha method ranged from .73 to 91. Independent t-test analysis was used to test the two null hypotheses at .05 alpha level of significant. The result revealed that male science students differ significantly from female counterparts in science process skills acquisition favouring males in skill of interpretation of data and prediction. The present researcher exposed the subject to Process-Based Instruction for science process skills acquisition while the previous study did not. BSPT and SPSAT were used for data collection in the present work while the previous study used questionnaire employing survey research design as oppose to experimental and control group in the present study. The previous result revealed that male science students differ significantly from female counterparts in science process skills acquisition. This finding does not agree with those of other researchers who reported that there was significant difference in science skills acquisition in favour of male or female. Mari,(2012) and Akani (2015) reported that female performed significantly better than males in science skills acquisition. Based on this findings among others, A similar study is needed in Basic Science concepts among Junior Secondary students to see if the result is the same or different.

Ekon and Eni (2015) investigated Gender and Acquisition of Science Process Skills among Junior Secondary School (JSS) 3 students in Calabar Municipality: Implication for Implementation of Universal Basic Education Objectives. One research and two hypotheses were used for the study. Two hundred (200) JSS3 students in three (3) co-educational schools participated in the study. A Science Process Skills Acquisition Test (ASPSAT) developed by the researcher was used for data collection. Descriptive Statistics in terms of percentages was used to answer the research questions; independent t-test and contingency chi-square were used to test the null-hypotheses at 0.05 level of significant. The result of analysis showed that majority of the students acquired the Basic Science process skills measured in favour of female students but at a very low and little above average. Students who acquired science process skill performed better than those who did not acquire those skills measured. The findings of the first study showed low Basic Science process skill acquisition. Only Basic Science Process skills were acquired in the previous study by the students. The present study investigates the impact of Process-Based Instructional Strategy on students' acquisition of some basic and integrated science process skills and also examine if both BSPS and ISPS was acquired at higher percentage than the previous study.

Zeidan and Jayosi,(2015) investigated the relationship between the Palestinian secondary school students knowledge level of science process skills and their attitudes toward senior secondary school two science. The study used an 18 - question Science Process Skills Test and a 25-item Attitudes toward Science Questionnaire. The association between knowledge level of science process skills and attitudes toward science was significant with a correlation coefficient of 0.69. The sample size was 159 students, Descriptive statistics, t-test and ANOVA were the statistical tools used to analyze the SPST. The results of the study indicated that there was a significant difference in science process skills due to gender favoring females. However, there were no significant differences in attitudes toward science due to the variables. The moderate result of SPST shows that Palestinian Senior Secondary students selected some correct option for items related to the skill of observation, prediction and measurement. Fewer of the targeted students selected the option for item related to the skill of controlling variables and experimentation. Both studies investigated acquisition of science process skills but differs in these ways; this study investigates the impact of PBIS on academic performance and retention on Basic Science concepts among Basic Science students in Zaria, Kaduna, Nigeria while the previous study was carried out among Palestinian Secondary School two students. In the previous study, moderate science process skills were acquired through the use of 18-questions Science Process Skills Test without instructional method.

In a similar study, Abungu, Okere and Wachange, (2014) conducted a research titled the effect of Process-Based Instructional Strategy (PBIS) on students ‘achievement in chemistry in Nyando District Kenya. Solomon Four Group Quasi experimental design was employed. The sample size was 153 form three students. The instrument was Chemistry Achievement Test (CAT) consisting of simple calculations, true and false items, and fills in blanks. The reliability coefficient of the CAT was estimated using Richardson (2K-R21) was 0.88. The data were analyzed using descriptive statistics, t-test, ANOVA and ANCOVA. Hypotheses were tested at 0.05 level of significance. The results revealed that PBIS had a significant effect on students' achievement in chemistry. This study investigated PBIS on students' achievement in chemistry using ANOVA and ANCOVA as statistical tools while the present study investigates academic performance in Basic Science concepts using t-test. The present study also differs from Abungu, Okere and Wachange, (2014) by adding other variables in the study such as science skills acquisition and retention.

Olufunke and Adebayo (2014) investigated the moderating effect of gender on Generative Instructional Strategy (GIS) and Predict Observe Explain (POE) Instructional Strategy Efficacy in improving lower primary science pupils' skills. The study adopted pre-test, post-test, control group, quasi-experimental research design. Three mixed primary schools from Abuja Educational Zone were selected using simple random sampling technique. Primary three pupils from three intact classes with population between 25-35 pupils were purposively selected for the study. The instrument used for data collection was Pupils Basic Science Practical Skills Test (PBSPST) which was designed to test learner's knowledge of Basic Science process skills. Data collected were analyzed using Analysis of Covariance (ANOVA) and t-test. Results showed that there was no significant moderating effect of gender on pupils practical skills in Primary Science when taught with GIS and POE instructional strategy =(0.27; $P>0.05$). The study concluded that practical skills should be constantly developed in male as well as in female pupil so as to improve Basic Science practical skills of lower primary school pupils. This finding does not agree with those of other researchers who reported that there is a significant difference of gender on students' practical skills in favour of male or female. Chukwuemeka and Nwosu (2008) reported that males performed significant better than females' in primary science pupils' practical skills. However, the present study is different from the previous because it was on Basic Science and retention among junior secondary two who were exposed to PBIS.

Also, Mari (2012) carried out a study to determine the effect of Process -Based Instruction on acquisition of formal reasoning ability in male and female subject in Kaduna state. 38 subjects were randomly selected from senior secondary school two chemistry students. The schools were pretested using Group Assessment of Logical Thinking Test (GALT) after which they were exposed to Process-Based Instruction for six weeks. The male and female subjects' post-test scores were compared using t-test statistics. The initial gap between the male and female subjects in formal reasoning ability was bridged in all the schemata (conservation, control of variables, proportional reasoning probability reasoning and combinational reasoning) except in correlational reasoning. The two studies are similar in this ways. Both studies used Process-Based Instructional Strategy as the mode of instruction but differs in that, the previous study was to determine the effect of Process-Based Instruction on acquisition of formal reasoning ability in male and female subject among secondary school two chemistry students in Kaduna state while the present study is based on the impact of Process-Based Instruction on acquisition of science process skills, performance and retention among Basic Science students in Zaria, Kaduna state. Another variable such as retention is added in the present study which differs from the former study. Kurumeh, Onah and Mohammed, (2012) carried out a study to determine the effects of the ethno mathematics teaching approach on Junior Secondary Three (JS3) students retention in statistics and also whether any of the sexes (male and female) would retain statistics concepts more than the others from teaching. The study was carried out in Obi and Oju Education Area Zone in Benue state, Nigeria, using a sample of 248 junior secondary three (JS3) students. The study employed quasi-experimental design of non-equivalent but cultural homogenous group, Statistic Retention Test (SRT) instrument with the reliability coefficient of 0.80 was used. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the null hypotheses at 0.05 level of significance. The result revealed among others that the ethno mathematics teaching approach was more effective in facilitating and improving students' retention in statistics than the conventional approach. The above study is similar with the present work in the following aspects: Both researchers carried out their work in JSS but differs from each other in the method of instruction, subject and level. The previous work was on effect of Ethno-Mathematics Teaching Approach of JSS3 students' retention in statistics. The present study is based on Process-Based Instructional strategy of JSS2 students' retention of science process skills and Basic Science concepts.

In a similar study, Iwuju, (2011) examined the effect of Activity Based Teaching Strategy (ABTS) on academic achievement in Basic science among students in Katsina. 118 JSS2 students and quasi-experimental research Design were employed for the study. Using Basic Science Achievement Test (BSAT) with reliability of 0.85 and t-test statistical analysis; findings revealed a significant difference in the academic achievement of students taught using ABTS and those taught using lecture method. The previous work was carried out on Basic Science on effect of academic performance while in the present study, was on science skills acquisition and retention.

Veselinovska, (2011) carried out study to determine the effects of usage of sequential teaching method on the academic achievement and retention level of second year Biology students in Macedonia.. Three groups of biology students in University “Goce Delcev”, Faculty of Natural and Technical Sciences, Institute of Biology, Stip, R. Macedonia were offered a topic on general characteristics of Proteins: Their Biological Functions and Primary Structure with different sequences of 3 teaching methods. The teaching methods were Laboratory method (student experiment), slide demonstration and lecture method. The first group started the course with experiments in the laboratory, then the relevant theory of proteins was given lecture method, and then the slides was shown (Group I). The sequence of these three teaching methods used in the first group was changed in both second and third group as follow: The lecture methods, slide show and experiment in Group II, and slide show, experiment and lecture method in Group III, respectively. Laboratory method used in the study was focused on the topic of this diversity and abundance reflects the central role of proteins in virtually all aspects of cell structure and function. Achievement test contained 20 questions, testing the knowledge of facts as well as the ability to transfer the knowledge and problem solving ability. This test was used as pre-test before methods’ application, post-test after the methods’ application and retention test after 30 days from methods’. The sample size was 47 students. Statistical tools were means, standard deviation while ANOVA was used to test the null hypotheses at 0.05 level of significance. The results showed that academic achievement and retention in the lessons began with experiment or demonstration was higher than lesson beginning with lecture. The previous study differs from the present study in that the researcher investigated the usage of three sequential teaching methods on the academic achievements of second year university students in Biological concepts. The present study however, is on science skills acquisition and the subjects were exposed to PBIS on Basic Science concepts among JSS two.

In similar study, Olorukooba and Lawal, (2010) investigated effect of Technology and society (STS) approach and lecture method on academic achievement and development of creative traits of JSS3 integrated science students in Katsina state. Using 87 students, Integrated Science Achievement Test (ISAT) with reliability of 0.86 and t-test statistical analysis .Result indicated that students exposed to STS approach performed significantly better than those exposed to lecture method favouring males .Hence STS produced a higher effect on students' performance. There was improvement in academic achievement compared to traditional method but their work was not based on Process-Based Instructional Strategy and variables such as science process skills acquisition and retention were not captured.

In a similar study, Dokme and Aydinli (2009) carried out a study to determine Turkish primary school second grade students level of performance on Basic Science process skills and whether there are statically significant in their performance linked to their gender grade level and economic background in Turkey. Data were collected with the authors constructed Basic Science Skill test (BSST). The test comprised of 10 items related to observing, classifying, measuring, metrically, inferring, predicting and communicating. A total of 670 students made up the sample. Statistical tools used were mean and standard deviation. Analysis was done using ANOVA. The result indicated that the subjects mean score was not low but not satisfactory. However, there was positive relationship between their performance and their gender, grade level economic background. This study is similar to the present one in that both studies are linked to their gender performance on basic science process skills. And differ in the following ways; the first study was on performance of Turkish primary school second grade students' level of performance on Basis Science Process Skills while the present study added acquisition of science skills (both basic and integrated process skills) and retention in addition to performance of Basic Science students in Junior Secondary school. Statistical tool used in the study was ANOVA while in the present study is t-test. The finding in the previous study indicated that the subjects mean score in science skills acquired was not low but not satisfactory.

Anaso, (2008) in a study titled effect of class-size on academic achievement and retention of different ability groups among SS11 chemistry students in Zaria, Kaduna State. The research Design was quasi-experimental design with 145 students as samples for the study. Chemistry Achievement Test (CAT) and Retention Ability Test (RAT) was the instrument used. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the null hypotheses at 0.05 level of significance. The result revealed that students in the class-size of 25 achieve high retention ability than their counterpart in class of 50 and 70.The study was carried on the effect of class-size on retention and academic achievement of SS11 chemistry students. The present study exposed the subjects to PBIS on acquisition of science skills, academic performance and retention of Basic Science concepts of class size 35 to 40 students in JSS. The previous study did not capture PBIS as teaching method, science skills acquisition and was based on SS11 chemistry.

Nwagbo and Uzoamaka, (2008) investigated the effect of biology practical activities on senior secondary school 1 students' process skill acquisition in Abuja Municipal Area

Council, Nigeria. The research design of the study was quasi-experimental specifically the pre-test and post-test nonequivalent control group design. Samples of one hundred and eleven Senior Secondary (SSI) Biology Students were used. Science Process Skills Acquisition Test (SPSAT) was the instrument used. Data collected were analyzed using mean, standard deviation and ANCOVA at 0.05 level of significance. The results revealed that practical activity method was more effective in fostering students' acquisition of science process skills than the lecture method. The present study investigates PBIS on students' skills acquisition and retention in Basic Science concepts in Junior Secondary School while the previous study was on the effect of biological practical on Senior Secondary School one students' skill acquisition.

Also, Oloyede, (2012) carried out a study to determine the relationship between acquisition of science process skills and achievement in chemistry in Bauchi. The sample consists of 320 senior secondary two students. The instruments used were a Test of Logical Thinking (TOLT) and a Test on Process Skills (TPS). TOLT was administering to the students as well as students' third term result from SS1 examination in chemistry. Mean and standard deviation with t-test were statistical tools used for the analysis. The students score on the three attributed were correlated using the Product Moment Correlation Coefficient. The findings showed a positive relationship between formal reasoning ability, acquisition of science process skills and chemistry achievement. Both studies investigated acquisition of science process skills and academic achievement but differ in this way; the present study was carried out in Basic Science concepts and retention among junior secondary 11 while the previous study was on SS1 chemistry students without retention.

. Aktamis and Ergin, (2008) worked on the effects of Scientific Process skills Education on learners scientific creativity, attitudes and academic achievement of chemistry higher elementary school students in Buca District, Turkey. The research Design was quasi-experimental- control involving pre and posttest design. 40 students from higher elementary schools were randomly selected, 20 being experimental were 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 result was analyzed using t-test. High academic achievement was recorded in the experimental group exposed to science process skills than the control group who were exposed to lecture method of instruction. The above study is similar with the present research work in the following aspects: Both studies analyzed their results using t-test. However, the former study differs in the sense that it used science process skills on students' scientific creativity, attitude and academic achievement in chemistry in Turkey with sample size of 40 students. The previous study also did not investigate science skills acquisition and retention. However, the present study addresses the impact of Process-Based Instructional Strategy on science skills acquisition and retention of some Basic Science concepts in Zaria, Kaduna State with sample size of 75 students.

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 in Abuja: "Implication for Primary Science Curriculum Delivery". They employed quasi experimental design, using pre and post- test. 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 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. This study is similar to the present research in the following aspects: both include acquisition of science process skills. However, the previous study had No evidence of science process skills acquired on mode of presentation of material resources among primary science pupils.

Usman, (2007) investigated the effectiveness of Science Process Approach on Remedial Science Students' Performance in chemistry, Jigawa State. The major objective of the study was to determine whether or not exposure to process approach promotes the acquisition of science skills and performance in chemistry among remedial students in Jigawa State. The study sample consisted of 78 students drawn from two tertiary institutions using a 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 Agriculture Hadejia comprising of 38 students was assigned as the control group. A Pre-test using Teacher Made Test (TMT) was administered to the two groups to determine equivalence of the two groups before treatment, while Test of Chemistry Achievement (TOCA) &Test of Science Process Skills (TOSPS) was administered as posttest to the two groups after treatment to ascertain the effect of the treatment. The data obtained were analyzed and the hypotheses stated were tested using t-test statistic at 0.05 level of significance. Major findings of the study revealed that: Process approach does not seem to be more effective than lecture method in enhancing academic performance in science. There was no significant difference in the level of acquisition of science process skills between males and females taught chemistry using the Process Based Instruction. Also males learn chemistry concepts better than females when they were taught using Process-Based Instruction. This study is similar to that of Usman (2007) in the following aspects: Both studies investigated Process-Based Instruction using t-test as the statistical tools. And differs in the following ways: The previous study was on science skills acquisition and academic performance of Remedial students in chemistry, Jigawa State without retention as a variable while the present study is based on the acquisition of science skills, academic performance and retention of Basic Science concepts among Junior Secondary School in Zaria, Kaduna State. The previous study revealed that lecture method was more effective in enhancing academic performance in chemistry than Process-Based Instructional strategy. The present study need to carry out this research to see whether the result is the same or not

Shaibu and Mari, (2003) investigated the effects of Process-Based Instructional Strategy, vis-à-vis the traditional lecture method, on the achievement of Nigerian Secondary two School Students in chemistry in Zaria, Kaduna State, on tasks involving formal reasoning in chemistry. A total of 76 students made up the sample. The Group Assessment Logical Thinking Test (GALT) was used. The design of the study was the pre-test and post-test, matched group design. The treatment, which involved process-skills instructional approach, lasted six weeks. Statistical tools used were mean, standard deviation and t-test for the analysis. The results showed that, the process-skill instructional approach group performed significantly better than the control group. This study is similar with Shaibu and

Mari,(2003) research on the impact of Process-Based Instruction on academic achievement but differs in the following aspect: the previous researcher worked on task involving formal reasoning ability in chemistry while the present researcher worked on science skills acquisition and retention in Basic Science. The students in the previous study were in senior secondary while in the present study they were in junior secondary school that are still at their concrete reasoning ability stage. The students therefore need task involving the use of concrete activities and exemplars' for science skill acquisition

Mari, (1994) worked on the understanding of science processes and its relationship to achievement in integrated science. The research was carried out using JSS students in Zaria and Sabon-Gari Local Government area of Kaduna state. The sample were obtained by random sampling technique comprised 110 JSS 1, 110 JSS 11 and JSS 111 giving a total number of 330 JSS students. Quasi-experimental research Design was used for the study. Two instrument used were Test of Process Skill (TOPS) and Test of Integrated Science Academic Performance (TOISAP) and t-test was used for analysis. Finding revealed that; there was significant difference in the understanding of science processes as expressed by the various groups, there was significant difference at $p<0.05$ level of confidence in the understanding of science processes between male and female students. Subjects from the private and government owned schools were found to differ significantly in their understanding of science processes at $P<0.05$ level of confidence. The study investigated the understanding of science processes and its relationship to achievement in integrated science without indicating method of instruction, science process skills acquired and retention by the subject.

2.9 Implication of Literature Reviewed on the Present Study

This study has revealed literature on previous works done related to the problems which are being faced in the teaching and learning of science. Of particular interest is the failure of the most science teachers to use appropriate teaching methods that will enhance students' confidence in science process skill acquisition and academic achievement in sciences. Many research works such as Shaibu and Mari, (2003), Aktamis and Ergin, (2008), Iwuju,(2011), Abungu, Okere and Wachange, (2014) compared lecture method and PBIS. Their results have shown that, lecture method was not particularly effective in acquisition of science process skills and improving academic achievement in sciences. Also, most of the research work done on the use of Process- Based Instructional methods as they relate to academic performance were carried out internationally and some are indigenous but few. The studies were conducted in different disciplines, levels, subject areas and locations. Aktamis and Ergin, (2008) worked in higher elementary school students in Turkey and looked at the effect of Process- Based Instructional Strategy (PBIS) on learners scientific, creativities, academic achievement and attitude towards chemistry. Abungu, Okere and Wachange (2014) worked on effect of Process- Based Instruction on academic achievement of form three chemistry students in Nyando Distric Kenya. The present study is carried out in Junior Secondary School two among Basic Science students in Zaria, Nigeria; therefore, it is different from Aktamis and Ergin, (2008), Abungu, Okere and Wachange (2014) work in terms of levels, subject areas and locations. These researches were carried out on integrated and Basic Science on academic achievement. Mari, (1994) conducted a study on understanding of science processes and its relationship to achievement in integrated science in JSS. Olorukooba and Lawal, (2010) worked on effect of Science Technology and

Society Approach on academic achievement and development of creative traits of JSS3. And Iwuju, (2011) worked on Activity Based Teaching Strategy on academic achievement in Basic Science. All their studies were based on integrated and Basic Science however; they did not capture science process skills acquisition and retention as in the present study.

Research works carried out on Process-Based Instruction and science skills acquisition were based on remedial science students and senior secondary in chemistry. Usman, (2007)) investigated the effectiveness of Science Process Approach on remedial science students' performance and science skills acquisition in chemistry and Mari,(2012) carried out a study to determine the effect of Process -Based Instruction on acquisition of formal reasoning ability in chemistry. Their results have shown that PBIS had effects on science skills acquisition in chemistry but their studies were not based on acquisition of science skills in Basic Science concepts and retention among JSS students as it is investigated in the present study.

Other research works carried out on different instructional strategy science skills acquisition among others were on primary school science, secondary school Biology and Chemistry. Nwagbo and Uzoamaka, (2008) work was on the effect of biology practical activities on secondary school students' skill acquisition. Chukwuemeka and Nwosu, (2008) worked on the effect of mode of presentation on acquisition of science process skills among primary science pupils. Olufunke and Adebayo, (2014) investigated the moderating effect of gender on Generative Instructional Strategy and Predict-Observe-Explain Instructional Strategy efficacy in improving lower primary pupils' skills. The present work investigated PBIS on science skills acquisition in Basic Science concepts among JSS therefore, is different from the previous studies

Most of the researchers who worked on the process skills acquired by male and female students involved primary and secondary school students were carried out either in primary science and chemistry, among others were relatively very few or none in Basic Science. Dokme and Aydinli, (2009) worked on primary school students' level of performance on Basic Science process skills linked to genders and grade level in Turkey. Mari, (2012) and Oloyede, (2012) showed in their studies positive relationship between formal reasoning ability and acquisition of science process skills among senior secondary school students in Chemistry. Ekon and Eni, (2015), Bassey and Amanso (2017) worked on gender and acquisition of science process skills among primary and secondary school students in Calabar, Cross River state, Nigeria. The present study was conducted on Basic Science in Junior Secondary School two students. Most of these research work mentioned above, indicated either low, average or moderate science process skills acquired by the students in favour of the females.

Some researchers conducted their research work and affirmed among others that, the use of senses are function of Process-Based Instructional Strategy which enhances retention of science concepts. Veselinovska, (2011) worked with second year university students in Mecedonia and investigated the usage of sequential teaching methods on the academic achievement and retention level in Biological concepts. The present study is carried out among Basic Science students in JSS Zaria, Kaduna state, Nigeria; therefore, it is different from Veselinovska, (2011) study in terms of level, subject area and location. The literature reviewed on retention being carried out is not in the area of Process-Based Instructional Strategy. Anaso (2011), worked on the effect of class-size on academic achievement and retention of different ability group among SS11 Chemistry students. The present study is carried on the impact of Process-Based Instruction on performance and retention of Basic-Science concepts among Basic-Science students. It is different from Anaso, (2011) study in terms of level and subject area. This study is to find out if exposure to PBIS would enhance retention of students in Basic Science concepts.

From the studies reviewed, it can be concluded that researchers conducted their studies on other disciplines than in Basic Science. Most researches carried out used different methods of instruction and those who used Process-Based Instructional Strategy, their studies were not based on acquisition of science process skills and retention in Basic Science concepts. This implies that, it is pertinent to conduct a research in Basic Science to cover Junior Secondary School students as in this study to see whether the result would be the same. Most of the researches on science process skills (BSPS and ISPS) indicated low, average or moderate science process skills acquired by the students. Studies carried out by AL-Rabaani, (2014), Zeidan and Jayosi, (2015), Ekon and Eni, (2015), Dokme and Aydinli, (2009) recorded average, low and moderate science skills acquired by students respectively. All the above studies did not use Process – Based Instructional Package and Basic Science. This study therefore fills this gap by investigating the impact of Process-Based Instructional Package on acquisition of science skills, performance and retention among Basic Science students. The present study also considered the gap in gender as it relates in the variables in the study.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study investigated the Impact of Process-Based Instruction on acquisition of science skills, performance and retention among Basic Science students in Zaria Education Zone of Kaduna State, Nigeria. In this chapter, a description of the methodology to be used for this study is presented under the following sub-headings:

3.2 Research Design for the Study

3.3 Population of the Study

3.4 Sample and Sampling Technique

3.5 Selection of Concepts.

3.6 Instrumentation

3.6.1 Validation of Instruments

3.7 Pilot Testing

3.8 Reliabilities of Instruments

3.9 Item Analysis

3.10 Administration of Treatment

3.11 Procedure for Data Collection

3.12 Procedure for Data Analysis

3.2 Research Design for the Study

The research design for this study was quasi-experimental control group design that employed pretest, posttest and post posttest. Intact classes were used, which did not allow for complete randomization of the subjects. (Sambo, 2008). Basic Science Performance

Test (BSPT) and Science Process Skills Acquisition Test (SPSAT) was administered to experimental and control groups as pre-test before the treatment in order to determine equivalence in the ability among the groups. After the pretest, the experimental group was exposed to Process-Based Instruction while the control group to lecture method. At the end of the six weeks treatment, a posttest (O_2), was administered to both groups (experimental and control) to determine if there was any difference in students' performance in selected Basic Science concepts and science skills acquisition. Two weeks later, a post posttest (O_3) was then administered to determine the retention level in Basic Science concepts and how much of the science process skills students were able to acquire. The same instrument BSPT and SPSAT was administered as pretest, posttest and post posttest. The research design is presented in Figure3.1

EG------------ O_1 -----------------X_1-------------O_2 ------------ O_3

CG ------------ O_1 ----------------X_O -------- O_2 -----------O_3

Fig. 3.1: Research Design

Where:

EG = Experimental Group (exposed to Process-Based Instruction)

CG = Control Group (exposed to lecture method)

O_1 = Pretest

O_2 = Posttest

O_3 = Post posttest

X_1 = Process-Based Instruction

X_o = Lecture method

3.3 Population of the Study

The population of the study consisted of all the JSS Two students in all twenty-five (25) coeducational public Junior Secondary Schools in Zaria Educational Zone of Kaduna State. The total population was four thousand one hundred and fifty-seven (4,157) of which 2,615 were male and 1542 female students as recorded by the ministry of Education, Zonal office, Zaria,(2017). JSS Two students were considered suitable for the study by virtue of their age and academic experience since they had already spent one year and had covered enough. Co-educational schools were used because gender was a factor in the study. The chronological age range of the students was between 12-14 years. The study population is presented in Table 3.1.

Table 3.1: Population of the Study

Name of School	Local Government	Male	Female	Total
GJSS Tudun-Jukun	Zaria	200	160	360
GJSS Rimin Doko	Zaria	265	134	399
GJSS Kofar Jatau	Zaria	128	102	230
GJSS Yakasai	Soba	36	20	56
GJSS Zaria	Zaria	115	100	215
GJSS Dakace	Zaria	92	60	152
GSS Kofan Kuyanbana	Zaria	113	98	221
SAISS Karau Karau A	Zaria	194	108	302
SAISS Karu Karu B	Zaria	16	11	27
GSS Kugu	Zaria	184	96	280
GSS Likoro	Sabon Gari	66	52	118
GJSS Chikaji	Sabon Gari	139	111	250
GJSS Tudun Wada	Zaria	252	202	454
GSS Bogari	Soba	29	21	50
GJSS Tudun Saibo	Soba	75	45	120
GJSS Matari	Soba	14	09	23
GSS Aminu	Sabon Gari	367	283	650
GJSS Awai	Soba	42	18	60
GJSS Mangi	Igabi	05	02	07
GSS Magajiya	Zaria	71	60	131
GJSS Gimba	Soba	48	21	69
GJSS Kofar Doka	Zaria	385	215	605
GSS Muchia	Sabon Gari	180	122	302
GSS Richifa	Zaria	28	21	50
GJSS Dinya	Soba	22	13	35
Total		**2615**	**1542**	**4157**

Source: Ministry of Education, Zonal Education office, Zaria (2017).

3.4 Sample and Sampling Technique

Simple random sampling involving balloting was used to select two schools from the twenty-five co-educational schools. This was done by writing the names of the schools on pieces of papers, squeezed them and put into a container. The container was shaken and a student was asked to randomly pick two schools, one after the other from the container. The two schools selected were assigned to experimental and control groups using the same procedure. The two schools selected were randomly assigned as experimental and control groups. Both schools were pretested and retested. Proportional sampling was used to select 35 students (21 males and 14 females) out of 78 students in a class for the experimental group while 40 students (23 males and 17 females) out of 82 students for the control group each totaling seventy-five (75) students. The reduction in sample size according to AL-Rabaani, (2014) was because the class size was too large to carry out Process- Based Instruction on science skills acquisition. Also the sample size of 75 was viable for the study because it was in line with the recommendation of Kerlinger and Lee, (2005), Fraenkel, Wallen and Hyun, (2011) that a minimum of thirty (30) subjects were viable for the experimental study of this nature. The sample selected is shown in table 3.2

Table 3.2 Sample of the Study

Group	School	Male	Female	Total
Experimental	A	21	14	35
Control	B	23	17	40
	Total	**44**	**31**	**75**

3.5 Selection of concepts

The following concepts were selected from Basic Science curriculum for JSS II.

1. Habitat and adaptation of organisms.
2. Kinetic theory of matters.
3. Thermal energy.

The choice of these topics was motivated by a number of reasons:

i. Studies like Duwan,(2011) and Nzewi (2011) show that students have difficulties in understanding some concepts in Basic Science such as Habitats and adaptation of organisms, Kinetic theory of matters and Thermal energy among others.

ii. The concepts are taught at the junior and senior secondary schools as well as at the University level as such the understanding of the concept is very important for the learners.

iii. More so, Duwan, (2011) and Nzewi (2011) stated that students find these concepts difficult either because, they were not taught in most cases or the teaching method used by the teacher was not appropriate.

3.6 Instrumentation

Two Instruments were used for the purpose of this study. They were the Basic Science Performance Test (BSPT) and the Science Process Skills Acquisition Test (SPSAT) with Process-Based Instructional Package (PBIP) which was developed by the researcher and incorporated in Process- Based Instructional Strategy based on Basic and Integrated Science Process Skills as contained in AAAS, (1967).

3.6.01 Basic Science Performance Test (BSPT)

The BSPT adapted questions from past Junior Secondary School Certificate Examinations (JSSCE) to measure the performance of students' exposed to PBI in Basic Science. The test comprised of forty (40) multiple choice questions (see appendix IV) designed based on the six skills (observation, measurement, inferring, classification, experimentation and interpretation of Data) drawn from these topics; Types of Habitat and Adaptation of organisms, Kinetic Theory of matter and its applications and Thermal Energy and its Applications These topics were selected among others because they were good representation of major areas in Basic Science. The table of items specification based on Bloom's Taxonomy of Cognitive Domain is shown in Table 3.3

Table 3.3: Specification of Test Items based on Bloom's Taxonomy of Cognitive Domain (BSPT)

S/N	Concepts	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
1.	Habitat and adaptation of organisms	1,2,3	23	21,22	3,5	19	14,24	10
2.	Kinetic theory of matter	4,32	6,28,29, 33	10,15,16	17,27,34	25,38	9,20	16
3.	Thermal energy	7,8,12	13,18,26,	11,40	35,36	30,39	31,37,	14
	Total							**40**

Source: Adapted from Bloom's Taxonomy of Cognitive Domain (1957)

3.6.02: Science Process Skills Acquisition Test (SPSAT) with Process-Based Instructional Package (PBIS)

i. **The SPSAT**

The SPSAT was adapted from Ajagun, (1998) and Gadzama, (2012) on Science Process skills measuring instrument to measure Science Process Skill Acquisition among Basic

Science students. The tests comprised of 40 structured questions (see appendix VI) designed to measure six skills; observation, inferring, measurement, classification, experimentation and interpretation of Data. Summary of Table of Specification on science process skills Acquisition (SPSAT) is represented in Table 3.4.

Table 3.4: Table of Specification on Science Process Skills Acquisition Test (SPSAT)

S/N	Process Skills	Items	Total
1.	Observation	1,2,15,22,31,32	6
2.	Measuring	3,8,14,25,35,38,39	7
3.	Inferring	5,11,13,18,23,24,29	7
4.	Classification	4,12,28,34,36,40	6
5.	Experimenting	6,7,9,10,17,19	6
6.	Interpreting Data	16,20,21,26,27,30,33,37	8
	Total		**40**

Source: Adapted from Mari, (2001)

ii Process-Based Instructional Package (PBIP)

Process-Based Instructional Strategy was incorporated into the package which was developed by the researcher (Appendix 11). The Process-Based Instructional Package was developed based out of Basic and Integrated Process Skills contained in American Association for the Advanced of Science,(1967) containing a space for the names of the students and gender. Class, subject, topic, behavioural objectives, concepts and activities in Basic Science are indicated in the package. The package was developed in order to ensure that all the experimental subjects, irrespective of their socio-economic background, had equal access to the relevant instructional materials. In developing the instructional package, the following text-books commonly recommended for junior secondary schools were used. These include:

Examination Focus on Integrated Science for Junior Secondary School Certificate Examination (JSCE) by Begun P.A.A, Ugwumba A.O, Sallau M.S and Saromi

M.A.(2008).University Press Ibadan, Nigeria revised edition. Basic Science; an Integrated Science course for Junior Secondary Schools by Ndu T.O.C and Somoye E.O (2008) Longman Nigeria Plc Ikeja Lagos. Comprehensive Basic Science for Junior Secondary Schools, Book Two by Ehindero O.J, Dibu-Ojerinde O.O, Aladeyaria F.O. (2010). Lantern books, Literamed Publications (NIG.), Limited. Classic Basic Science for Junior Secondary Schools, Book Two by Akintelure, Ohiro and Mahmud (2014). Thursmay, Publishers Limited.

An orientation of two days, 80 minutes each was given to the subjects to study the package. According to Aktamin and Ergin (2008) this was to help the subject prepared for the actual activities .Also to inform the experimental group about the specific kinds of activities and what was expected of them in Process –Based Instructional learning. Students are also to be taught on how to use the materials they engage in the activities on science process skills. Orientation on Process-Based Instructional Package (PBIP) on Acquisition of Science Process Skills among Basic Science JSS11 Students is presented in appendix 1

3.6.1 Validity of Instruments

The validation of the instrument BSPT and SPSAT with PBIP were done by three Senior Lecturers with PhDs qualifications who were well experienced in test construction. Two of them were from Science Education Department, Ahmadu Bello University, Zaria and the other from Science Education Department College of Education Katsina-Ala, Benue State for validation. The lecturers were requested to assess among others things the:

i. content validity of the instruments;

ii. language component of the items;

iii. appropriateness of the items;

iv. clarity of statements in the instruments and

v. make constructive criticisms and corrections that would help in improving the quality of the instruments. (Letters of validation are presented in Appendix XI.)

3.6.1.1 Validation of Basic Science performance Test (BSPT)

The instrument BSPT was adapted from Junior Secondary School Certificate Examination (JSSCE) and modified by the researcher. The validation of the Instrument was done by three Senior lecturers with minimum qualification of PhD. Two of them were in Science Education Department, Ahmadu Bello University Zaria and the other from Science Education Department, college of Education Katsina-Ala. The lecturers were requested to assess among other things the content validity of the instrument, language component of the instrument, appropriateness of the items in terms of reading difficulty level for the groups that are meant for, and clarity of statement in the instrument. The expert made constructive criticisms and corrections on the basis of content and face validity of the instrument. All 40 items were selected but item 16 was modified and retained while items 5 and 30 were discarded and replaced for being too easy (see appendix IV). For example the initial item 16 reads as, a crate of 50kg is pushed along a floor with a force for example 20N of a distance of 5m.Calculate the work done, it was modified as; A crate of 50kg is pushed along a floor with a force for example 20N of a distance of 5m. State the work done. On the other hand items 34 was discarded for not being difficult and replaced. For example the Initial item 34 was, calculate the power of a pump which can lift 500kg of water through a vertical height of 12m in 0.3minutes with these options; a) 3.27w b) 4.0kw c) 2.26kw d) 3.5kw. It was replaced as: Which is the most accurate statement?

(a) Heat and temperature is the same thing

(b) Heat is a measure of how hot something is

(c) Temperature is measured in Joules

(d) Temperature measures how hot an object is

3.6.1.*2* Validation of the instrument SPSAT with PBIP

These instruments SPSAT with PBIP were validated by three senior lecturers from Science Education Department of Ahmadu Bello University and the other from Science Education Department College of Education Katsina-Ala who validated the BSPT. The lecturers were requested to assess among others things the content of validity of the instrument, its language component of the instrument, appropriateness of the items, in terms of reading difficulty for the groups that they are meant for, clarity of statements in the instrument and check possible errors in the suggested answers.

The expert made constructive criticisms and corrections on the basis of content and validity of the instrument. All the 40 items were retained with item 22 modified (appendix VI) as follows: Initial item reads, Particles in solid, liquid and gases behave different, Draw and label two diagrams to illustrate the behaviour. Show the arrangement of particles in solid and gases. The corrected items now reads, Particles in solid, liquid and gases behave differently. Draw and label two diagrams to illustrate the behavior and arrangement of particles in solid and gases.

The lesson notes prepared for teaching the experimental group that is Process –Based Instructional Package (Appendix II) and control group (Appendix III) as well the marking scheme for the BSPT (Appendix IV & VI) and SPSAT (Appendix V & VII) were validated by three senior lecturers from the Department of Science Education, Ahmadu Bello University and college of Education Katsina-Ala to determine whether:

i. contents of the instrument were correct and appropriate for JSS11 Standard.

ii. items were clear, precise and of standard.

Based on the validation from the experts item 22 from the activities in the experimental group was modified (appendix VI) to suit time table arrangements in the Junior Secondary School.

3.7 Pilot Testing

In the pilot testing, two instruments: Basic Science Performance Test and Science Process Skills Acquisition Test (BSPT & SPSAT) were tested .The pilot testing was conducted in two schools namely Government Junior Secondary School Chindit, Sabon Gari and Government Secondary School Kofar Doka, Zaria. The pilot study was carried out with 40 subjects. The subjects were not part of the population of the study. The test instruments were administered to Basic Science students and thereafter the result obtained was used to compute the coefficient of the reliability(r). BSPT and SPSAT consist of 40 multiple choice items and structured questions for the SPSAT. Instructions on how to answer the questions was read and explained verbally by the researcher and students were allowed to ask questions for further clarification

The pilot testing was conducted under a very strict condition and no students were allowed to go out with the question paper in order to avoid linkage of the items in the instrument which may in turn affect the final post-test result. A period of 2 hours each were allocated for answering the test items on BSPT and SPSAT respectively in order to ensure that students answer the questions carefully. The method used for BSPT pilot testing was the test and retest method at interval of 2 weeks in line with Tuckman, (1975) and Sambo, (2008). The marking scheme was designed to help in uniformity of awarding scores. After collecting the test items for both tests, answer sheets were marked and scored. Reliability of BSAT and SPSAT was determined by adopting Pearson's Product Moment Correlation Coefficient (PPMCC) to identify internal consistency. The subjects were also exposed to Process-Based Instructional Package (PBIP) for two days to enable the researcher address areas of difficulties and assess whether the time of 80minutes each allocated for the activities in the PBIP were adequate.

The purpose of this pilot study was to determine the characteristics of the test items which include their difficulty and discrimination indices as well as the reliability coefficient. The result of the study was used to determine:

i. the approximate time that will require the respondents to complete the test.
ii. the number of weeks that would be suitable for conducting the study.
iii. the amount of materials that would require teaching the subject effectively during the main study.
iv. assess the clarity of the items of BSPT and SPSAT.
v. Calculate the reliability coefficient of the instruments and difficulty index of the items.

3.8 Reliability of Instruments

The degree of error in measuring and estimation of a test is called its reliability (Bichi, 2002). A test is said to be reliable if repeated measurement using the test gives more or less the same results. Using the data obtained from the same pilot study, the reliabilities of the

Basic Science Performance Test (BSPT) and Science Process Skills Acquisition Test (SPSAT) were determined.

3.8.1 Reliability of the Instrument (BSPT)

The reliability of the instrument (BSPT) was determined using test-retest method .The scores of the test (first test) were correlated with those of the retest(second test) using Pearson's Product-Moment Correlation Coefficient(PPMCC) statistic; by application of the Statistical Product for Service Solution(SPSS) and the reliability coefficient value of r=0.76 was obtained for the BSPT. (Appendix IX). If this coefficient value is compared with the value determined by some of the previous researchers sited (such as Shaibu & Mari 2003; r= 0.77, Zeidan &Jayosi 2015; r=0.69) who also used the instrument for their studies, it can be seen that the instrument was still reliable. Thus it can be used to generate data on Process-Based academic achievement for the present study. An interval of two weeks was given between the first administration of the test and the second one. This is in line with the Tuckman, (1975) and Sambo (2008) who recommended that a minimum interval of a week is advisable to be given before the administration of the second test so as to avoid influence of familiarity of the research instrument.

3.8.2 Reliability of the Instrument (SPSAT)

The reliability of the instrument (SPSAT) was determined using test-retest method. The scores of the test (first test) were correlated with those of the retest (second test) using Pearson's Product-Moment Correlation Coefficient (PPMCC) statistic; by application of SPSS. The reliability coefficient value of r= 0.71 was obtained for the SPSAT. (Appendix X) This coefficient indicted that the instrument was reliable and was used to collect data for Science Process Skills Acquisition for the study. An interval of two weeks was given between the first administration of the test and the second one. This is in line with the Tuckman, (1975) and Sambo (2008) who recommended that a minimum interval of a week is advisable to be given before the administration of the second test so as to avoid influence of familiarity of the research instrument.

3.9 Item Analysis

Item analysis for Basic Science Performance Test (BSPT) was carried out from the pilot test scores to determine the items difficulty (facility) index and discrimination index. According to Sambo (2008) the purpose of item analysis is to enable the test constructor to distinguish between good and poor items. A good item is one of which the difficulty index falls between 40% and 60% and for which the discrimination index exceeds 0.40. Ibrahim and Zakariyya (2015) asserted that item analysis (internal consistency) of a test item is concerned with evaluation of responses to each test item, so as to ensure that each test item is valid. If all test items are valid, the whole test will also be valid, but if some items in the test are not valid then this reduces the validity of the other test. Item analysis is mainly carried out on already pilot tested items with the hope that the test will be corrected for further use and it is also assumed that the general or overall test is valid to some extent, so that item analysis is just to identify the few invalid or bad test items. Two indices are calculated under item analysis. There are difficulty (facility) index and discrimination index.

3.9.1 Facility (difficulty) Index

Difficulty index is defined by Ibrahim and Zakariyya (2015) as the percentage of students who responded correctly to a particular test item. It is at times called easiness percentage. For, the higher the difficulty index, the easier the question is, while the lower the difficulty index, the more difficult is the question. Difficulty index is used to determine which item is too easy and which one is difficult.

While Usman, (2007) and Sambo (2008) asserted that items with difficulty index between 40% and 60% are accepted, Ibrahim and Zakariyya (2015) are of the view that the ideal difficulty index is 50%. However, these authors opined that indices ranging from 30% to 70% are considered good. According to Ibrahim and Zakariyya (2015) item with difficulty index above 80% is easy while that below 20% is too difficult. In this study, the items difficulty index was computed in line with Ibrahim and Zakariyya (2015) view. That is, items with difficulty index above 80% are considered too easy while those with difficulty index below 20% are too difficult. Therefore, such items are either to be modified or changed for being too easy or too difficult for further use so as to suit the research. In the Basic Science Performance Test (BSPT) the difficulty index ranged from 0% to 95.0%. However, the difficulty index that falls between the range 20% to 80% was retained. Based on the difficulty indices calculated items 5, 16, and 30 of BSPT were Modified and Replaced (MR) changed for being inappropriate or too easy; this implied that the items have 80% difficulty indices. Items 34 in the other hand was discarded and Replaced (DCRP) based on the assumption that it was too difficult because none of the respondent in both the upper and lower halves of the class got it right for each test item, the difficulty index (Df) is calculated by

The formular for Df is:

$$\text{Df} = \frac{Ru + RL}{N} \times 100$$

Where

Df = Difficulty Index of the items

Ru = Number of students/respondents who get the item correct in the upper group

RL = Number of respondents who get the item correct in the lower group

N = Number of respondents in each of the upper and lower

The pilot result in respect of the difficulty index of the BSPT is represented in appendix VIII

3.9.2 Discrimination Index

Discrimination index is one of the indices that are calculated under item analysis According to Ibrahim and Zakariyya (2015) discrimination index is used in measuring the extent to which the test items discriminates between brilliant (knowledgeable) students and poor (unknowledgeable) students in the same class or between upper half of the class and lower half of the class to be precise. Here the entire students in the class who attempted or responded to the test items are divided into two; the upper half of the class (U) and the lower half of the class (L) based on their performance in the test, for each test items, the discrimination index (Ds) is calculated by

The formula for Ds is

$$\text{Ds} = \frac{Ru - RL}{{}^{1}\!/_{2}N} \times 100$$

Ds = Discrimination index

RU = the number of correct responses in the upper group

RL = the number of the correct responses in the lower group.

N = Number of respondents in the upper and lower group

The discrimination index of a test is a measure of its ability to discriminate between high and low ranks in the test as a whole. Discrimination index for each item is calculated by subtracting the number of students in the lower group who answered the item correctly from the number in the upper group who got the item right. According to Ibrahim and Zakariyya

(2015) item with discrimination index which ranges between 50% to 20% are appropriate while Sambo, (2008) is of the view that the test items which have between 71% to 57% discrimination indexes are acceptable. In this study, the Basic Science Performance Test (BSPT) has between 55% to 15% discrimination indexes. For more detail, the pilot test result in respect of the discrimination index of the BSPT is presented in appendix VIII

3.10 Administration of the Treatment

The treatment of this study involves exposing the JSS 11 students in the experimental group to Basic Science concepts using PBIP. The students were engaged in activities in the following topics, types of habitats and adaptation of organisms, population and population density of organisms in a habitat, kinetics theory of matter and its application among others (Appendix 1I) using Process-Based Instructional Package**.** Six Process Skills were used in this study out of the eleven process skills outlined by the American Association for the Advancement of Science. (Mari, 2001). According to Aktamis and Ergin (2008) these skills are the foundation for the teaching of Basic Science in Junior Secondary Schools. Out of these six process skills, four were basic skills (observing, measuring, inferring and classifying) while the other two were the integrated process skills (experimenting and interpretation of data).

3.10.1 Treatment of Experimental Group

Before exposing the students to experimental group, they were giving two days orientation on the Process-Based Instruction Package as described in appendix I. The aim of orientation was to inform the subjects in the experimental group about the specific kinds of activities, what was expected of them in PBI learning process and also for each student to learn the use of sense organs in carrying activities. The experimental group was exposed to teaching for

6weeks of 1hour 20minutes per lesson per week. The experiment group was exposed to Process-Based Instructional strategy (PBIS). In the experimental class, the students were assigned to work in groups of six made up of five students per group. The groups were assigned to carryout activities in accordance with the package. The Process-Based Instruction learning strategy is presented as follows:

STEP 1: This includes a space for the name of student and gender. There is indication of class, subject, duration, topic and behavoural objectives are stated to be achieved at end of the activities.

STEP 2: **Instruction/ Introduction**

The students were shared into seven groups of five each to work on the activities.

New words were stated and explained. Students are to use their sense organs in working out the skills in the activities. The places for the activities were indicated either in the laboratory/ outside the laboratory for the students to carry out the activities.

Step 3: Students Activities

List of materials were provided for the students to work with the skills to be acquired on each activity. Methods for each activity were stated and spaces indicated for answering the questions. The teacher guided the students on how to carry out the activities while students made use of their sense organs to work.

Step 4: Evaluation and Conclusion

Teacher evaluates the students work by selecting three students with their packages to read some areas of their work in front of the class. Corrections are made and students' packages were collected for marking.

The summary of Process-Based Instructional learning strategy is presented in a Flowchart in Figure 3.2

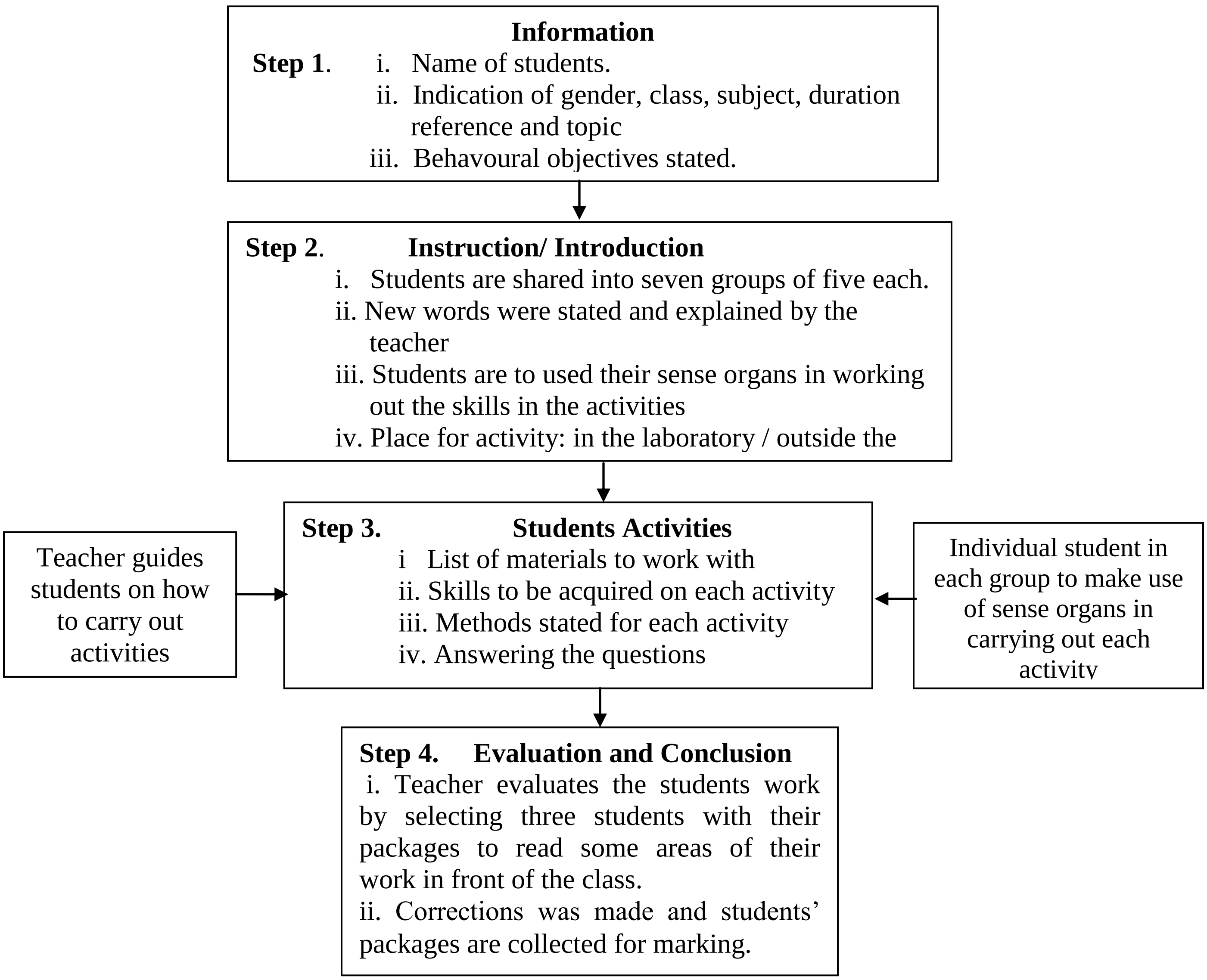

Fig. 3.2: Flowchart of Process-Based Instruction
Source: Adapted from the AAAS, (1967)

During the experimental group, the students were sometimes engaged in some activities outside the laboratory to collect specimens. In some cases, all the materials for the activities were provided by the researcher. The activities engaged upon by students were based on

Basic Science concepts in each PBIS. Such packages also include an outline of activities, aims, materials, methods/instructions and the require science process skills the students were to acquire in the course of study.

The researcher during the activities acted as the guide to students in cross checking and assessing their work throughout the treatment period. The students were instructed to work on common assignment based on the use of science process skills and submit their result sheets for assessment. The students acquired these science process skills through Basic Science activities designed on the topics in the course of the study. The findings of the researcher after the evaluation revealed that the students acquired the process skills that they were supposed to acquire as stated. (Appendix II)

3.10.2 Teaching the Control Group

The control group was exposed to the same Basic Science concepts by the researcher using the lecture method. This involves basically verbal presentation of ideas about the topics. During the session, the students listen and copy the important points in their exercise books as the researcher writes on the board. The teacher explained the Basic Science concepts taught found to be difficult to the students while teaching. The contact session was also for 6weeks of 1hour 20minutes per lesson. (Appendix III)

3.11 Procedure for Data collection

By the end of the treatment the students in the two groups were examined by administration of the test instrument as Post-test which lasted for 2hours each for the BSPT and the SPSAT. The post tests of the two groups are presented in appendices IV and VI. The scripts were marked and collated in line with the marking scheme guidelines (see appendices V and VII) to determine the performance and how much of science process skills acquired by the students. Post posttest was used to determine retention ability of both the experimental and control groups. Scores were divided based on gender that is male and female students. Three types of data collected during the research include:

- Pretest (to ascertain the group equivalence)
- Posttest(to ascertain the performance and skills acquisition levels)
- Post posttest(to ascertain the retention level)

3.12 Procedure for Data Analysis

Data generated from this study were analyzed based on the following:

i. Answer the research questions

ii. Hypotheses testing at $\alpha \underline{-} 0.05$

i. Answering the Research Questions

The research questions were analyzed using Data collected from BSPT and SPSAT inform of mean scores and standard deviation.

ii Hypotheses Testing

The Statistical Package for Social Science (SPSS) version 20 was used as an application to analyze the data collected.

Data generated for this study were analyzed in the testing of hypothesis at $P \leq 0.05$ level of significance as follows:

HO_1: There is no significant difference between the mean performance scores of students taught Basic Science concepts using Process-Based Instruction and those taught the same concepts using lecture method.

t-test was used for the analysis

HO_2: There is no significant difference between the mean performance scores of male and female students taught Basic Science concepts using Process- Based Instruction and those taught the same concepts using lecture method

t-test was used for the analysis.

HO_3: There is no significantly difference in the mean scores of students exposed to Science Process-Skills Instruction and those taught the same concepts using lecture method.

t-test was used to analyze the null hypothesis.

HO_4: There is no significant difference between the retention abilities scores of students taught Basic Science concepts using Process-Based Instruction and those taught the same concepts using lecture method.

t-test was used to analyze the null hypothesis.

HO_5: There is no significant difference between the mean performance score of male and female students in each process skill.

t-test was used to analyze the null hypothesis

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

The study investigated the impact of Process- Based Instruction on acquisition of science skills, performance and retention among Basic Science students in Zaria Educational zone, Kaduna State. The focus of this chapter is to analyze the data generated in relation to the research questions and null hypotheses stated in chapter one. The chapter is presented under the following sub-headings:

4.2 Analysis and Results Presentation

4.2.1 Answering the Research Questions

4.2.2 Testing the Null Hypotheses

4.3 Summary of Findings

4.4 Discussion of Results

4.2 Analysis and Results Presentation

i Pretest data generated via Basic Science Performance Test (BSPT) to establish group equivalence before the experiment

ii Posttest data generated via Basic Science Performance (BSPT) and Science Process Skills Acquisition Test (SPSAT) to establish performance and skills acquisition after treatment

iii Postpost test data to measure retention of learners concepts generated via BSPT.

4.2.1 Answering Research Questions

Research Question One: What is the difference between the mean academic performance scores of students taught Basic Science concepts using Process-Based Instruction and those taught using Lecture Method?

To answer research question one the posttest scores collected were analyzed using descriptive statistics in form of mean scores and mean difference as shown in Tables 4.1a

Table 4.1a: Posttest Mean, Standard Deviation and Mean Difference between the Experimental and Control Group

Group	N	Mean	Std. Deviation	Mean Diff
Experimental	35	71.64	19.83	39.32
Control	40	32.32	22.34	

Table 4.1a shows that there was difference between the mean academic performance scores of experimental and control groups. The mean scores of 71.64 and standard deviation of 19.83 for the experimental is higher than the mean score of 32.32 and the standard deviation of 22.34 for the control group. The mean difference was 39.32. This shows that students taught Basic Science concepts using Process-Based Instruction with a mean of 71.64 performed better than those in the control group who had a mean score of 32.32. To check for significant difference, a null hypothesis was tested and presented in Table 4.1b

Hypothesis One: There is no significant difference between the mean academic performance scores of students taught Basic Science concepts using Process-Based Instruction and those taught same concepts using lecture method.

To test this null hypothesis one, the Basic Science performance posttest scores of students taught using Process-Based Instruction and those taught using lecture method were subjected to t-test. The result is shown in Table 4.1b.

Table 4.1b: t-test Comparism of the Mean Academic Performance Scores of Experimental and Control Groups after treatment.

Group	N	Mean	Std. Deviation	t	df	p-value	Remark
Experimental	35	71.64	19.83	8.01	73	0.001	Significant
Control	40	32.32	22.34				

Significant at $p \leq 0.05$

The result presented in Table 4.1b reveals that the t-value calculated is 8.01 and the P-value of 0.001 obtained is less than the $p \leq 0.05$ level of significance set for the study. This indicates that there is significant difference between the mean score of the experimental and the control groups after treatment. Hence the P-value of 0.001 obtained is less than the $p \leq 0.05$ in favour of the experimental group. Thus the null hypothesis which states that there is no significant difference between the mean academic performance scores of students taught Basic Science concepts using Process-Based Instruction and those taught same concepts using lecture method is therefore rejected.

Research Question Two: What is the difference between the mean academic performance scores of male and female students taught Basic Science concepts using Process-Based Instruction?

To answer research question two, the posttest scores collected were descriptive statistics of mean scores and mean difference as shown in Tables 4.2a.

Table 4.2a shows the mean difference between the posttest mean scores for male and female students in the experimental group.

Table 4.2a: Posttest Mean, Standard Deviation and Mean Difference of Male and Female in the Experimental Group

Experimental	N	Mean	Std. Deviation	Mean Diff
Male	21	80.67	14.51	22.58
Female	14	58.09	19.39	

Table 4.2a shows there is difference between the mean academic performance scores of male and female experimental. The mean scores of 80.67 and standard deviation of 14.51 for the male experimental is higher than the mean score of 58.09 and standard deviation of 19.39 for the female experimental. The mean difference was 22.58. To check for significant difference, a null hypothesis was tested as presented in Table 4,2b.

Hypothesis Two: There is no significant difference between the mean academic performance scores of male and female students taught Basic Science concepts using Process- Based Instruction and those taught same concepts using lecture method.

To test the null hypothesis two, the Basic Science Performance posttest scores of students taught using Process-Based Instruction were subjected to t-test. The result is shown in Table 4.2b.

Table 4.2b: t-test Comparism of the mean Academic Performance Scores of Male and Female in the Experimental Group.

Group	N	Mean	Std. Deviation	T	df	p-value	Remark
Male Experimental	21	80.67	14.50	3.94	33	.001	Significant
Female Experimental	14	58.09	19.39				

Significant at $p \leq 0.05$

Table 4.2b shows that the t-value calculated is 3.94 and the P-value of 0.00 obtained is less than the $p \leq 0.05$ level of significance set for the study. This shows that there is significant difference between the mean performance score of male and female students in the experimental group. This is because the P-value of .001 obtained is less than the $p \leq 0.05$ in favour of the male students. Hence the null hypothesis which states that there is no significant difference between the mean academic performance score of male and female students taught Basic Science concept using Process-Based Instruction and those taught same concepts using lecture method is therefore rejected.

Research Question Three: What is the mean difference between the mean score of students exposed to Science Process-Skills Instruction and those taught using lecture method?

To answer research question three, the posttest scores on skill acquisition using Process-Based Instruction were analyzed using descriptive statistics in form of mean scores, standard deviation and mean difference as shown in Table 4.3a.

Table 4.3a: Posttest Mean Academic Performance, Standard Deviation and Mean Difference of Experimental and Control Group on Science Process Skills Acquisition.

Variable	Skills Acquisition	N	Mean	Std. Deviation	Mean Diff
Posttest	Experimental group	35	69.73	27.38	32.42
	Control group	35	37.31	16.35	

Table 4.3a shows that there is difference between the mean academic performance score of the experimental and control group on science process skills acquisition. The mean score of 69.73 and standard deviation of 27.38 for the experimental is higher than the mean score of 37.31 and the standard deviation of 16.35 for the control group. The mean difference was 32.42. To check for significant difference, a null hypothesis was tested and presented in Table 4.3b.

Hypothesis Three: There is no significant difference in the mean scores of students exposed to science process skills Instruction and those taught using lecture method. In order to test the null hypothesis three, the Basic Science performance pretest and posttest scores of students taught using Process-Based Instruction on science process skills acquisition were subjected to t-test. The result is shown in Table 4.3b

Table 4.3b: t-test Comparism of mean scores of Experimental and Control Group on Science Process Skills Acquisition.

Group	N	Mean	Std. Deviation	t	df	p-value	Remark
Experimental skills	35	69.73	27.38	6.02	68	0.001	Sig.
Control Skills	35	37.31	16.35				

Significant at $p \leq 0.05$

Table 4.3b shows that the t-value calculated is 6.02 and the P-value of 0.00 is less than the $p \leq 0.05$ level of significance set for the study. This indicates that there is significant difference between the mean scores of experimental and control group on science process skills acquisition. Hence the P-value of 0.001 obtained is less than the $p \leq 0.05$ in favour of experimental group. Thus the null hypothesis which states that there is no significant difference in the mean score of students exposed to Science Process-skills Instruction and those taught using lecture method is therefore rejected.

Research Question Four: What is the mean difference between the retention abilities of students taught Basic Science concepts using Process-Based Instruction and lecture method?

To answer research question four, the post-posttest scores of students taught Basic Science concepts using Process-Based Instruction and Lecture Method were analyzed using descriptive statistics of mean scores, standard deviation and mean difference as presented in Table 4.4a.

Table 4.4a: Post-posttest Mean scores, Standard Deviation and Mean Difference of Retention abilities of the Experimental and Control Group

	Groups	N	Mean	Std. Deviation	Mean Diff
Retention	Experimental	35	65.90	24.68	28.57
	Control	40	37.33	25.58	

Table 4.4a shows that there is mean difference between the retention abilities of the experimental and lecture method. The mean scores of 65.90 and standard deviation of 24.68 for the experimental is higher than the mean of 37.33 and standard deviation of 25.58 for the control group. The mean difference was 28.57. To check for significant difference, a null hypothesis was tested and presented in Table 4.4b

Hypothesis Four: There is no significant difference between the retention abilities mean scores of students taught Basic Science concepts using Process-Based Instruction and those taught using lecture method.

In order to test the null hypothesis four, the Basic Science performance posttest and post-posttest scores of students taught using Process-Based Instruction and lecture method were subjected to t-test. The result is as presented in Table 4.4b.

Table 4.4b: t-test Comparism of the Retention abilities mean scores of the Experimental and Control Groups

	Group	N	Mean	Std. Deviation	t	df	p-value	Remark
Retention Ability	Experimental	35	65.90	24.68	4.91	73	0.001	Sig.
	Control	40	37.33	25.58				

Significant at $p \leq 0.05$

Table 4.4b shows that the t-value calculated is 4.91 and the P-value of 0.00 obtained is less than $p \leq 0.05$ level of significance set for the study. This indicates that there is significant difference between the mean score of the experimental and control group after treatment. Hence P-value of .0.001 obtained is less than $p \leq 0.05$ in favour of the experimental group who retained more the leant Basic Science concepts. Thus the null hypothesis which states that there is no significant mean difference between the retention abilities mean score of students taught Basic Science concepts using Process-Based Instruction and those taught using lecture method, is therefore rejected.

Research Question Five: What is the difference between the mean performance score of male and female students in each process skill?

In order to answer research question five, the individual skills acquired by male and female taught using Basic Science concepts were analyzed descriptively using mean scores, standard deviation and mean difference as obtainable in Table 4.5a.

Table 4.5a: Comparism of Mean Performance Score of Male and Female Students in each Science Process Skill.

Skills	Variable	N	Mean	Std. Deviation	Mean Diff
Observation	Male	21	44.29	19.60	33.03
	Female	14	77.32	19.49	
Inferring	Male	21	50.95	25.39	16.37
	Female	14	67.32	20.98	
Classification	Male	21	50.12	25.08	18.45
	Female	14	68.57	18.34	
Measurement	Male	21	49.17	22.36	20.85
	Female	14	70.00	21.95	
Experimentation	Male	21	44.94	15.92	31.4
	Female	14	76.34	19.53	
Interpretation of data	Male	21	75.00	15.39	43.75
	Female	14	31.25	10.37	

Table 4.5a shows that the mean scores of male and female students in observation skills were 44.29 and 77.32 respectively. This gives a mean difference of 33.03 in favour of the female students. To check for significant difference, a null hypothesis was tested and presented in Table 4.5b.

Table 4.5a also shows that the mean scores of male and female students in inferring skills were 50.59 and 67.32 respectively. This gives a mean difference of 16.37 in favour the female student. To check for significant difference, a null hypothesis was tested and presented in Table 4.5b

Similarly, Table 4.5a reveals that the mean scores of male and female students in Classification, measurement and experimentation skills were 50.12 and 68.57, 49.17 and 70.00, 44.94 and 76.34 between the male and female students respectively. This gives mean differences of 18.45, 20.85 and 31.4 respectively in favour of the female students in observation, classification and experimentation. To check for significant difference, a null hypothesis was tested and presented in Table 4.5b.

Table 4.5a shows that the mean scores of male and female students in the skill of interpretation of data were 75.00 and 31.25 respectively. This gives a mean difference of 43.75 in favour of the male students. To check for significant difference, a null hypothesis was tested and presented in Table 4.5b

Hypothesis Five: There is no significant difference between the mean performance score of male and female students in each process skill.

In other to test hypothesis five, the posttest mean scores for science process skills application was used for the six different process skills identified (observation, inferring, measurement, experimentation, classification and interpretation) for both male and female students as presented in Table 4.5b

Table 4.5b: Summary of t-test Comparism of Performance of Male and Female in each Science Process Skills.

Skills	Variable	N	Mean	Std.	t	df	p-value	Remark
Observation	Male	21	44.29	19.60	4.89	33	.001	Significant
	Female	14	77.32	19.49				
Inferring	Male	21	50.95	25.39	1.99	33	.54	Not Significant
	Female	14	67.32	20.98				
Classification	Male	21	50.12	25.08	2.36	33	.024	Significant
	Female	14	68.57	18.34				
Measurement	Male	21	49.17	22.36	2.72	33	.011	Significant
	Female	14	70.00	21.95				
Experimentation	Male	21	44.94	15.92	5.22	33	.001	Significant
	Female	14	76.34	19.53				
Interpretation of data	Male	21	75.00	15.39	9.30	33	.001	Significant
	Female	14	31.25	10.37				

Significant at $p \leq 0.05$

Table 4.5b shows that the summary of t-test calculated were 4.89, 2.72, 5.22 and 9.30 and the P-value of .001, .024, .011 and .001 obtained were less than $p \leq 0.05$ level of significance for the study. This means that there was significant difference between the mean performance scores of male and female students in process skills of observation, classification, measurement, experimentation and interpretation of data because P-values of .001,.024, .011 and .001 obtained were less than $p \leq 0.05$ in favour of female in observation, classification, measurement and experimentation skills and male in interpretation of data. Hence the null hypothesis which states that there is no significant difference between the mean performance scores of male and female students in observation, classification, measurement, experimentation and interpretation of data was therefore rejected. There was no significant difference however, between the mean performance scores of male and female students in inferring process skills because P-values of 0.54 obtained was greater than $p \leq 0.05$ level of significance for the study. This implies that both the male and female students significantly performed equally in inferring. Hence, the null hypothesis which states that there is no significant difference between mean performance scores of male and female in inferring process skills is therefore retained.

4.4 Summary of Findings

The major findings from this research work are as follows

1. There was a significant difference between the mean performance scores of students taught Basic Science concepts exposed to Process-Based Instruction and those exposed to lecture method in favour of the experimental group.
2. There was a significant difference between the mean performance scores of male and female students exposed to Process-Based Instruction in favour of the male students
3. There was a significantly difference in the mean scores of students exposed to Science Process-Skills Instruction and those taught using lecture method in favour of the experimental group.
4. There was a significant difference between the retention abilities mean scores of students taught Basic Science concepts using Process-Based Instruction and those taught using lecture method in favour of the experimental group.
5. There was a significant difference between the mean performance score of male and female in observation, classification, measurement, experimentation and interpretation of data process skills. The female students performed significantly

better than the male students in observation, classification, measurement and experimentation while the male students performed significantly better than the female in interpretation of Data. There was however no significant difference between the mean performance scores of male and female students in inferring process skills hence both the male and female students performed equally in inferring thus this skill is gender friendly

4.4 Discussion of Results

The study investigated the impact of Process-Based Instruction on acquisition of Science Skills, Performance and Retention among Basic Science Students in Zaria Educational Zone, Kaduna State. The findings of the study are discussed as follows:

The result of hypothesis one ,revealed that the students in the experimental group who were taught Basic Science concepts using Process- Based Instruction performed significantly better, than those in the control group. This implies that the significant difference in the performance is in favour of the experimental group, suggesting a greater impact of Process-Based Instructional Strategy (PBIS) over the Lecture Method (LM) in the understanding of Basic Science concepts. The findings of this study is in conformity with the findings of Shaibu and Mari(2003) who found out and reported that there was significant difference in the performance of students in tasks involving formal reasoning when taught using Process-Based Instructional Strategy in favour of the experimental group. This finding is also in support with the research findings of Aktamin & Ergin (2008) who reported a significant difference in the academic performance of students taught scientific creativity in chemistry using Process-Based Instructional Strategy and Lecture Method in favour of the experimental group. The findings is also in consonance with the following researchers Chukwuamaka & Nwosu (2008), Abungu, Okere & Wachange, (2014) who in their findings discovered significant difference in the academic performance on students worked on the effect of mode of presentation of material resources and students achievement in chemistry respectively in favour of PBIS. The impact of PBIS observed in this study could be because of its nature as activity- based which provided opportunity for students to participate actively in tasks in the class activities .This result disagrees with the findings of Sani (2007) who discovered a significant difference in the performance of remedial science students in chemistry in favour of LM when exposed to Process- Based Instruction. The difference findings may be because the researcher used pre-degree students who might have acquired formal reasoning and could learn abstract concepts without the use of intense activities and concrete examples. This study therefore indicated that Process -Based Instruction was better than lecture teaching method in improving students' performance in Basic Science. Also PBIS is less teachers directed, more learners' centered and an activity-based for students to control their own action in the process of learning.

Hypothesis two showed that there was a significant difference in the mean performance scores of male and female students when taught using the Process-Based Instruction. The male students performed significantly better than the females in the experimental group. This means that the male experimental had a greater impact of Process- Based Instructional Strategy over the female experimental group in the understanding of Basic Science concept. This report agrees with that of Sani (2007), Aktamis and Ergin (2008), Kurumeh, Onah and Mohammed (2012) who reported that male students performed better than female when mathematic concepts were taught using PBIS. Abungu Okere and Wachange, (2014) also reported that male students performed better in science than females when taught chemistry using PBIS . The difference in the performance of male and female students is in favour of the males as revealed by this result might be attributed to cultural and religious factors in predominantly Islamic area, where females are often restricted from exploring their environment while the males freely go into explorative adventures. The finding is in disagreement with that of Mari, (2012) who revealed superiority in the performance of female over male when they were taught chemistry concepts using Process-Based Instruction. The difference may be because of the subjects used were male and female who were university staff children, both gender are treated equally and are freely all around to actively explore their environment.

The findings in Hypothesis three revealed that students taught Basic Science concepts using Process-Based Instruction and Lecture Method differ significantly in acquisition of science process skills. It implies that students acquired more science process skills when exposed to Process -Based Instruction than those taught using Lecture Method in favour of PBIS. The findings agree with studies carried out by Nwagbo and Uzoamaka (2008), Oloyede (2012), Zeidan and Joyosi (2015) who reported that Process -Based Instruction was more effective in fostering acquisition of science process skills than the lecture method. This may be that science skills acquired by students were induced by the fact that they were able to interact with the teaching materials by PBIS. The findings is in disagreement with that of Al Rabanni (2014) who reported the inability of students to reach the high level of science process skills in the acquisition of Basic Science and integrated skills by pre-service social studies student teachers when exposed to PBIS and LM in favour of LM. This may be because the concepts of science process skills were not commonly acknowledged by academics and student's teachers' because literatures of social studies rarely present such concept of both BSPS and ISPS. They are presented as thinking and research skills. However, the active involvement of students in Process- Based Instruction may have given rise to efficient learning which accounted for the reported significant effect in acquisition of science skills in the present study.

In Hypothesis four the result revealed that, there was significant difference in the retention ability mean scores between students taught using Process -Based Instructional Strategy (PBIS) compared to the Lecture Method (LM). This implies that students taught using PBIS retained and learnt more concepts than those in the LM. This might be due to the fact that students' involvement in activities in PBIS enhanced retention of the concepts learnt but using Lecture Method may have bored the students by not allowing them achieve maximally and retain the Basic concept learnt. This finding agrees with that of Iwuju (2011) and Veselinovska (2011) who reported that Activity Based Strategy (ABTS) enhanced student performance and retention ability when taught the concepts of Biology and mathematics than the LM. The result disagreed with that of Usman, (2007) who reported that Process- Based Instruction does not seem to be more effective than LM in enhancing academic achievement (retention in chemistry) of remedial chemistry students. The difference findings may be because at this level of education (pre-degree) students could learn abstract concepts without necessarily involving activities. In this study students exposed to PBIS learnt better and achieved academically when they were involved in activity oriented method hence improve their retention memory of Basic Science concept as reflected in the study.

The result in Hypothesis five revealed that there was significant difference between the mean performance of male and female students in skill of observation, experimentation, classification, measurement and interpretation of data. The significant difference is in favour of female students in the skill of observation, classification, measurement and experimentation and male students in the skill of interpretation of data. This implies that, the female students performed significantly better in the mastery of the skill of observation, classification, measurement and experimentation than their male counterparts. The male students on the other hand performed better than the female students on tasks involving the interpretation of data on Basic Science concepts. This may be because the female students understood better tasks on Basic Science concepts involving the skill of observation and experimentation than the male students after exposure to PBI. The male students on the other hand demonstrated better understanding on Basic Science concepts on tasks involving the skill of interpretation of Data. This report agrees with that of Ekon and Eni (2015), Zeidan and Joyosi (2015) who reported the superiority of female students in the use of the skill of observation, classification, measurement and experimentation in integrated science concepts. This findings also agrees with that of Sani (2007), Bassey and Amanso (2017) who reported that the males excel in the skill of interpretation of data than the females in favour of male students. This report disagrees with the findings of Mari (2012) who reported a significant difference in the skill of interpretation of data in favour of the female students in chemistry. The difference in the findings may be because Mari determined gender- related difference in acquisition of process skills by formal reasoning while in this study, most of the students were still at concrete reasoning ability stage and the activities involved the use of concrete activities and exemplars

In the same Hypothesis five the analysis revealed no significant difference between inferring skill acquired by male and female taught using Science Process skills acquisition. This implies that, the male and female students measured equally in the skill of inferring This report agrees with the findings of Usman, (2007), Bassey and Amanso, (2017)who discovered no gender related difference in the acquisition of inferring. The report also agrees with the findings of Al-Rabaani, (2014) who discovered no gender related difference in the acquisition of inferring skill. This may be because both the male and female students had equal understanding on tasks on Basic Science concepts involving the skill of inferring when exposed to PBI.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

The study investigated the impact of Process- Based Instruction on acquisition of science skills performance and retention among Basic Science students in Zaria Educational Zone. This chapter summarizes the entire study as presented in the following sub-headings

5.2 Summary of the Study

5.2.1 Summary of Major Findings

5.3 Conclusion

5.4 Contribution to Knowledge

5.5 Recommendations

5.6 Limitation of the Study

5.7 Suggestion for Further Studies

5.2 Summary of the Study

This study investigated the impact of Process-Based Instruction on acquisition of science skills, performance and retention among Basic Science students. It also investigated the impact of gender related differences on students' performance in Basic Science concepts and acquisition of science skills when exposed to Process-Based Instructional Strategy. The sample comprised a total of seventy-five (75) Junior Secondary School two Basic Science students drawn from two schools from twenty five coeducational schools in Zaria Educational Zone Kaduna, Nigeria. This sample was chosen by using simple random sampling techniques. The two instrument used were Basic Science Performance Test (BSPT) and Science Process Skills Acquisition Test (SPSAT) with Process-Based Instructional

Package (PBIP). The package was developed in order to ensure that all the experimental subjects, irrespective of their socio-economic background, had equal access to the relevant instructional materials. A 40 items multiple choice, short answer test with reliability coefficient 0.76 and 0.71 for BSPT and SPSAT respectively which indicated that the instrument was reliable using test- retest method according to Tuckman (1975), cited in Sambo (2008). The data generated were analyzed to test five hypotheses formulated to guide the study. Data analysis was conducted using the Statistical Package for Social Science (SPSS) version 20.0. The discussion of the results and summary of findings were reported accordingly. Analysis of the results indicated that Process- Based Instructional strategy had positive impact on the acquisition of science skill, performance and retention of Basic Science concepts over lecture method. In addition there was significant difference in the acquisition of science process skills and performance between male and female students when taught Basic Science concepts using PBIS. Though, the performance of both subjects was significantly the same in skill of inferring. The significant difference was in favour of female in the observation, classification, measurement and experimentation skills while in interpretation was in favour of male students.

5.3 Summary of Major Findings

The findings of this study are summarized as follows;

1. Students taught Basic Science concepts using Process-Based Instruction (experimental group) performed significantly better than those exposed to Lecture Method in favour of the experimental group.
2. Male students performed significantly better than female students in Basic Science concepts after exposure to Process-Based Instruction in favour of male students.

3. Students taught Basic Science concepts using Process-Based Instructional and Lecture Method differ significantly in acquisition of science process skills in favour of experimental group.

4. Students taught Basic Science concepts using Process –Based Instruction retained and leant the Basic Science concepts than those taught using Lecture Method in favour of the experimental group

5. Male and female students taught Basic Science differ significantly in skills of observation, classification, measurement, experimentation and interpretation of Data after exposure to Process-Based Instruction. Thus female students performed significantly in favour of female in observation, classification, measurement, and experimentation while the male students performed significantly better than the male students in interpretation of Data. However, male and female students do not differ significantly in inferring process skill acquired by students taught using Process-Based Instruction showing that both the male and female students performed equally in the skill of inferring.

5.4 Conclusion

From the findings of the study, the following conclusions were made;

Use of Process- Based Instructional Strategy has the potential of enhancing performance and retention of Basic Science concepts by learners

Male students benefit more than the females when they were exposed to Basic Science concepts by Process- Based Instruction.

Use of Process -Based Instructional strategy is potentially viable for enhancing Science skills acquisition in Junior Secondary School when taught Basic Science concepts.

Process-Based Instructional Package had improved the students' performance and science skills acquisition than lecture method on Basic Science concepts that had posed difficult in the study of Basic Science at Junior Secondary level.

Process-Based Instruction is gender friendly in enhancing the skill of inferring.

The finding further suggested that the impact of Process- Based Instruction on science skills acquisition, performance and retention led to better performance, science skill acquisition and retention in experimental group than the control group.

5.4 Contribution to Knowledge

i. The use of Process –Based Instructional Package model developed by the researcher and used on process skills acquisition, performance and retention of Basic Science concepts among Junior Secondary School can be adopted or adapted by science teachers in teaching Basic Science concepts.

ii. The instrument developed by the researcher can be adopted or adapted by other researchers in subsequent studies related to impact of Process-Based instruction on science skills acquisition, performance and retention of Basic Science concepts. This is unique in the field of Basic Science Education.

iii. Process-Based Instructional Package and flowchart were used as treatment models for the experimental groups which was very effective. The flowchart was designed by the researcher. This can be used by other researchers.

iv. Process-Based Instructional strategy enhanced the acquisition of science process skills in both males and females of Basic Science concepts however; the male students benefited more than females.

v. Process-Based Instruction enhanced the retention of Basic Science concepts. The findings of the study have also added information to the existing literature on Basic Science.

5.5 Recommendations

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

1) The State Government should encourage teacher training institutions in the Federal, State Colleges of Education, Organizations such as Science Teachers Association of Nigeria (STAN) and the Nigeria Educational Research and Development Council (NERDC) should organize seminars, workshops and conferences on Process-Based Instructional Strategy for Basic Science teachers at Junior Secondary Schools levels. This will enhance their science skills and performance.
2) Process-Based Instructional Strategy should be encouraged by Science Teachers Association of Nigeria in the teaching and learning of Basic Science at the Junior Secondary School as it is found to improve students' academic performance, science skills acquisition and retention.
3) The Process-Based Instructional Strategy should be incorporated in Basic Science teacher training curriculum by Ministry of Education in order to produce teachers who are able to handle Science Process skills Instructional mode of teaching effectively.

5.6 Limitation of the Study

This study has some limitations that include the following:

i. The conclusion reached about the impact of Process-Based Instructional Strategy in this study, was only limited to some concepts in Basic Science

ii. Science Process Skills Acquisition Test (SPSAT) used for assessing science skills acquisition in the subjects might have effect on the result if larger sample was used

5.7 Suggestions for Further Studies

Based on the findings of this study the following suggestion may be found useful:

i. A similar study be conducted elsewhere to see whether it will yield similar or different result with the present study

ii. The composition of schools be changed to include both public and private Junior Secondary Schools

iii. The result obtained in this study was for Basic Science. The method can therefore be tried for other science disciplines at the Senior Secondary schools like in chemistry, physics, biology and geography.

iv. There is need to conduct further investigation on the role if any that gender differences play in the interactions between the strategy and various types of curricula as different studies seem to be showing different results.

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APPENDIX I

Two Days orientation on Process-Based Instructional Package (PBIP) on Acquisition of Science Process Skills among Basic Science JSS11 Students

1. Overview: Process-Based Instruction in science is very important in the formal presentation of science to students. There is a strong belief that those students who were properly introduced to science through Process-B**a**sed Instruction were creative and solve scientific problem. While it is possible to easily forget science content learnt, Process-Based Instruction tends to help learners retain the Basic Science concepts learnt a longer period hence it uses the science process skills.

   Process-Based Instruction was incorporated into a package called Process-Based Instructional Package. It consists of names of students, a series of Basic Science concepts that involve the use of one or more process skills as students engage in activities. Science process skills are classified as basic science and integrated skills. These skills can be accessed by applying them to a series of laboratory activities.

2. Purpose of Process- Based Instructional Package: Is to use Process- Based Instruction to engage students in activities in order to acquire six science process skills out of many science process skills. Process- Based Instructional Package contains a space for the names of the students and gender, Class, subject, topic, behavioral objectives, concepts, materials and activities in Basic Science. Activities are to be carried out either outside or in the laboratory. Each subject is entitle to a package made up of all the activities with the skills to acquire. The six process skills are observing, measuring, inferring, classifying, experimenting and interpreting data. According to Aktamis and Ergin,(2008) the six skills are the basic foundation for the teaching and learning of Basic Science concepts in junior secondary.

3. Materials used in the study are arranged according to different activities based on Basic Science concepts and methods to follow.

4. Below are explanations of the six science process skills indicating their usage by the students.

(A) Observational Skills,

Is the ability to:

i. Measure the volume, capacity of volume, measure the length and measuring devices.

ii. Use senses effectively.

iii. Estimate.

iv. Select relevant observations.

v. Measure accurately, using appropriate units.

vi. Using your senses to gather information about an object or event. It is a description of what was actually perceived.

(B) Measurement,

Is the ability to:

i. Identifying the capacity, range, and increments of measuring devices as a ruler, beaker, cylinder, pipette, and thermometer.

ii. Identifying length, temperature, volume, and mass to the capacity of the instrument.

iii. Converting units within the metric system.

v. using stand measures or estimations to describe specific dimensions of an object or event.

(C) Inferring,

Is the ability to:

i. Formulating assumptions based upon observations.

ii. Distinguishing between observations and inferences.

iii. Using observations and inferences to identify testable questions or problems.

(D) Interpretation of data,

Is the ability to:

i. make sound generalization from a set of data.

ii. Identify the cause and effect relationship.

iii. Provide reasonable justification for any generalization made.

iv. Draw as many plausible inferences as are permitted by a given data set.

v. Test an inference by collecting more data and

vi. Recognize which data lend support to an inference.

(E) Classifying Skills

The ability to:

i. Group things by students’ own criteria.

ii. Recognize similarities and differences.

iii. Use a key to identify things (living and non-living).

iv. Construct a key.

v. Group data in a variety of ways (e.g graphs and tables).

vi. Understand the limitations of a classification system.

vii. Grouping or ordering objects or events into categories based upon characteristics or defined criteria.

.(F) Experimenting Skills,

Is the ability to:

i. Select the best and safest technique.

ii. Choose and assemble suitable apparatus.

iii. Device simple experiments to obtain information.

iv. Understand the use of a control experiment.

v. Draw valid conclusions based.

vi. Organize apparatus on working space.

Conclusion: Students are to apply the process skills learnt in the various activities during the lessons.

APPENDIX II

LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON PLAN ONE

METHOD OF TEACHING: PROCESS-BASED INSTRUCTIONAL PACKAGE

STEP 1: INFORMATION

NAME OF STUDENT……………………………………….

GENDER: Male ☐ **Female** ☐

CLASS:	JSS II
SUBJECT:	BASIC SCIENCE
NO: OF STUDENTS IN CLASS:	35
TOPIC:	TYPES OF HABITATS AND ADAPTATION OF ORGANISMS
DURATIONS:	80mins

BEHAVOURAL OBJECTIVES: By the end of the lesson, students should be able to

i. acquire the skill of observation, classification and data interpretation

ii. list different habitats of living organisms.

iii. identify the living organisms found in different habitats.

iv. classify the organisms according to the features that distinguish them in different habitats.

v. identify some biotic and abiotic factors in a habitat.

.

STEP 2: INSTRUCTION /INSTRODUCTION:

i. Students are shared into seven groups of five each to work on the activities

ii. Explanation of new words by the teacher:

Habitat - Is the kind of place or environment where organisms normally live. Examples of types of habitat are terrestrial and aquatic.

Adaptation- Is any specific feature that helps an organism to live and survive in a particular habitat.

Biotic factors- These refer to the living things in the habitat such as plants and animals.

Abiotic factors- They are the non-living components of the habitat. Examples are soil PH(in terrestrial habitat),level of salt(in aquatic habitat), water and the shape of the land

iii. Students are to use their sense organs to carry out the activities

iv. Place of activity: In the laboratory/outside the laboratory

STEP 3: STUDENTS' ACTIVITIES

ACTIVITY1a :(outside the laboratory) STUDENTS AROUND THE SCHOOL GARDEN

Materials: school garden and garden shovels

Skills to acquire: observation, classification,

Methods:

i. observe carefully different types of organisms in the school garden, on the trees, ground and dig some places for underground organisms.

ii. List them i..………… ii………….and………..

ACTIVITY1b :(in the laboratory) NAMING HABITATS AND FEATURES OF ORGANISMS

Materials: Use activity 1a to do the activity 1b.

Skills to acquire: observation, classification, and inference

Methods:

i. Use your sheet of paper from activity 1a to answer the questions below:
ii. List the two main types of habitats you observed in the school garden (a)…………..and (b)…………..
iii. Classify the organisms you listed into three groups (on, under and above the ground): (a) on ground………. (b) Under the ground…….. (c) Above the ground………

iv. How many types of organisms are in each habitat? (a).........(b)………and (c)………

v. Write two features that are shared by organisms in each group, (a)……..and…….. (b)……….and……….. (c)…………and……….

ACTIVITY 2:(in the laboratory) CLASSIFICATION OF PRESERVED SPECIMEN AND EXAMINING ORGANISMS IN AQUARIUM.

Materials: preserved specimen of toad, fish, lizard, an aquarium, grasshoppers, butterfly, water lily, earthworms, a young mango plant and cactus on the table.

Skills to acquire: observation, inference, classification, experimentation and data interpretation.

Method:

(i) Classify the organisms in three groups in a tabular form with one common feature each.

	Organisms	Habitats	Adaptive features
i.	Group 1		
ii.	Group 2		
iii.	Group 3		

(ii) How many organisms are in each of the habitats? (i),……..(ii)…………and (iii)…….

(iii) Which of the habitats has more organisms? ……………..

(iv) Use an improvised aquarium on the table comprising a toad, fish and some plants in it.

(a) Observe the organisms in the aquarium and list them…………………….

(b) Remove the fish and toad out of the aquarium and observed them for 5 minutes in a bowl.

Record what happen to the organisms:

i. Fish…………… and why? ………………ii. Toad …………………and why………

(c) List some of the biotic and abiotic factors founds in the aquarium. Biotic factors: i……………….ii…………. Abiotic factors: i…………………ii…………...

(d) Write the habitat that the aquarium represents……………..

STEP 4: Evaluation/ Conclusion: Seven students one from each group was called out to to read their findings in activity one and two respectively. Corrections were made and students' packages were collected for marking

LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON PLAN TWO:

METHOD OF TEACHING: PROCESS –BASED INSRUCTIONAL PACKAGE
STEP 1: INFORMATION

NAME OF STUDENT…………………………………….

GENDER: Male ☐ **Female** ☐

SUBJECT:	BASIC SCIENCE
CLASS:	JSS II
NO: OF STUDENTS IN CLASS:	35
TOPIC:	POPULATION AND POPULATON DENSITY OF ORGANISMS IN A HABITAT
DURATIONS:	80 mins.

BEHAVIOURAL OBJECTIVES: By the end of lesson, students should be able to:

(i) .acquire the skill observation, inference, measurement classification and data interpretation

(ii) list different organisms around the school garden.

(iii) measure a particular area in the garden and identify the population of the organisms.

(iv) throw or place a meter square quadrat on a particular area around the school garden and count the number of organisms (plants and animals) in it.

.

STEP 2: INSTRUCTION/INTRODUCTION:
i. Students are shared into seven groups of five students each to work on the activities

ii. Explanation of new words by the teacher:

Population-Is the number of a group of organisms of the same species living in a habitat.
Population density-Is the measure of the size of the population living in a unit area of the habitat at a particular time.
Quadrat – Is an instrument made of a square or rectangular wire, plastics and wooden or mental frame with predetermined area used for population studies
iii. Students are to use their senses organs to carry out the activities.
iv. Place for the activities: outside / in the laboratory

STEP 3: STUDENT ACTIVITIES
ACTIVITIES 1:(outside the laboratory). Students in the school garden
Materials: measuring tapes, school garden, and a quadrat
Skills to acquire: observation, inference, measurement, classification and interpretation of data

Method:

i. Take a look around the school garden

ii. Make a list of different organisms you can see, a………b………..c……… and d. ………..

iii. Each group is to measure two portions of the school garden 15m by 10m with the measuring tape

Iv. Throw or place a meter square of a quadrat about five times at different places on the measured area

(a) State the number of throws…………

(b) Count the number of organisms inside the quadrat at each throw and record them (example, grasses, ants and so on)………………………..

ACTIVITY 2:(outside the laboratory) Identifying the population of organism in the environment and in a particular area.

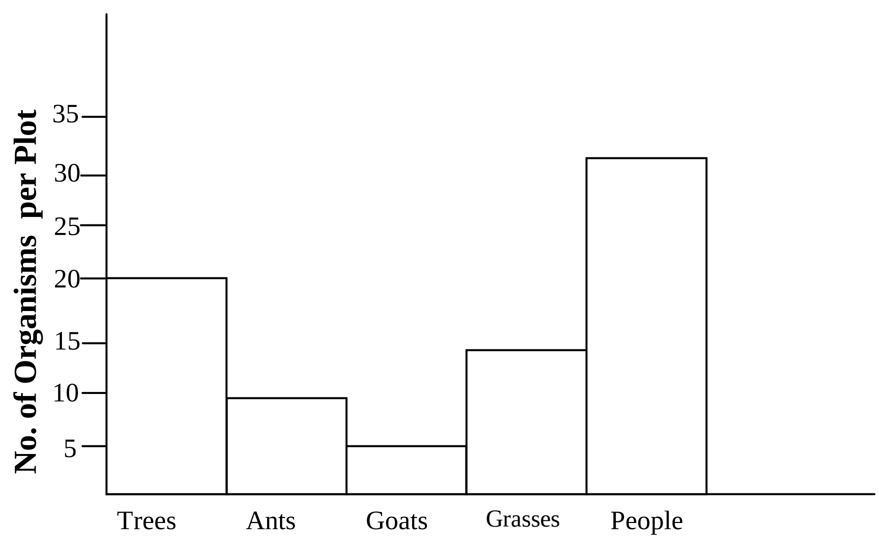
Materials: quadrat

Skills to acquire: observation, inference, measurement and interpretation of data.

Method:

a. list out the population of organisms counted at each throw of the quadrat as in iv(a) above and record them……….,………..,………,………..and………..

b. Plot a bar chart in that respect for example; the following are the list of population of different organisms, 20smalls trees, 10 ants, 5 goats, 15 grasses and 30 people steps in a plot of an area.



Population of organisms per a plot of an area in an environment

Look at the above bar chart and answer the following questions:

i. which is the largest population from the bar chart?....................

ii. State the difference between the population of trees and that of grasses…………….

iii. Classify the population of organisms beginning from the least population to the highest population……………………….

iv. Plot your own bar chart using the organisms you counted in ‘a’:

Population of organisms per a plot of an area in an environment

STEP 4: EVALUATION/ CONCLUSION: Teacher asks seven students one from each group to read out their findings on the activities and corrections were made. Their packages were collected for marking.

LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON PLAN THREE

METHOD OF TEACHING: PROCESS-BASED INSTRUCTIONAL PACKAGE

STEP 1: INFORMATION

NAME OF STUDENT…………………………………….

GENDER: Male ☐ Female ☐

SUBJECT: BASIC SCIENCE

CLASS: JSS II

NO. OF STUDENTS IN CLASS: 35

TOPIC: KINETIC THEORY OF MATTER AND ITS APPLICATIONS.

DURATION: 80mins

BEHAVIOURAL OBJECTIVES: By the end of the lesson, the students should be able to:

(i) develop the skill of observation, inference, classification, measurement, experimentation and data interpretation.
(ii) generalize on the basis of observing the principles of kinetic theory of matter.
(iii) examine solid (ice cube), water, gas and state at least two properties each
(iv) assemble apparatus for experiment correctly.
(v) follow instruction to complete a task on boiling and evaporation.
(vi) state at least 2 factors that affect evaporation
(vii) sketch some diagrams and tables to represent some of the information.

STEP 2: INSTRUCTION/INTRODUCTION:
i. Students are shared into seven groups of five each to carry out the activities.
ii. Explanation of new words by the teacher:

Kinetic theory of matter- Is the nature and behaviour of matter that are explained in terms of assumption.
Evaporation- This is the process by which liquid escape into the atmosphere in form of vapour.
Boiling- Is the process by which liquid are evaporated into a gaseous state at a particular temperature.
Matter- Is anything that has mass and can occupy space. Matter exists in three states, solid, liquid and gas.
iii. Students to their sense organs to carry out activities.
iv.Place of activity: outside/in the laboratory

STEP 3: **STUDENTS ACTIVITIES:**

Activity 1[A] (in the laboratory) Investigate the particle nature of matter by diffusion using the guidelines in the method.

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Materials: A beaker, water, pipette, potassium dichromate solution and a clock.

Skills to acquire: observation, inference, experimentation, measurement and data interpretation.

Method:

i. Fill a beaker of 250ml with water

ii Use pipette to deliver small quantity of potassium dichromate solution at the bottom of the beaker.

iii. Live it to stand for 1minute, 2minute and 3minutes

iv. Record the reading in the table below:

In a minutes	In 2 minutes	In 3 minutes

v. Draw the diagram to represent your observation

vi. Write your conclusion on your observation

Activity 1[B]: Investigate the particle nature of matter by diffusion using ammonia

Materials: A stop watches and a bottle of ammonia

Skills to acquire: observation, inference and interpretation of data

Method:

(i) Open the bottle of ammonia

(ii) Observe the smell and explain the smell within the time interval using a stop watch for :

2seconds…………………………. …………

3seconds …………………………………….

5seconds……………………………..............

iii.Write your conclusion………………………….

Activity 2(in the laboratory) Examine particle in specimen A (ice block) B (water) C (steam from B)

Materials: Beaker, ice cubes, Bunsen burner, tripod stand, water, measuring cylinder.

Skills to acquire: observation, inference, experimentation, measurement and interpretation of data

Method:

(i) Place specimen A and B in a beaker

(ii) What state of matter is A…………. B………… and C……………

(iii) Measure specimen B using measuring cylinder and record your observation…………

(iv) Boil specimen B to a boiling point and heat specimen A with Bunsen burner. Record your observation. B…………….

A…………….

(v) Sketch diagrams to illustrate what you have seen in (i),(ii) and (iii) above:

(i)……………………………………………………

(ii)…………………………………………………..

(iii)…………………………………………………

(vi). Complete this table by a tick in the space

Matter	**Shape**	**Volume**
Solid		
Liquid		
Gas		

Activity 3^{A}:(in the laboratory) Investigate evaporation of methylated spirit:

Materials: Methylated spirit, your hand

.**Skills to acquire**: observation, inference

Method: Put one drop of methylated spirit on the back of your hand and leave it for a couple of minutes.

i. State how you felt………………..

ii. What happen after that………….

Activity 3^B: Investigate Boiling and Evaporation water

Materials: Beaker, water, sodium chloride (salt), Bunsen burner, thermometer, a clock, retort stand.

Skills to acquire: observation, inference, measurement, experimentation and interpretation of data

Method: Test for boiling

(i) Put water in a beaker of 250ml

(ii) Use the thermometer to measure the temperature of the water and record your reading………………………..

(iii) Heat the water on the Bunsen burner and place the thermometer to measure the degree of hotness at every

2minutes…………………..

4minutes……………………

6minutes ………………….

(iv) At what time and temperature did the water boil…………………….

(v) Write your Conclusion……………………………..

(vi) Dissolve salt in water and heat until it dries off. Record what you saw………. and why…………………….?

STEP 4: Evaluation / Conclusion: Seven students one from each group was called to read their findings. Corrections were made and student's packages were collected for marking

LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON PLAN FOUR

METHOD OF TECHING: PROCESS-BASED INSTUCTIONAL PACKAGE

STEP 1: INFORMATION

NAME OF STUDENT…………………………………….

GENDER: Male ☐ **Female** ☐

SUBJECT: BASIC SCIENCE

C**LASS**: JSS II

NO. OF STUDENTS IN CLASS: 35

TOPIC: CONCEPTS OF WORK, ENERGY AND POWER

DURATION: 80MINS.

BEHAVIOURAL OBJECTIVES: By the end of the lesson the students should be able to:

(i) acquire the skill of observation, inference, measurement, experimentation and data interpretation

(ii) investigate the concept of work and energy using a wooden box.

(iii) investigate how much work is done on different objects when they are lifted from the floor onto the surface of a table.

(iv) use the spring balance to determine the mass of objects.

(v) investigate power when doing work and

(vi) identify kinetic and potential energy

STEP 2: INTRODUCTION/INSTRUCTION:

i. Students are shared into seven groups of five to work on the activities.

ii**.** Explanation of new words by the teacher:

Work- Is a product of force and distance moved in a given direction

Power-Is the rate of doing work.

Energy- Is the capacity or ability to do work.

Force-Is anything that will cause a body at rest to move or a body in a motion to stop. It is measured in the unit called Newton (N).

Potential Energy –Is the type of energy possessed by a body due to its position.

Kinetic Energy-Is the energy possessed by a moving body.

iii. Students are to use their sense organs to carry out the activities

iv. Place of activity-outside/in the laboratory

STEP 3: **STUDENTS ACTIVITIES**

ACTIVITY 1 (in the laboratory) Investigate the concept of work and energy.

Materials: Wooden box, table, measuring tape.

Skills to acquire: observation, inference, measurement and interpretation of data

Method:

(i) Measure an area on the floor with a measuring tape 1meter long

(ii) Push a wooden box across the floor through the length and on the surface of the table.

(iii)Which of the surfaces is easier to push the wooden box? Across the floor…………… and why? ....Across the surface of the floor…………and why? ....

(iv)What did you apply to push the box? ....

(v) The amount of space between the push through to the end of 1meter is---------------

Investigate Work Done **Figure 1**

Activity 2: Investigating how much work is done on different objects when they are lifted from the floor onto the surface of a table in figure 1

Material: A table, a spring balance, a meter ruler or tape measure and objects to lift (such as a jersey, a pencil case and a shoe.

Skill to acquire: observation, inference, classification, measurement, experimentation and data interpretation.

Method:

Students are to carry out the activities using their tables. Object like jersey, pencil case and shoe are dropped by their tables on the floor to be used for the activities. Use figure 1. as an example to carry out the activities.

i. Measure the height of the surface of your table with ruler or tape measure as in figure 1.above……………

ii. Place these objects jersey, pencil case and shoe a distance away from your table. Use spring balance to determine the mass of each object.

iii. Lift each object (jersey, pencil case and shoe) from the floor on the table.

Record findings from i- iii in the table below:

i. Jersey……….

ii. Pencil case………..

iii. Shoe……….

v. Calculate the amount of work done in each case in the table as shown below:

For example:

Object	Distance (m)	Force(N) is =Mass	Work done (J) F X D
Jersey	2	3	6J
Pencil case			
Shoe			

Activity 3: Investigate your power when you climb on an improvised four flight of stairs.

Material: Improvised wooden stairs, measuring tape, stop watch with a second and scale.

Skill to acquire: observation, inference, measurement and data interpretation.

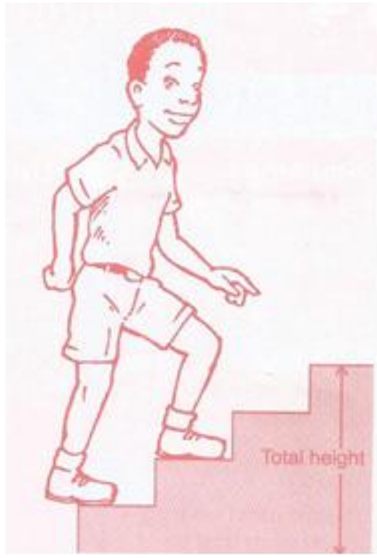


Fig. 2

Climbing a Flight of stairs

Method:

Four students are to use the improvised wooden stairs as above to acquire the information needed. They are to investigate their power when they climb on an improvised four flight of stairs as shown in figure 2.

a. Measure your mass in kilograms using scale and record it……….,……….
…………and

b. measure the vertical height of the flight of stairs with the measuring tape…………..

c. Use stop watch to measure the time it will take three students to:

(i) Walk up the flight of stairs

(ii) Run up the flight of stairs

d. Record your findings for 3a to 3c in the table below. For example

Time taken to walk up the flight of stairs

Students	**Mass(kg)**	**Time(s)**	**Height(m)**
Amina	**35**	**10**	**2**

Time taken to run up the flight of stairs

Students	Mass(kg)	Time(s)	Height(m)

e. Write your conclusion from the result of the experiments……………………..

Activity 4: Investigation of potential and kinetic energy

Materials: a stones, books, balls, school bag

Skills to acquire: observation, experimentation, classification, measurement and data interpretation

Students are to place the following objects: a school bag, a stone, a book on the table about to fall, school bag drop at certain height made on the wall. They are to indicate the type of energy used by the objects with reasons.

Method:

i. Make a measurement on the wall in the laboratory.
ii. Raise your school bag at a certain height and drop.
iii. Write down the height at which you drop the bag and state the type of energy
iv. Use a measuring tape to measure 1m on the ground.
v. Place two balls A and B at a distance of 1m apart on the floor. Roll ball A to hit ball. State what happen? ....
vi. Measure the height of the table and push a book from the table to fall down. Record the height at which the book fell and your observation……………..
vii. Two students in each group are to run to and from the door of the laboratory. Indicate the time taken in seconds of the students that ran to and from the door of the laboratory.

    Student 1.Time taken to run to and from the door of the laboratory……

    Student 2.Time taken to run to and from the door of the laboratory …….

viii. Place a stone on the ground. Observe it and state the type of energy………

ix. Classify the above exercise or activities ii - viii into potential and kinetic energy.

Potential Energy	Kinetic Energy
i.	
ii	
iii.	
iv.	
v.	
vi.	
vii.	

viii. Draw a conclusion from your observations.

STEP 4: Evaluation/ Conclusion: Seven students one from each group was called to read their findings. Corrections were made and students' packages were collected for marking.

LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON PLAN FIVE

METHOD OF TEACHING: PROCESS-BASED INSTRUCTIONAL PACKAGE

STEP 1: INFORMATION

NAME OF STUDENT……………………………………

GENDER: Male ☐ **Female** ☐

SUBJECT:	BASIC SCIENCE
CLASS:	JSS II
NO. OF STUDENTS IN CLASS	35
TOPIC:	TRANSER OF HEAT
DURATION:	80mins.

BEHAVIOURAL OBJECTIVES: By the end of the lesson, students should be able to:

(i) illustrate that when two bodies are in contact, heat flows from the hot to the cold one.

(ii) observe heat transfer by conduction, convection and radiation

(iii) state the application of each

(iv) classify objects under good and bad conductor

STEP 2: **INTRODUCTION/INSTRUCTION**:

i. Students are shared into seven groups of five to carry out the activities.

ii. Explanation of new words by the teacher:

Heat transfer- Is the flow of heat from its source to other place

Conduction-Is a process of heat transfer from one particle to another in a solid, example a metal

Convection- Is the transfer of heat by movement of liquid or gas

Radiation- Is heat carried by means of waves and does not require a material medium

iii. Students are to use their sense organs to carry out the activities.

iv. Place of activity- Outside/ in the laboratory

STEP 3: STUDENTS ACTIVITIES

Activities 1:(in the laboratory) Investigating heat flow by conduction.

Materials: Plastic spoon, metal spoon, hot water, metal pot, beaker

Skills to acquire: observation, inference, classification, measurement and data interpretation.

Method:

(i) Pour the hot water inside the beaker.

(ii) Dip the metal spoon inside the hot water and hold its end for sometime

Write your observation ……………………………

(iii) State why metal pots and spoons with plastic handles are used for cooking………

Activities 2: Investigate heat energy as it flows through a metal rod.

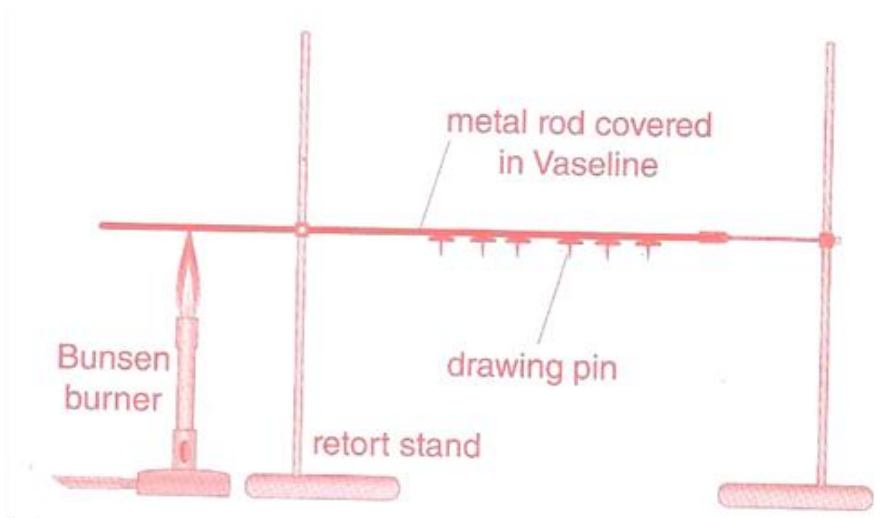
Materials: Metal rod, Vaseline, retort stand, drawing pin, Bunsen burner, stop watch and a ruler.

Skills to acquire: observation, inference, experimentation measurement and data interpretation.

Method: Set up an experiment as shown in this diagram.

The drawing pins will be stuck to the metal rod.

Experiment set up to test the flow of heat energy.



a. Heat one side of the rod as shown in the diagram. Which drawing pin fell off first? ____________________. At what distance………… cm?

Write a short paragraph to explain your answer___________

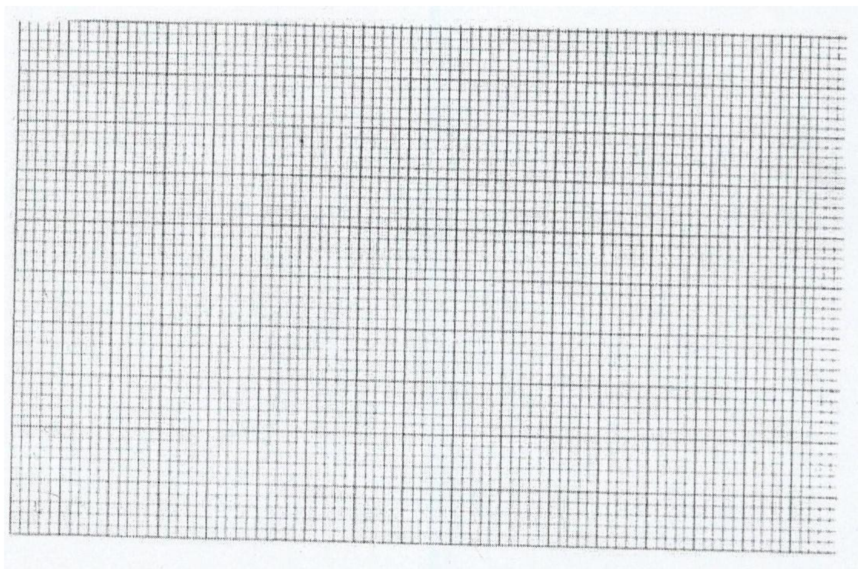
b. Record the time and distance it took for the rest of the drawing pin to fall off in your experiment using the table below:

Experiment to Test Heat Flow

Distance (cm)				
Time drop(s)				

c. Plot a line graph of your results using the graph below:

Distance (cm)



Time drop(s)

Activity 3: Investigation heat flow by convection.

Materials: Beaker, cold water, a beaker, an empty biro, a clock, Bunsen burner, few crystals of potassium tetraoxo-manganate (VII) (potassium permanganate)

Skills to acquire: observation, inference, measurement, experimentation and data interpretation.

Method:

(i) Use an empty biro to deliver small quantity of potassium permanganate crystals gently at the bottom of the beaker of water

(ii) Heat the base of the beaker on a Bunsen burner just under where the crystals have fallen

(iii) Use the clock to observe and record your observation in 2mins…….. 4mins………. and 6mins……………

(vi) Draw a diagram of what you saw

……………………………….

Activity 4: Investigate heat flow by Radiation

Materials: Two empty cans painted black and white, a good source of heat, two thermometers, water.

Skill to acquire: observation, inference, experimentation, measurement and interpretation data

Method:

(i) Half full the cans with water.

(ii) Place the cans 5cm equidistant from the source of heat.

(iii) Put thermometer in the cans of different colour and note the temperature. Represent this in a diagram:

(iv). State how the heat reaches the cans

Write down how you feel near the source of heat

……………………………………..

Activity 5: Classification of objects under good and bad conductor

Materials: Water, wood, metal key, glass plastic spoon, Bunsen burner

Skills to acquire: observation, inference, experiment and classification.

Method:

Place the entire objects one after the other on flame of fire and classify the result under good or bad conductor. State your reasons for each answer.

Good Conductors …………………………Reasons for answer……………….

Bad Conductors……………………………Reasons for answer………………

STEP 4: Evaluation/Conclusion: Seven students one from each group was called to read their work. Corrections were made and teacher collects students' packages for marking

LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON PLAN SIX

METHOD OF TEACHING: PROCESS–BASED INSTRUCTIONAL PACKAGE

STEP 1: INFORMATION

NAME OF STUDENT…………………………………….

GENDER: Male ☐ **Female** ☐

SUBJECT: BASIC SCIENCE

CLASS: JSS II

NO. OF STUDENTS IN CLASS: 35

TOPIC: TYPES AND CAUSES OF CHANGES IN MATTER

DURATION: 80mins.

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BEHAVIOURAL OBJECTIVCES: By the end of the lesson students should be able to:

(i) state different ways matter changes.

(ii) list observable changes that occurs

(iii) classify the changes under temporary or permanent changes

(iv) state the causes of such changes (factors)

(v) represent some of the changes in a diagram

STEP 2: INTRODUCTION/INSTRUCTION:

i. Students are shared into seven groups of five to work on the activities.

ii. Explanation of new words by the teacher:

Temporary changes: Are changes that can be reversed.

Permanent changes: Are changes that can not be reversed.

iii. Students are to use their sense to out the activities.

iv. Place of activity: outside/in the laboratory

STEP 3 : **STUDENTS ACTVITIES**

ACTIVITY I:(in the laboratory) Identify different ways matter changes.

Materials: a candle, candle holder and lighter.

Skills to acquire: observation, inference, experimentation.

Method

(i) Place the candle in the candle holder.

(ii) Light the candle

(iii) Let it burn for a few minutes.

Observation

(a) Identify what was applied on the candle………………

(b) State the type of change: Temporary or permanent………………….

(c) State whether a new substances was formed or not…………………

(d) Represent your observation in a diagram

Activity 2: Observing the effect of heat on sugar solution.

Materials: Sugar, evaporation dish beaker, water, tripod stand, Bunsen burner, gauze.

Skills to acquire: observation experimentation, measurement and classification.

Method

i. Dissolve a table spoonful of sugar in $5cm^3$ of water in a beaker.

ii. Record your observation………………………………………….

iii. Pour what is formed into an evaporating dish.

iv. Heat gently over the Bunsen burner until water evaporates completely.

v. Record your observation …………………………………………..

vi. State if new substance was formed and the type changes………………..and…………

Activity 3: Burning Wood

Materials: A small pieces of dry wood that can burn easily, matches, a crucible and tripod stand.

Skills to acquire: observation, experimentation and classification

Method:

(i) Place the pieces of wood in the crucible

(ii) Place the crucible on the tripod stand

(iii) Strike the match and light the wood.

(iv) Allow the wood to burn out

(v) Record your observation……………………………

(vi) Draw the diagram of your observation

(vii) State two factors that affect changes…………………and…………………

(viii) State two differences between temporary and permanent change…………..

…………………………………………………………………………..

Activity 4: Classify the following materials under temporary or permanent changes and state the reasons for each.

Materials:

(i) Yellow leaves…………………. and reason………………

(2) Growing plants of plants ……………………….and Reason………………

(3) Ice block Melting……………………………and Reason…………………

(4) Iron rust……………………………..and Reason……………………….

(5) Decaying plants…………………..and Reason……………………..

(6) Water and oil mixed together…………….and Reason………………….

STEP 4: Evaluation/Conclusion: Seven students one from each group was called to read out their findings. Corrections were made and students' packages were collected for marking.

APPENDIX III

LESSON PLAN FOR CONTROL GROUP

LESSON PLAN ONE

METHOD OF TEACHING:	LECTURE METHOD
SUBJECT:	BASIC SCIENCE
GROUP:	CONTROL
CLASS:	JSS II
NO. OF STUDENTS IN CLASS:	40
TOPIC:	TYPES OF HABITAT AND ADAPTION OF ORGANISMS
DURATION:	80mins.
REFERENCE:	Classic Basic Science for Junior Secondary School Book Two Thursmay Educational Services Limited, 2014
INSTRUCTIONAL MATERIALS:	Textbook, chalk board, charts showing different organisms in different habitats
BEHAVIUORAL OBJECTIVES:	By the end of the lesson, students should be able to;

i. list different habitats of living organisms.

ii. identify the living organisms found in different habitats.

iii. classify the organisms according to the features that distinguish them in different habitats.

iv. identify some biotic and abiotic factors in a habitat.

PREVIOUS KNOWLEDGE: The students live in the environment where different organisms live.

INTRODUCTION: The teacher asks students to list the organisms within their environment.

PRESENTATION:

Step1: The teacher explains habitat as a place where an organism lives. The study of habitat is called ecology. There are different types of habitat like school environment, pond, tropical rainforest, home, and nest.

Step 2: Teacher states and grouped types of habitats:

Habitat can be grouped into aquatic (water) and terrestrial (land) habitat

The aquatic habitat is subdivided into fresh and salt water habitats Examples of fresh water habitat include ponds, stream, and lakes. Examples of salt water habitat are ocean, seas. Different animals are found in salt water habitat like crab, crayfish whale, and microscopic organisms like brown algae.

Step 3: Teacher explains the adaptation of organisms to their habitats using the chart showing different organisms and their habitats

Plants and animals live in places that suit them because their bodies are structured in such a way that they can survive in their habitat. In this way it is said that the plant or animal has adapted to their habitat For example the ducks webbed feet helps it to swim, its feathers do not get soaked with water like those of the chicken.

Step 4: Biotic and A biotic factors in habitat are explained by the teacher with the examples:

Organisms in their habitat are affected by many factors. These include; living (biotic) and non-living (abiotic) factors. Examples of biotic factors are animals and plants and micro -organisms such as food, diseases and competition. Examples of abiotic factors are temperature, dissolved gases, and dissolved salts, amount of water, light intensity.

EVALUATION: the teacher evaluates the lesson by asking students questions;

i. Define a habitat

ii. Give three differences between fresh and salt water habitat.

iii. Mention three biotic and a biotic factor in a habitat.

iv. List five different habitats.

v. Classify toad, frog, fish, bird and earthworm into different habitat.

CONCLUSION: The teacher concludes by summarizing the lesson;

I. A place where an organism lives is its habitat

II. There is aquatic and terrestrial habitat.

III. Aquatic has fresh and salt water habitat

III. Organisms live where it suits them

ASSIGNMENT: The teacher gives students assignment to study their home surroundings and sort out the different habitats they see.

LESSON PLAN FOR CONTROL GROUP

LESSON PLAN TWO

METHOD OF TEACHING: LECTURE METHOD
SUBJECT: BASIC SCIENCE
GROUP: CONTROL
CLASS: JSS II
NO: OF STUDENTS IN CLASS: 40
TOPIC: POPULATION AND POPULATON DENSITY OF ORGANISMS IN A HABITAT
DURATIONS: 80mins
REFERENCE: Classic Basic Science for Junior Secondary Schools Book 2 Thursmay Educational Service Limited (2014)

INSTRUCTIONAL MATERIALS:
Measuring tapes, school environment, quadrat, worksheets,

BEHAVIOURAL OBJECTIVES: By the end of the lesson, students should be able to;
(i) list different organisms around the school environment.
(ii) discuss how a particular area around the school environment can be measured.
(iii) explain how quadrat can be used to identify organisms in a particular area on a plot
(iv) explain how to throw a meter square quadrat on a particular area around the school environment and identify the population of organisms in it.

PREVIOUS KNOWLEDGE: students have been taught types of habitat and adaptation of organisms in a habitat. Examples: man, goats and rats.
INTRODUCTION: Teacher asks student question based on their previous knowledge example (i) what is a habitat? (ii) State two main types of habitat (iii) state an example of organisms living in each of the habitat.

PRESENTATION:

Step1: teacher defines habitat as a group of organisms of the same kind living in a given place at a given time is called population while population density is a measure of the size of a population living in a unit area of a habitat.

Step II: Students are to list different organisms they have been seeing around the school environment (lizards, goats, plants, birds)

Step 3: Teacher explain how to measure an area around the school environment. An area can be measured 15m by 10m. Within that area, throw or place a quadrat in about different point within the area. Assuming is a maize farm. Count the number of maize plants in each point and find average for 5 points. Therefore the population density of the maize plant per unit area is calculated. This is called the quadrant method.

Teacher explains that mathematically population density = $\frac{\text{Population Size}}{\text{Area}}$

Assuming if a space of $20m^2$ in a garden, there are 1,000 maize plants, calculate the density

1000 = 50 maize/m^2

This implies that there are 50 maize plants growing on 1 square meter of land hence the population is dense.

Step 4: Teacher explains that among the organisms listed, assuming 1 million lizards in a 10,000 km^2 area, what is the population density?

$$\text{Population density} = \frac{2000,000}{10,000} km^2$$

$$= 200.0km^2$$

Step 5: Students are to count all the population of all the organisms listed.

Evaluation: Teacher asks students the following questions:

(i) Name some of the population of organisms around your school environment.

(ii) The size of the population divide by the area is called what?

(iii) What is the area of a quadrat?

Conclusion: The lesson by summarizing briefly the main point as follow:

(i) Population of organisms is lizard, goats, ants, trees.

(ii) Population density is the measure of the size of the population living in a unit area of the habitat.

(iii) Area of a quadrat equals to one meter square.

Assignment: Students are to estimate population density using quadrat around the surrounding of their homes.

LESSON PLAN FOR CONTROL GROUP

LESSON PLAN THREE

METHOD OF TEACHING:	LECTURE METHOD
SUBJECT:	BASIC SCIENCE
GROUP:	CONTROL
CLASS:	JSS II
NO. OF STUDENTS IN CLASS:	40
DURATION:	80mins
TOPIC:	KINETIC THOERY OF MATTER AND ITS APPLICATIONS
INSTRUCTIONAL MATERIALS:	Charts illustrating three states of matter and change of State.
REFERENCE:	Classic Basic Science for Junior Secondary School Book 2 Thursmay Educational Services Limited, 2014.
BEHAVIOURAL OBJECTIVES:	By the end of lesson students should be able to:

(i) state the principles of kinetic theory

(ii) list properties of matter,

(iii) explain boiling and evaporation using kinetic theory

(iv) mention at least 2 factors affecting evaporation

PREVIOUS KNOWLEDGE: Students have learnt the forms in which matter exists

INTRODUCTION: The teacher asks students questions base on previous knowledge as follows:

i. define matter

ii. State the forms in which matter exist

PRESENTATION:

STEP1: The teacher explains the assumption of the kinetic theory of matter that the particles of matter are in constant random motion because they possess kinetic energy that brings about their motion. An increase in temperature causes an increase in the motion of the particles and, hence, an increase in the average kinetic energy of the particles.

STEP 2: The teacher explains further that the three states of matter have certain properties as follows:

SOLID

- They have a fixed shape and volume
- Particles are closely packed together and are unable to move from one place to another
- They cannot be compressed
- They have high density and the force that joins those particles are called cohesion Force
- Example include cube of sugar

LIQUID

- Particles are not quite close together as in solid
- Have fixed volume but take the shape of whatever but takes the shape of whatever container it is put
- Cannot be easily compressed
- Have a fairly high density
- Example include water

GAS

- Particles move about freely and faster with a large distance between the particles
- Do not have definite shape or volume but takes the shape of the container
- The cohesion forces are very weak thereby causing the particle to move constantly in all direction.
- Have very low densities.
- Example include oxygen

STPE 3: The teacher explains change of state and displays the chart for students to see

Solid →freeze → liquid →condense →gas

Solid ice →melt →liquid →vaporize → gas

STEP 4: Teacher explains boiling and evaporation using kinetic theory that when water is heated, the heat is transferred to water particles gradually. The heat will lead to the breakdown of the surface tension of liquid. Once the water particles gain energy from heat, the bond joining the particles together will break and particles will be seen as vapour and the process during which water particles change to gas and particles escape is called evaporation. Factors affecting evaporation include temperature and nature of liquid.

EVALUATION: The teacher asks students the following questions: example:

i. State the principles of kinetic theory of matter.

ii. Mention two factors affecting evaporation.

iii. List five properties of matter.

CONCLUSION: The teacher concludes the lesson by summarizing main points

- Matter exist in three states solid, liquid and gas
- Kinetic theory states that particles of matter are in constant random motion because they possess kinetic energy that bring about motion
- Evaporation can also take place without heating

ASSIGNMENT: teacher tells the students to boil water at home, observe and explain the result using kinetic theory of matter

LESSON PLAN FOR CONTROL GROUP

LESSON PLAN FOUR

METHOD OF TEACHING: LECTURE METHOD

SUBJECT: BASIC SCIENCE

GROUP: CONTROL

CLASS: JSS II

NO. OF STUDENTS IN CLASS: 40

TIME: 80mins.

TOPIC: CONCEPT OF WORK, ENERGY AND POWER

INSTRUCTIONAL MATERIALS: Chalk and chalk board

REFERENCE: Classic Basic Science for Junior Secondary School Book Two. Thursmay Education Services Limited, 2014.

BEHAVIOURAL OBJECTIVES: By the end of the lesson students should be able to:

(i) explain the concept work, energy and power

(ii) state energy changes that occur when work is done

(iii) calculate the work done when a given force moves an object through a known distance in the direction of the force, and

(iv) solve problems on work, energy and power.

(v) identify kinetic and potential energy

PREVIOUS KNOWLEDGE: Students have been seeing moving and non-moving things around them examples, cars, fans and trees

INTRODUCTION: The teacher asks the students questions to list out things that can move and do not move around them.

PRESENTATION: -

STEP 1: WORK: The teacher explains to students that work is done when a force causes an object to move in the direction of the applied force. Work is the physical effect of energy transfer. Without energy no work can be done .Work is the product of force multiplied by distance moved in the direction of the force. Work=Force (F) x distance (d)
Work: f x d ------------.

Work is measured in unit called Joules (J). Force is anything that will cause a body at rest to move, or a body in motion to stop. It can be expressed as: Force (F) =mass (m) x acceleration (a), F=m x a-----------------, Force is measured in the unit called Newton (N), it also means that Work: m x a x d

Example 1: Calculate the work done raising an object of 1kg through a distance of 1m. Take $g=l0m/s^2$

Solution: F= lkg x l0 = 10N, Distance=lm $\therefore$ WD=F x D=10x1=10Nm=10J

STEP II: ENERGY: The teacher explains that energy is the ability to do work. There are different forms of energy example include heat, solar, electrical, chemical and mechanical energy. Mechanical energy consist of potential (PE) and kinetic (KE) energy. PE is the energy stored in a body e.g. raising your school bag 1m high. It is given by mgh where m is mass is acceleration due to gravity and h is height. KE is the energy due to its motion e.g. a rolling ball or a moving car. It is given by $1/2mv^{2,}$ where m is mass and v is for velocity.

Example 2: Calculate the PE and KE of a ball of mass 0.03 kg thrown from a height of m and has a velocity of 2ms.

Solution: PE =Mgh= 0.03xl0x6=1.8J. KE=1/2Mv2 =l/2x0.03x4=0.06J

STEP III: POWER: The teacher explains that power is the rate of doing work

Power=work done/time taken or P =w/t, where w =mxh. The 5.1 unit of power is watt (W) and the rate of work is measured in J/s

Example 3: calculate the power of a students with mass 40kg who runs a height of 5m in 10sec given $g=l0m/s^2$

Solution: F = 40x10=400N,D =5m, WD= F x D=400x5=

Power=WD/Time=2000/10=200J/sec

EVALUATION: Teacher asks the following questions:

i. Define work, energy and power and state their 5.1 unit
ii. State the energy changes that occur when work is done.
iii. Calculate the work done when a box of 2kg is raised through a vertical height of 5m ($Ag =10m/s^2$)

CONCLUSION: Teacher concludes the lesson by summarizing main points as follows:

- Energy is the ability to do work
- Work is the force multiplied by distance moved in the direction of the force
- Power is the rate of doing work
- The S.1 unit of work and energy is the Joule
- The S.1 unit of power is the watt

ASSIGNMENT: The teacher asks the students to practice more exercises on revision question on page 131 of their text book.(Classic Basic Science for JSSII).

LESSON PLAN FOR CONTROL GROUP

LESSON PLAN FIVE

METHOD OF TEACHING:	LECTURE
SUBJECT:	BASIC SCIENCE
GROUP:	CONTROL
NO OF STUDENTS IN CLASS:	40
DURATION:	80mins.
TOPIC:	TRANSFER OF HEAT
INSTRUCTIONAL MATERIALS:	Chalk and chalk board, diagrams illustrating different methods of heat transfer.
REFERENCE:	Classic Basic Science Junior Secondary Schools. Thursmay Education Science Limited,
BEHAVIOURAL OBJECTIVES:	By the end of the lesson, students should be able to:

(i) illustrate that when two bodies are in contact, heat flows from the hot to the cold one.

(ii) list the methods of heat transfer.

(iii) explain:

(a) Conduction and state two uses of its application

(b) Convection and state two uses of its applications

(c) Radiation and state two of its applications

(iv) classify objects under good and bad conductor

Previous Knowledge: Students could identify when something is hot or cold.

Introduction: Teacher asks the students to rob their hands for a minute, touch their checks and say how they feel.

PRESENTATION:

Step 1: The teacher explains that the primary source of energy is the sun, and its energy reaches us in form of light and heat. Thermal energy is heat energy and can be transferred from one place to another.

STEP 1I: Using the chart the teacher explains that heat is a form of energy and can be transferred in three ways.

(A) Conduction- is a process of heat transfer from one particle to another without movement of the particles. This can be illustrated by dipping a metal spoon inside hot water for sometimes .The part of the spoon which is not in hot water becomes hot.

.Hot water transferred heat to the part of the spoon in hot water. This means heat has been conducted along the metal spoon.

(B) Convection: particles transfer the heat from one point to another. Transfer of heat by convection can be illustrated by heating a crystal of $KMnO_4$ on one side of a beaker of water for some time until all the water becomes hot from the bottom to the top through convection.

(C) Radiation-: the heat is carried by means of waves and does not require any medium and the particles move freely. Heat transfer by radiation can be illustrated by inserting a thermometer inside a beaker of hot water and another one near the beaker for some minutes, the temperature of the thermometer near the beaker soon rises up and the heat transfer is by means of waves. Radiation helps heat to be transferred to a person warming him or herself at the side of a fire during cold season.

STEP III

GOOD AND BAD CONDUCTORS

Substances that conduct heat readily are said to be good conductors of heat. All metals are good conductors of heat but some are better than others. Those that do not conduct heat readily are bad conductors; examples include water, glass, wood, air and so on.

EVALUATION: The teacher asks students the following questions:

i. Mention three ways of heat transfer

ii. Give two examples of good and bad conductors of heat

iii. State two applications of conduction and radiation.

CONCLUSION: The teacher concludes the lesson by summarizing main points:

- Heat is a form of energy
- Heat energy can be transferred from one place to another by three methods- conduction, convection and radiation.
- Metals are good conductors of heat, though some are better than others
- Non- metals such as glass, wood, plastic and water are poor conductors of heat.

ASSIGNMENT: The teacher gives an assignment as follows:

Look around your home environment and pick as many different materials as you can get.

Sort them out into good and bad conductors of heat.

LESSON PLAN FOR CONTROL GROUP

LESSON PLAN SIX

METHOD OF TEACHING:	LECTURE METHOD
SUBJECT:	BASIC SCIENCE
GROUP:	CONTROL
CLASS:	JSS II
NO. OF STUDENTS IN CLASS:	40
TOPIC:	TYPES AND CAUSES OF CHANGES IN MATTER
DURATION:	80mins.
REFERENCE:	Classic Basic Science for Junior Secondary Schools Book Two, Thursmay Educational Services Limited, 2014
INSTRUCTIONAL MATERIALS:	Chalk and chalkboard, match stick, ice cube
BEHAVIOURAL ONJECTIVES:	By the end of the lesson students should be able to:

(i) state different ways matter changes.

(ii) list observable changes that occurs

(iii) classify the changes under temporary or permanent changes

(iv) state the causes of such changes (factors)

PREVIOUS KNOWLEDGE: Students have learnt about the different form matter exist.

INTRODUCTION: The teacher introduces the lesson by asking students questions base on previous knowledge:

i. Mention the three state of matter

ii. Give two differences between solid, liquid and gaseous state

PRESENTATION:

STEP I: The teacher presents the lesson by explaining that matter can change when exposed to light, heat, air, water or pressure. When a substance is heated, it could change completely to another e.g. when a piece of wood is burnt it changes completely to form charcoal. Such changes could be temporary (physical) or permanent (chemical)

In temporary changes, the identity and composition of the matter is not changed but the physical state is changed for example, When a solid ice block in a test tube is heated over a flame, it melts into liquid water. Ice block and melted water have the same composition.

In permanent changes, the identity and composition of the matter is totally changed. This type of changes occurs when substances react to form other substances example burning of a piece of paper or wood to form ash.

STEP II: Causes of changes in Matter

Before a change of state can occur, certain factors must be altered. These include: temperature, pressure, electric current, chemicals and arrangement of particles in the matter.

STEP III: Differences between physical and chemical changes

	Temporary(Physical)	**Permanent(Chemical)**
i.	It is easily reversible	Not easily reversible
ii.	No new substances are formed	New substances are formed
iii.	No change in mass of substances involved in such change	There is change in mass of involved in such change
iv.	Does not involve any great heat Involves great heat change which occur during change of state	Involves great heat change.

EVALUATION: The teacher evaluates the lesson by asking students question as follows:

i. List three factors that can bring about change in matter

ii. Give three differences between temporary and permanent change.

iii Mention two types of changes in matter.

CONCLUSION: The teacher concludes the lesson by summarizing main points:

- Changes matter undergo are classified into physical and physical changes
- During physical change, a substance changes its physical appearance but not its composition; while in chemical change, a substance is transformed into a chemically different substance thereby changing its physical appearance and chemical composition.
- Factors that bring about changes in matter include; temperature, pressure, electric current, chemicals and arrangement of particles in the matter.

ASSIGNMENT: The teacher gives an assignment to sort the following into physical and chemical change:- melting of ice, burning of candle wax, lighting of matchstick, dissolution of salt

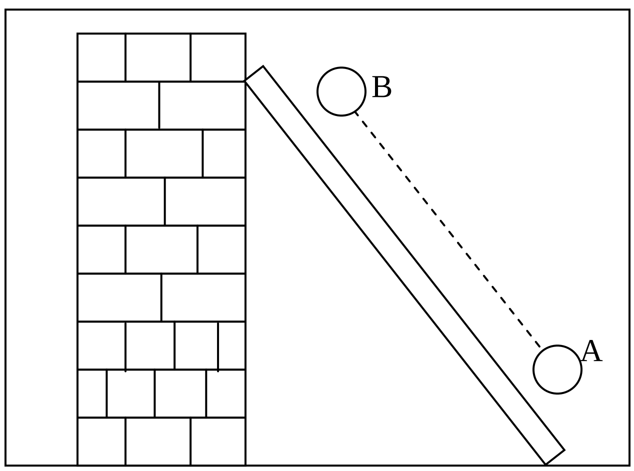
APPENDIX IV

BASIC SCIENCE PERFORMANCE TEST (BSPT) **TIME: 2HOURS**

Name:____

School:____

These questions are meant to help examine the Impact of Process-based Instructional Strategy on Achievement Test of students in Basic Science. Each item is followed by four – alternative responses lettered A – D. Circle the response you choose for each item.



1. From the diagram above the type of energy produced when ball B hits ball A is called
   (a) Potential energy
   (b) Kinetic energy
   (c) Heat energy
   (d) Light energy
2. Tilapia is to aquatic as hen is to ____________
   (a) aerial
   (b) Water
   (c) Terrestrial
   (d) Guinea corn

The following are the adaptive features of some organisms indicate the alphabet that represents the organism

I. Possession of tail and fins for swimming

II. Webs between their toes for swimming
III. Development of water storage tissue in leaves and stems to survive in dry season
IV. Have wings that enable them to fly in the air

3. Adaptive feature for II represent
   (a) tadpole
   (b) Fish
   (c) Cactus
   (d) Frog

4. When a force moves on object over a distance, energy is transferred and _______ is done
   (a) Force
   (b) Work
   (c) Energy
   (d) Object

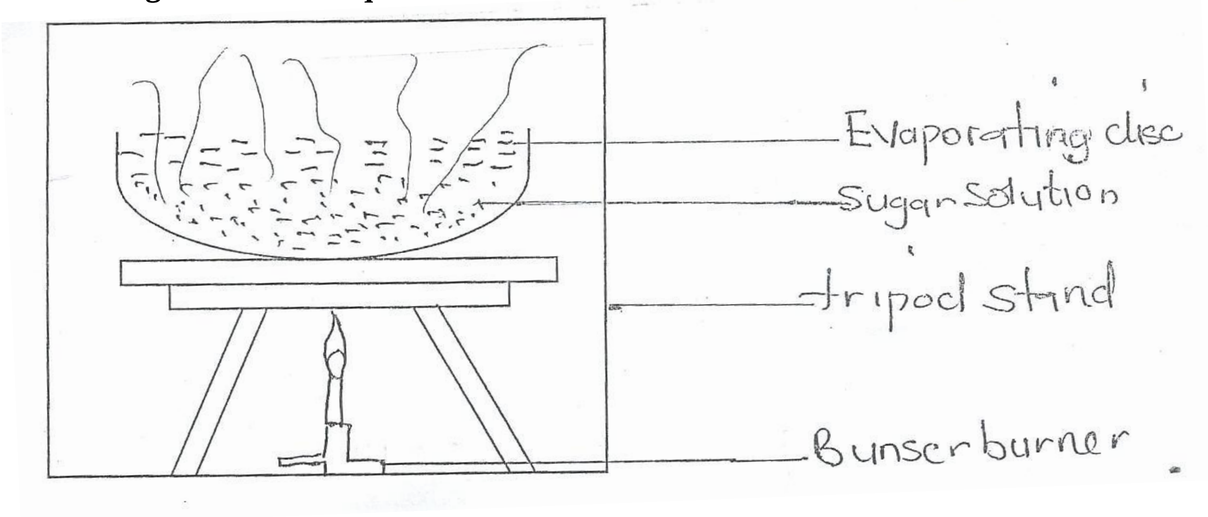
5. Which of these organisms are likely to be inside a pond?
   (a) Birds, fish, tadpole
   (b) Fish, birds, tadpole
   (c) Water lily, birds, tadpole
   (d) Fish, water lily tadpole

6. Work done is the same as energy transferred, it follows that the amount of energy transferred depends on
   (a) The force applied and distance traveled
   (b) The measured and distance traveled
   (c) The distance traveled and the push
   (d) The force applied and friction

7. All the following are permanent change except
   (a) Iron rust
   (b) Yellowing of leaves of plants
   (c) Burning substances
   (d) Water changes into ice

8. One of these statements is not correct about matter
   (a) Matter is always a solid material
   (b) Matter can undergo temporal or permanent change
   (c) Heat can affect matter
   (c) Matter can exist in three states

Use this figure to answer questions 9 – 12



9. In this experiment, the sugar dissolves in water to form
   - (a) Sugar
   - (b) Mixture
   - (c) Solution
   - (d) Solid

10. When the content is heated the water
    - (a) Condense
    - (b) Solidified
    - (c) Liquidities
    - (d) Evaporates

11. After this, the content solidifies to form
    - (a) New substance
    - (b) No new substance
    - (c) Old substance
    - (d) Old and new substance

12. This type of change is called
    - (a) Chemical change
    - (b) Solid, change
    - (c) Physical change
    - (d) Heating change

13. One of the characteristics of chemical change is that

(a) New substances are formed

(b) No new substances are formed

(c) Change is not permanent

(d) Change is reversible

14. The fish, toad and plant inside an aquarium best describe.

(a) Organisms

(b) Biotic factors

(c) Abiotic factors

(d) Population factor

15. When an object is heated, the particles in that region gain heat energy and start to

(a) Vibrates

(b) Move

(c) Collides

(d) Cool

16. A crate of mass 50kg is pushed along a floor with a force e.g. 20N of a distance of 5m.calculate work done

(a) 100j

(b) 1000j

(c) 10j

(d) 10,000j

17. What is the population density of two million Lizard's living in 10,000km^2 area?

(a) 0.002km^{-2}

(b) 0.020km^{-2}

(c) 0.200km^{-2}

(d) 200.0km^{-2}

18 what energy is in a moving car

(a) Potential

(b) Mechanical

(c) Kinetic

(d) chemical

19 from these organism listed duck, crocodile, fish, mango tree, water lily and which of these organisms are terrestrial habitat?

(a) Duck, fish and mango tree

(b) Mouse, crocodile and mango tree

(c) Fish, crocodile and mango tree

(d) Mouse, duck and mango tree

20. Particles of matter are in constant random motion because they possess

(a) Kinetic energy

(b) Potential energy

(c) Chemical energy

(d) Heat energy

21 An instrument used to find out the number of organism in tossed is known as

(a) Sacchi disc

(b) Quadrat

(c) Light meter

(d) Amendment

22 A number of individual organisms per unit area are called

(a) Population size

(b) Population density

(c) Population area

23. One of these features signifies the adaptive feature of an elephant.

(a) Has long attractive flowers that attracts animal for pollination

(b) Have leaves shape like needles to reduce water lose

(c) Has tusk used to collect food and for protection

(d) Stem is often thick and fleshy to store as much water as possible

24. These are list of organisms, what do they have in common catfish, crocodile, hippo, tilapia, and whale

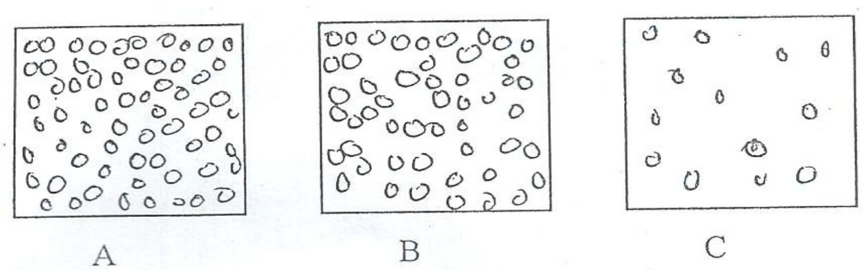
(a) Structure

(b) Habitat

(c) Features

(d) Food

25.



Examine the three diagrams a – c. They represent the molecular arrangement of a liquid, a gas and a solid in which state are the particles close together but not in regular arrangement.

(a) Liquid

(b) Solid

(c) Gas

(d) Vapour

26. Materials such as plastic, wood and glass are poor conductor of heat and are also

(a) Convection

(b) Absorption

(c) Radiation

(d) Insulators

27. Diskson lifts a 25kg sack 6m in 5s using a pulley. What is his power?

(a) 3000w

(b) 300W

(c) 30W

(d) 30,000

28. Evaporation occurs at all temperature while boiling occurs at the __________ of liquid.

(a) Cooling point

(b) Motion point

(c) Colliding point

(d) Boiling point

29. Convection happen is liquid and gases because

(a) They can flow

(b) They cannot flow

(c) They have speed

(d) They have no speed

30. Which is the most accurate statement?

(a) Heat and temperature is the same thing

(b) Heat is a measure of how hot something is

(c) Temperature is measured in Joules

(d) Temperature measures how hot an object is

31. In physical changes the original substance is

(a) Destroyed

(b) Recovered

(c) Changed

(d) Burnt

32. All of these, except one that brings about changes in a matter

(a) Moisture

(b) Pressure

(c) Wind

(d) Rainfall

33. Cohesion is the force that joins ___________particles together.

(a) Solid

(b) Liquid

(c) Gas

(d) Substances

34. What work is done when a mass of 6.00kg is raised through a vertical height of 2.5 (Acceleration due to gravity is $10m/s^2$)

(a) 150J
(b) 127J
(c) 120J
(d) 125J

35 A decrease in temperature of a liquid cause ------------------ in the motion of particles

(a) Increase
(b) Decrease
(c) Reduction
(d) Deduction

36. Dark surfaces are poor reflectors of heat because

(a) They do not absorb heat energy
(b) They heat up very quickly
(c) They are good absorbers of heat energy
(d) They heat up slowly.

37. All these can transfer heat except

(a) Electrolysis
(b) Convection
(c) Radiation
(d) Conduction

38. All these statement best explains chemical changes in matter.

(a) Does not involve great heat change
(b) New substances are formed
(c) No change in mass of substance is involved
(d) Easily reversible

39. All the following are good conductor except

(a) Magnesium
(b) Copper
(c) Iron
(d) Wood

40. When a student raises his school bag 10m high. It has __________ energy.

(a) Kinetic
(b) Potential
(c) Mechanical
(d) Light

APPENDIX V

MARKING SCHEME FOR BSPT

The test items consist of 40 multiple choice questions. Each question carries one mark. Totaling forty (40marks).

(1)	A	(11)	B	(21)	B	(31)	B
(2)	C	(12)	C	(22)	C	(32)	B
(3)	D	(13)	A	(23)	C	(33)	A
(4)	B	(14)	C	(24)	B	(34)	A
(5)	D	(15)	A	(25)	A	(35)	B
(6)	A	(16)	A	(26)	D	(36)	C
(7)	D	(17)	D	(27)	B	(37)	A
(8)	A	(18)	C	(28)	D	(38)	D
(9)	C	(19)	D	(29)	A	(39)	B
(10)	D	(20)	A	(30)	B	(40)	B

1 X 40 = 40 Marks

2 HOURS

APPENDIX VI

SCIENCE PROCESS SKILLS ACQUISITION TEST (SPSAT)

Name: ____

School:____

These questions are meant to help examine the impact of Process-Based Instructional Strategy on Acquisition of Science Process Skills and Retention of students in Basic Science.

Instruction: You are required to provide the answers on the sheet of papers given to you.

Fig. 1: A diagram of a habitat. Use it to answer question 1 – 3.

Fig. 1:

1. State the type of habitat ______________________(skill: observation)
2. List two types of organisms or living things that can be found in it________ (Skill: observation).
3. Measure the habitat with ruler and state the area of the habitat ________ in centimeter square (Skill: measurement)

Figure 2: Is population of organisms in a habitat.

Duck	Mouse	Crocodile
Trees	Frog	Zebra

Fig. 2:

Use Fig. 2 to answer question 4 and 5

4. Divide the organisms into two groups (Skill: Classification)

Group 1	**Group 2**

5. State your reasons for your answers in question 4 Group 1___ (Skill: Inference)

Group 2____

Adamu carried out experiment on types of changes using different pieces of materials (a) magnesium ribbon and (b) a piece of wax

(A) i He measured the magnesium ribbon 8cm long

ii. He held the magnesium ribbon on a pair tongs over the burner

(B) i. Adamu places a piece of wax into evaporating dish

ii. He heat it gently till there was a change in state

iii. He kept the wax in the dish to cook for about five minutes

Use the above experiment (a and b) conducted by Adamu to answer questions 6-8

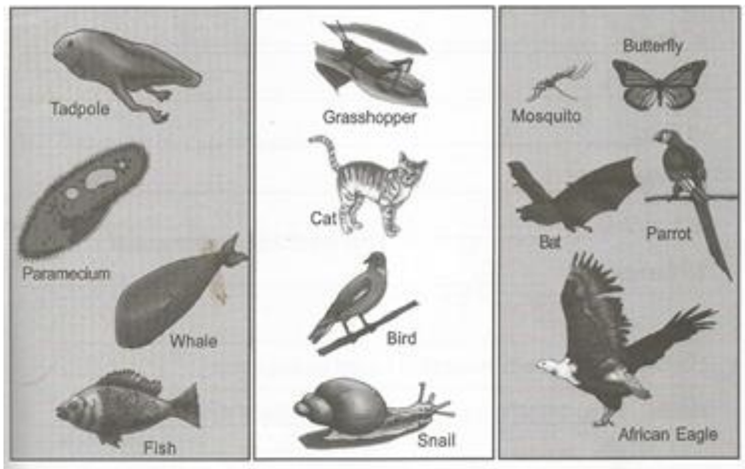
6. What are the types of changes that occur in experiment A________________ and B_______________________? (Skill: Experiment).

7. What happened to the wax when it was heated? ______________________________. And when cooled__________________________________(Skill: Experimenting).

8. Assuming only 6cm magnesium ribbon burnt off, what will be the length remaining? ____(Skill measurement).

9. The magnesium ribbon burnt and turned into a __________________ substance called ________________ (Skill: Experimenting).

Different types of organisms that live in habitat A, B and C are illustrated in figure 4.



A **B** **C**

Fig. 3

Use Figure 3 to answer Question 10 – 12

10. Which habitats are organisms in C found? ____________________ (skill: observation)

11. State one reason for your answer in question 11____________ (Skill: Inference)

12. Group the organisms in B and C into two groups; Group 1: ___________________

Group2:__________ and

State the reasons for your answer ___________________(Skill: Classification)

Figure 4: Illustration of a girl with a book on her head standing by a wall.

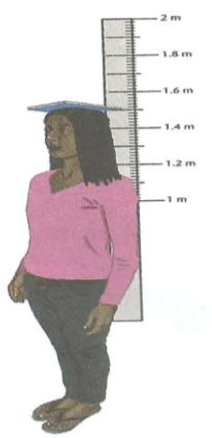


Fig.4

13. What is the height of the girl with the book on her head in figure 4? And if the book fell down from that height, state the type of energy______________ (skill: measurement)

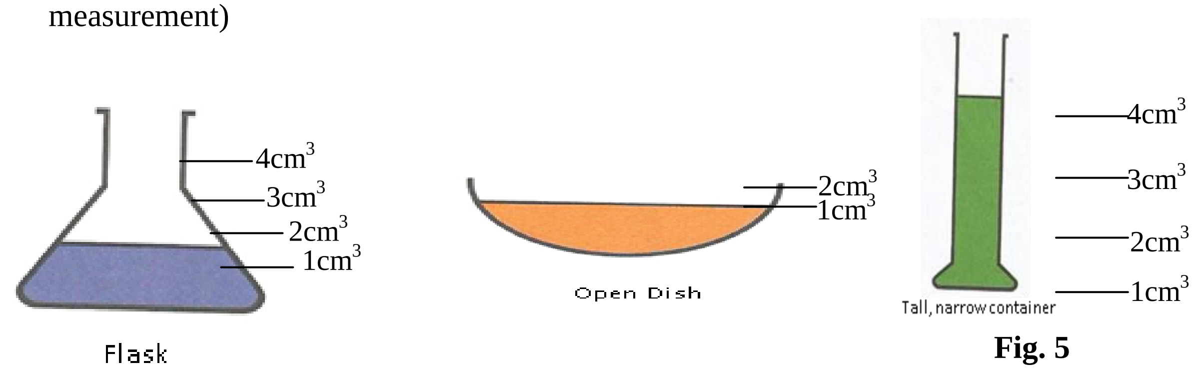


Fig. 5

The diagram in figure 5 is an illustration of evaporation from different containers after they have been left to stand with water in a warm place for some days.

14. Observing figure 5, which container has less water __________ and why _____

(Skill: measurement)

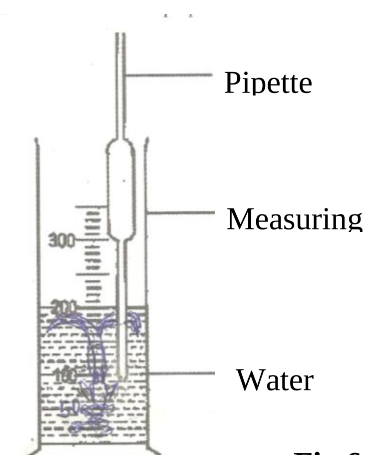


Fig.6

15. From Figure 6 above a beaker measuring 300ml is filled with 200ml distilled water, a pipette is used to deliver small quantity of potassium dichromate solution gently at the bottom of the beaker and allowed to stand for minutes (1 min, 3mins and 5mins)..

Use the table to complete what happened at 1min, 3 mins and 5 mins at each level of water.

In a minute	**In 3 minutes**	**In 5 minutes**

(Skill, observation)

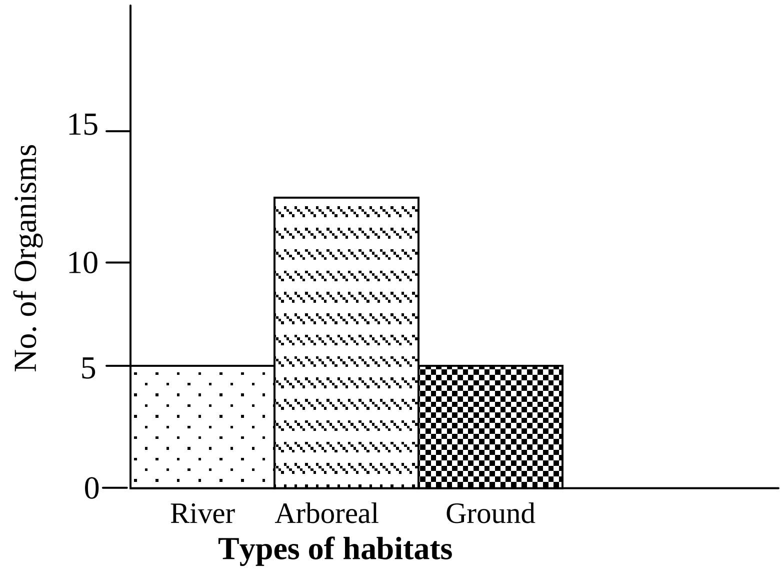


Fig. 7

Figure 7: Bar chart showing the number of organisms and their habitats.

16. From figure 7 which habitats has equal number of organisms________ and state the number of organisms in the habitats______________(skill: interpretation of data)

17. In a permanent or chemical changes ______________ is given out. (Skill: experimenting)

Figure 8 shows power as a measure of how quickly a machine transfers energy when it does work. A powerful person and a weak person can both do a job such as lifting a heavy weight from a shelf to a higher one. But the stronger person can lift the weight in shorter time. This is because stronger people have more power. From the above statement, if Salamatu, Gbade and Muhtar each take a turn to lift a heavy box to the top of a flight of stairs using a rope over a pulley as illustrated in Figure 8, timing each other.

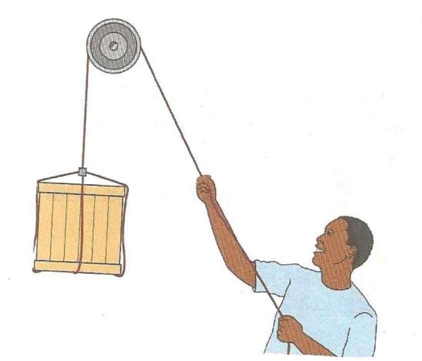


Fig. 8

- Gbade lifts the box in 10s.
- Salamatu lifts the box in 15s
- Muhtar lifts the box in 20s.

Use the illustration above to answer question 18 – 19

18. Who among the three produce the most power and why ______________________

(Skill: Inference)

19. What is the sum of the time taken by Gbade, Salamatu and Mukhtar to lift the boxes______________________?

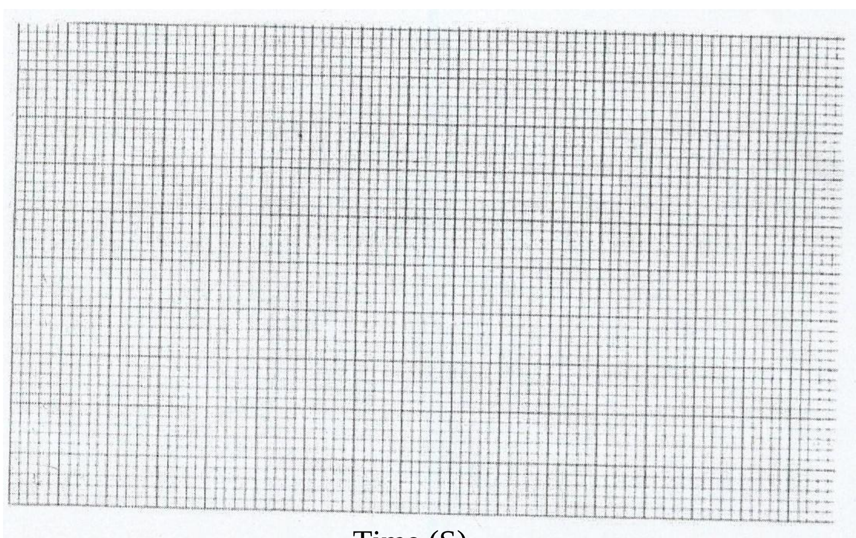
(Skill: Experimenting)

. The results presented below are collected from a study of the power and time the students use to lift a box with a pulley.

	Power (watts)	**Time(sec)**
Halima	35	5
Lami	42	7
Yakubu	50	10

20. Plot a suitable graph of the above result

Power (W)



Time (S)

(Skill: Interpretation of data)

21. From the graph find the different between the highest and lowest power. _________

____

(Skill: Interpretation of data)

22. Particles in solid, liquid and gases behave different. Draw and label two diagrams to illustrate the behaviour and arrangement of particles in solid and gases______________________ (Skill: Observation)

23. from question 22 state the reasons for your diagrams

Solid ______________________

Gases ______________________

(Skill: Inference)

24. Many objects that are used in everyday life are made from materials that are good conductor or good insulators. State the reason why metal pots and pans have handles made from insulators______________________

(Skill: Inference)

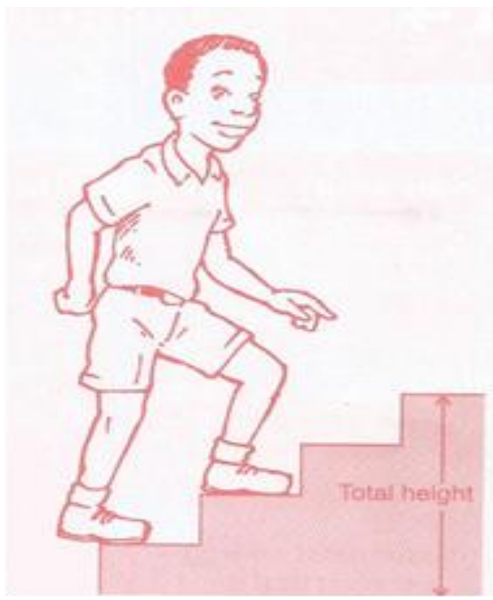


Fig. 9

In Figure 9: A boy is climbing a flight of stairs.

25. Measure and write the answer of the vertical height of the flight of stairs with ruler in figure 9 in meters_________________ (Skill Measurement)

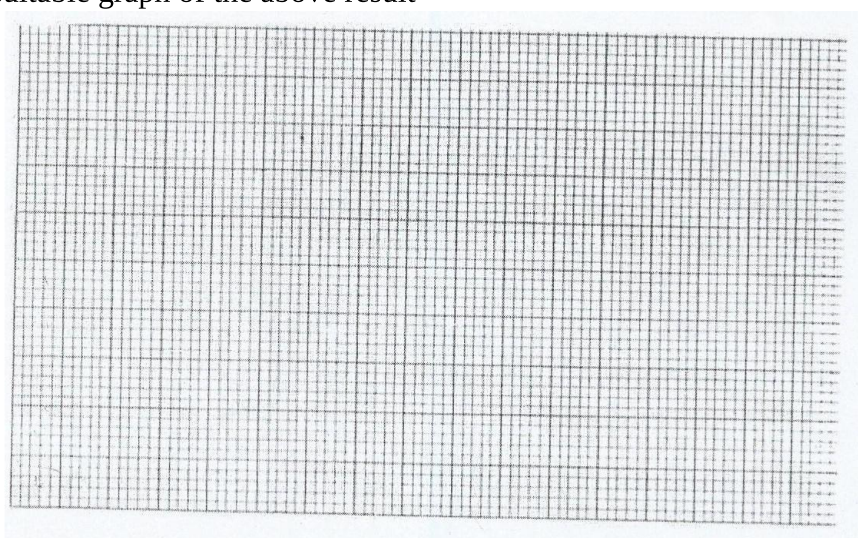
Use Figure 9 to answer questions 26– 28

From figure 9, 4 students with different mass (kg) run up the flight of stairs at different time at a height of 2.5m. Use the table below to plot a suitable graph of mass (kg) against time(s)

Students	**Mass (kg)**	**Time(s)**	**Height (m)**
Audu	26	6	2.5m
Ana	30	8	2.5m
Ladi	35	10	2.5m
Musa	40	12	2.5m

26. Plot a suitable graph of the above result

Mass (kg)



Time (s)

(Skill: Interpretation of data)

27. Why did Musa take 12 s to run up the flight of stairs ____________________
(Interpretation of data)

28. From table on figure 9 assign the students to position according to the time taken by each student to run up the flight of stairs. _______________________
(skill: Classification)

29. When a bottle of perfume is opened in a room after a couple of minutes the fragrance (smell) is throughout the room. This shows _______________
(Skill: Inference)

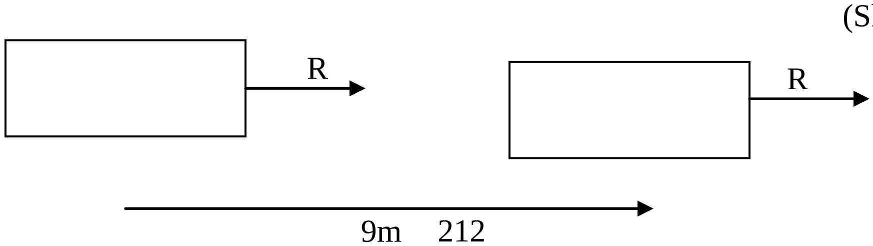


Fig. 10

30. Figure 10 shows a box that is pulled at a constant speed across a flat surface by rope. A force of 6N is applied to the box. The box moves at 9m. Calculate the work done, show your working.

(Skill: interpretation of Data)

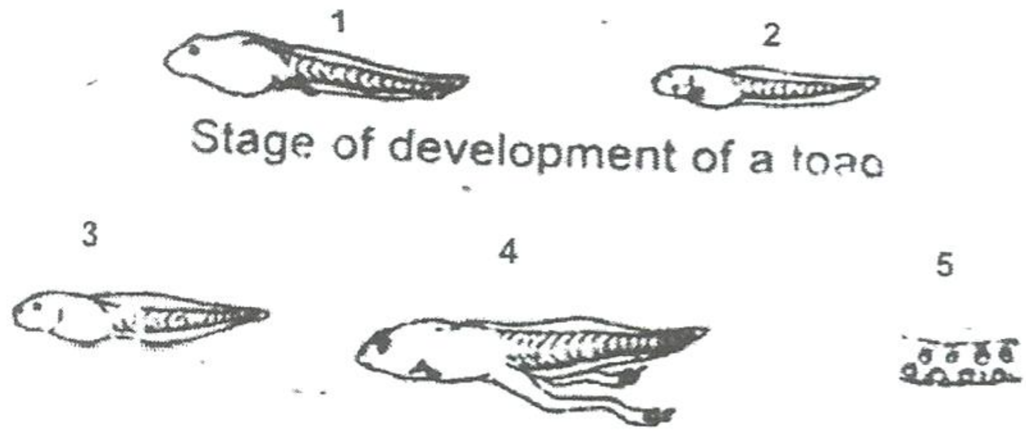


Fig.11

31. Musa carried out study in figure 11 on different types of organisms in a pond. He caught the following tadpoles of different stages of development of a frog.

Use the above statement to answer this question.

32. Re-arrange the correct order of the developmental stages of a frog in Fig.11

(Skill: observation)

Fig.12

32.   Figure 12 shows different beaks of birds adapted for a particular feeding habit of these birds. Choose from beak I-IV the bird whose beak is adapted for fishing as is labeled

(Skill: observation)

33.   Students of JS3 went for an excursion to see the botanical garden at the department of biological sciences A.B.U Zaria. They tossed their $1m^2$ quadrant 5times in different places.

The following organisms were captured and counted at each toss. These results were obtained and recorded in the table below

No of tosses	1	2	3	4	5
No of organisms counted	10 ants	20 Grasses	12 Earth worm	15 Small Plants	5 Lizards

Plot a bar chart to show the above result.

34   From the table in question 33 re-arrange the organisms captured in ascending order ____________________and state which among the organism is the largest____________________.(Skill: Classification)

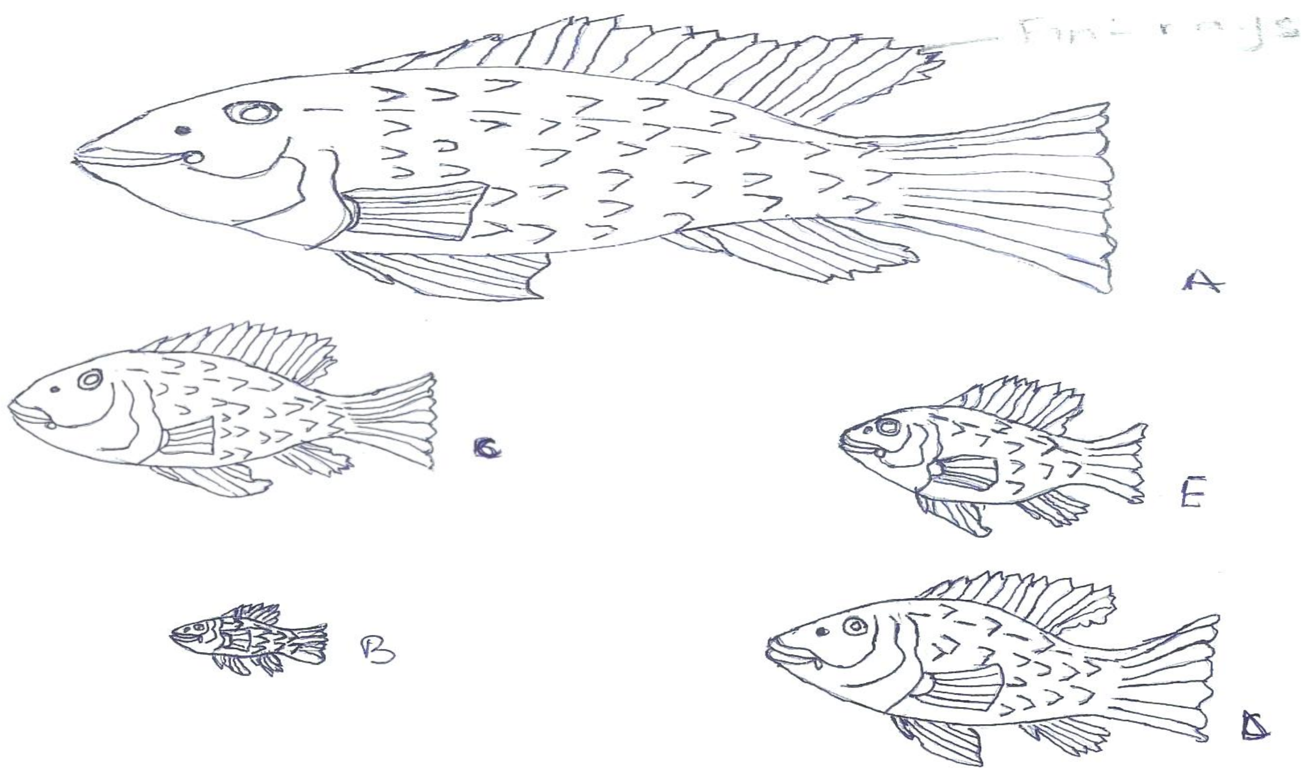


Fig.13

Figure 13 are five different types of Tilapia fishes. Look at them carefully and answer question 35-37.

35. Measure the length of the biggest fish with your ruler__________________________

(Skill: Measurement)

36. Rearrange fishes from the smaller to the biggest according to the letters_________

(Skill: Classification)

The scales on the fishes in figure 13 are counted and recorded in the table below

	No of Scales counted
Fish A	35
Fish C	22
Fish D	15
Fish E	9
Fish B	8

37. Plot a bar graph to show number of scales against fishes (Skill: Interpretation of data)

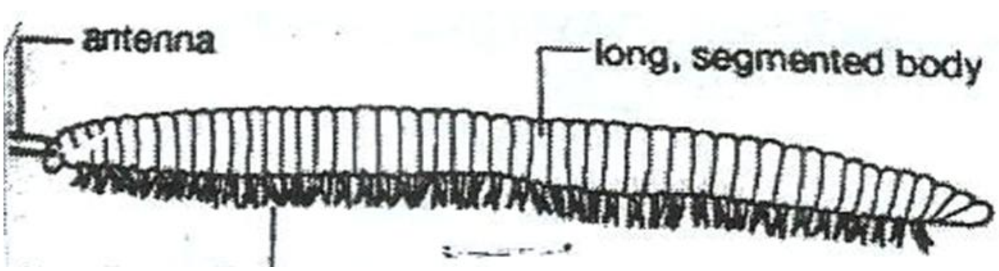


Fig.14

38. Figure 14 is a diagram of a millipede found in the school garden (i) measure the length of the millipede _________ and count the number of segments on the body______________

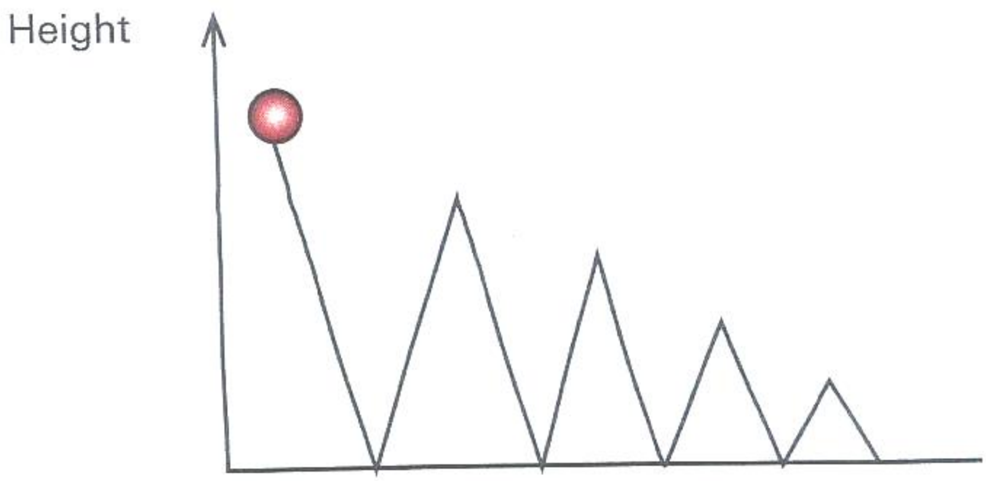


Fig. 15 Graph of height of the ball against time

The graph in figure 15 shows the height of changes in a tennis ball as it is dropped from a certain height above the ground.

39. From figure 15 (i) measure the height of tennis ball and write the answer in meters _________ (ii) count the number of time the ball bounces ______________

(Skill; measurement)

The table below represents the collection for a birthday party of items weight in kilogram

Items	12 cartons of Maggi	A bag of rice	2 bags of sugar	10 cartons of drinks
Weight in kg	30	50	70	78

40. From the table above arrange the items stating with the heaviest items to be carried by the vehicle first to the party___________.

(Skill: Classification)

APPENDIX VII

MARKING SCHEME FOR SPSAT

1. Aquatic/pond………………………………………………………….. 1x1=1mk
2. Fish/frog/tadpole………………………………………………………..2x1=2mks
3. 11.5x5.5=63.25cm^2……………………………………………………..2x1=2mks
4. Group 1: Zebra, mouse, trees………………………. …………………2x1=2mks

   Group 2: Duck, frog, crocodile
5. Group 1: Can stay on land because of their structure trees (roots)/animal (hoofs)

   Group 2: Organisms have webbed feet ……………….. …………………2x2=4mks
6. Chemical or permanent change, Physical or Temporary change…………2x1=2mks

7. Melted into liquid and solidified or turns into solid ………………………..2x1=2mks
8. 2cm …………………………………………………………………….1x1=1mk
9. White substance called ash………………………………………………… 2x1=2mks

10 Arboreal……………………………………………………………. 1x1=1mk

11. They have feather for flight…………………………………………………2x1=2mks
12. Croup 1: Cat, snail (found on land)

    Group 2: Bird, parrot, African eagle, and bat……………………………….3x2=6mks

    (They can fly, have structures to fly)
13. 1.5m

    height…………………………………………………………………….1x1=1mk
14. Open dish, more water has evaporated from the open dish than from the other two containers

    - Surface area of the water in the open dish available for evaporation is greater and so more water evaporates……………………………………………………3x2=6mks
15. In a minute potassium dichromate solution start to spread outside to 50ml level of water…………………………………………………………………………3x2=6mks

    In 3mimutes red colour spreads almost through the water to 100ml level of water.

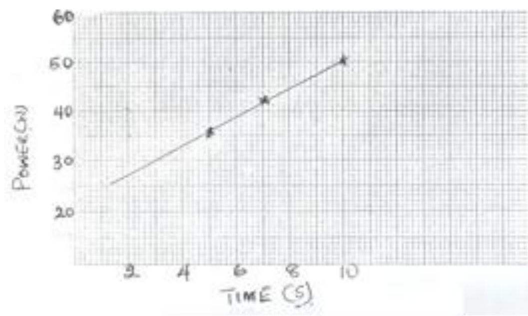
    In 5minutes the red colour spread evenly through the water to 200ml level of water.
16. River and Arboreal/13……………………………………………………….2x1=2mks

17. Heat……………………………………………………………………………..1x1=1mk

18. Gbade/because he is stronger and lift the box in 10s………………………..2x1=2mks

19. 45s…………………………………………………………………………2x1=2mks

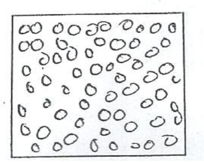
20. A graph of Student on power and time they use to lift a box with a pulley

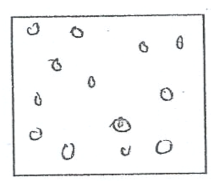


7mks

21. 50 - 35 = 15……………………………………………………1x1=1mk

.





Solid
Regular arrangement of particles

Gases irregular
arrangement of particles …….2x2=4mks

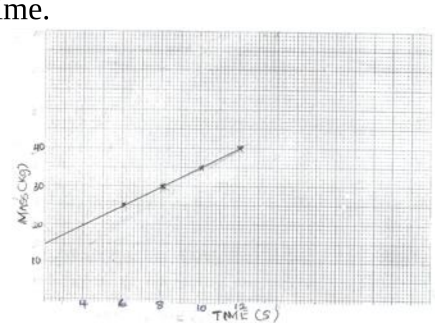
23. Solid – Strong forces between particles
– Particles vibrates and don't move around

Gases – Particles are very weak ………………………………………2x2=4mks
– No forces between particles
– Rapid movement of particles

24. During cooking when the metal pots and pans get very hot, the heat is not transferred to the handle…………………………………………………………….2x1=2mks

25. 0.03m………………………………………………………………2x2=4mks

26. A graph of four students with different mass (Kg) that run up the flight of stairs at different time.



27. Is because he is massive or heavy………………………….1x1=1mk

28. Audu-1st, Ana-2nd, Ladi-3rd, Musa-4th…………………..1x1=1mk

29. Diffusion………………………………………………..1x1=1mk

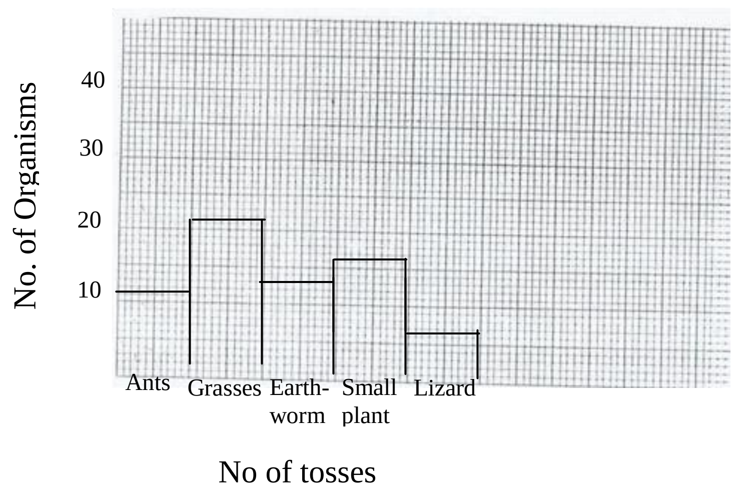
30. Work = Force x distance =J

= 6 x 9 = 54J……………………………………..1x1=1mk

31. 5 →3→2→4……………………………………………………….2x1=2mks

32. IV……………………………………………………………1x1=1mk

33 **A bar chart of organisms captured by students at each toss at the botanical garden**



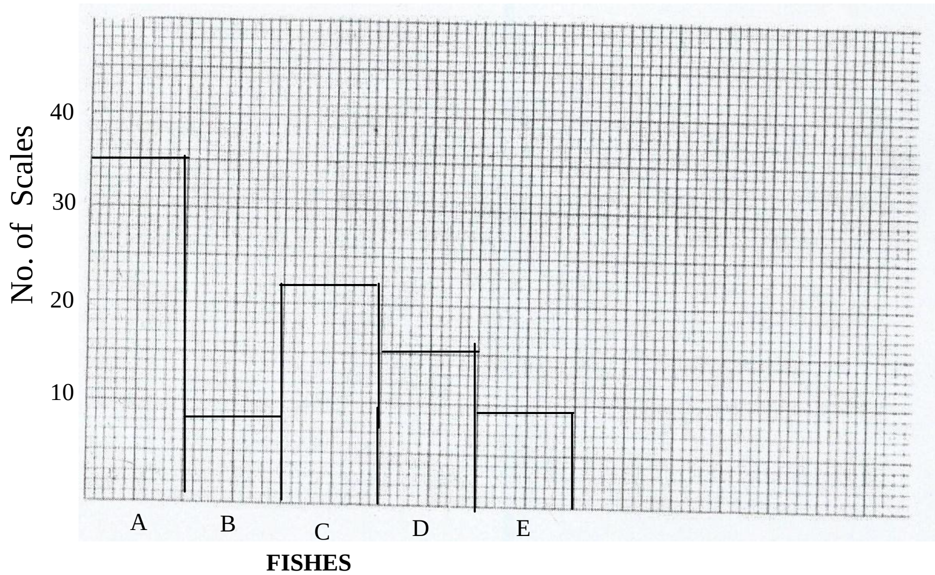
7mks

34. 5-Lizard, 10-ants, 12-eartworms, 15-smallplants, 20-grasses………………2x1=2mks

35. 13cm ………………………………………………………………………1x1=mks

36. B, E, D and A…………………………………………………………..1x1=1mk

A Bar graph showing numbers of scales on fishes



7mks

38. 12.5cm……………………………………………………………………2x1=2mks
39. 0.05m……………………………………………………………………..2x1=2mks
40. 78kg of 10 cartons of drinks.70kg of 2 bags of sugar, 50kg of a bag of rice and 30kg of 12 cartoons of Maggi cubes………………………………………………2x1=2mks

<u>Marking Scheme for graphs:</u>

- choice of graph bar chart……………………………………1mk

- correct axis with labeling……………………………………1mk

- all points correctly plotted…………………………………...3mks

-correct axis but no label………………………………………1mk

-incorrect axis…………………………………………………..0

-reasonable scale………………………………………………<u>1mk</u>

Total…………………………………………………...7mks

The test items consist of 40 questions comprising supplying answers to the questions. Each question carries their respective marks totaling forty (40) marks.

APPENDIX VIII
ITEM ANALYSIS FO MULTIPLE CHOICE QUESTIONS (BSPT): TABLE OF DIFFICULTY AND DISCRIMINATION INDICES.

Item No	Upper (RU)		Lower (RL)	Item difficulty $\frac{Ru + RL}{N} \times 100$	Df %	Item discrimination index $\frac{Ru + RL}{N/2} \times 100$	DS %
1		18	14	0.800	80.0	0.20	20
2		9	11	0.500	50.0	0.20	20
3		20	12	0.800	80.0	0.40	40
4		10	15	0.62	62.5	0.20	20
5	DCRP	20	14	0.85	85.0	0.30	30
6		18	13	0.7750	77.5	0.25	25
7		6	10	0.400	40.0	0.20	20
8		12	5	0.425	42.5	0.35	35
9		17	11	0.700	70.0	0.30	30
10		17	10	0.675	67.5	0.30	30
11		7	4	0.275	27.5	0.15	15
12		19	13	0.800	80	0.30	30
13		15	10	0.625	62.5	0.25	25
14		10	6	0.400	40.0	0.45	45
15		16	7	0.575	57.5	0.45	45
16	MR	6	18	0.450	45.0	0.30	50
17		19	12	0.775	77.5	0.35	35
18		9	11	0.500	50.0	0.20	20
19		19	8	0.675	67.50	0.55	55
20		2	7	0.225	22.5	-0.2	22.5
21		19	8	0.675	67.5	0.55	55
22		9	5	0.350	35.0	0.20	20
23		13	7	0.500	50.0	0.30	30
24		12	4	0.400	40.0	0.40	40
25		17	10	0.675	67.5	0.35	35
26		10	15	0.625	65.5	-0.25	25
27		17	11	0.700	70.0	0.30	30
28		12	4	0.400	40.0	0.40	40
29		16	7	0.575	57.5	0.45	45
30	DCRP	15	18	0.875	87.5	0.25	20
31		15	10	0.625	65.5	0.25	25
32		17	16	0.700	70.0	0.30	30
33		15	10	0.625	62.5	0.25	25
34	DCRP	19	19	0.950	95.0	0.00	0
35		20	12	0.800	80.0	0.40	40
36		12	5	0.425	42.5	0.35	35
37		13	7	0.500	50.0	0.30	30
38		16	7	0.575	67.5	0.45	45
39		19	13	0.800	80.0	0.30	30
40		12	5	0.425	42.5	0.35	35

Key: **M=** Modified and Retained, **DCRP=** Discarded and Replaced

APPENDIX 1X

Reliability OUTPUT FOR Basic science performance test (BSPT)

Correlations

Notes

Output Created		27-Feb-2018 04:13:33
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	40
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each pair of variables are based on all the cases with valid data for that pair.
Syntax		CORRELATIONS /VARIABLES=X Y /PRINT=TWOTAIL NOSIG /MISSING=PAIRWISE.
Resources	Processor Time	00:00:00.047
	Elapsed Time	00:00:00.063

```
[DataSet1]
```

Correlations

		X	Y
X	Pearson Correlation	1	.760**
	Sig. (2-tailed)		.000
	N	40	40
Y	Pearson Correlation	.760**	1
	Sig. (2-tailed)	.000	
	N	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

APPENDIX X

Reliability OUTPUT FOR THE SCIENCE PROCESS SKILLS ACQUISITION INSTRUMENT (SPSAT)

Correlations

Notes

Output Created		27-Feb-2018 04:13:45
Comments		
Input	Active Dataset	DataSet1
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	40
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each pair of variables are based on all the cases with valid data for that pair.
Syntax		CORRELATIONS /VARIABLES=X2 Y2 /PRINT=TWOTAIL NOSIG /MISSING=PAIRWISE.
Resources	Processor Time	00:00:00.219
	Elapsed Time	00:00:00.124

[DataSet1]

Correlations

		X2	Y2
X2	Pearson Correlation	1	.714**
	Sig. (2-tailed)		.000
	N	40	40
Y2	Pearson Correlation	.714**	1
	Sig. (2-tailed)	.000	
	N	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

APPENDIX XI

Department of Science Education,
Faculty of Education,
Ahmadu Bello University,
Zaria.
July, 2016

The Lecturer,
Department of Science Education,
Faculty of Education,
Ahmadu Bello University,
Zaria.

Dear Sir/Ma,

VALIDATION OF RESEARCH INSTRUMENT

The bearer of this letter Christiana Adanyi P16EDSC9059 is a postgraduate student in Science Education, currently researching on "Impact of Process-Based Instruction on Acquisition of Science Skills, Performance and Retention among Basic Science students in Kaduna State. She has developed some instruments for data collection. Copies of which are enclosed herewith.

Kindly go through the instrument and validate them with reference to the following:

a. Are the items clear, precise and free from ambiguity?
b. Will the data generated be appropriate to answer the research question?
c. Are the items comprehensive enough to evaluate the impact of Process-based Instruction (PBI)?
d. What general suggestions can you make to improve the quality of the instrument?
e. Is the language clear and precise for the target audience (JSS Two)?

I would be most grateful if this request would receive your kind attention in spite of your every tight schedule.

Thanks.

Yours faithfully,

Christiana, ADANYI

Department of Science Education,
Faculty of Education,
Ahmadu Bello University,
Zaria.
July, 2016

The Lecturer,
Institute of Education,
Ahmadu Bello University,
Zaria.

Dear Sir/Ma,

VALIDATION OF RESEARCH INSTRUMENT

The bearer of this letter Christiana Adanyi, P16EDSC9059 is a postgraduate student in Science Education, currently researching on "Impact of Process-Based Instruction on Acquisition of Science Skills, Performance and Retention among Basic Science Students in Kaduna State. She has developed some instruments for data collection. Copies of which are enclosed herewith.

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d. What general suggestions can you make to improve the quality of the instrument?
e. Is the language clear and precise for the target audience (JSS Two)?

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Thanks.

Yours faithfully,

Christiana, ADANYI

Department of Science Education,
Faculty of Education,
Ahmadu Bello University,
Zaria.
July, 2016

The Lecturer,
Department of Science Education,
College of Education,
Katsina-Ala,
Benue State,
Zaria.

Dear Sir/Ma,

VALIDATION OF RESARCH INSTRUMENT

The bearer of this letter Christiana Adanyi P16EDSC9059 is a postgraduate student in Science Education, currently researching on "Impact of Process-Based Instruction on Acquisition of Science Skills, Performance and Retention among Basic Science students in Kaduna State. She has developed some instruments for data collection. Copies of which are enclosed herewith.

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a. Are the items clear, precise and free from ambiguity?
b. Will the data generated be appropriate to answer the research question?
c. Are the items comprehensive enough to evaluate the impact of Process-based Instruction (PBI)?
d. What general suggestions can you make to improve the quality of the instrument?
e. Is the language clear and precise for the target audience (JSS Two)?

I would be most grateful if this request would receive your kind attention in spite of your every tight schedule.

Thanks.

Yours faithfully,

Christiana, ADANYI.

APPENDIX X11

DEPARTMENT OF SCIENCE EDUCATION
AHMADU BELLO UNIVERSITY ZARIA

Vice Chancellor: ***Professor Ibrahim Garba*** *B.Sc, M.Sc(ABU) Ph.D DIC (London), FNMGS*
Head of Department: ***Dr. Mamman Musa*** *B.Ed, M.Ed, Ph.D (ABU, FMAN, FANE, DAC.*

Your Ref:
Our Ref: DSE/R/I/Vol.1 ***Date:*** 21/10/15

MINISTRY OF EDUCATION
SCIENCE AND TECHNOLOGY,
ZONAL OFFICE HEADQUARTERS,
ZARIA

Dear Sir/Madam,

PG INTRODUCTORY LETTER TO ACCESS RESEARCH DATA

This is to introduce the bearer, ADANYI CHRISTIANA, with registration number Ph.D/EDU/5626/11-12, as one of our POST GRADUATE students who is conducting a research on the topic:

Impact of Process-Based Instruction on Acquisation of science skills, Retention and Performance among Basic science students Kaduna state, Nigeria.

Please accept our sincere thanks in advance for your kind action.

Yours faithfully,

H. O. D.
Science Education
A. B. U, Zaria

Dr. Mamman Musa
Head, Science Education Department