ASSESSMENT OF THE EFFECTS OF ACTIVITY-BASED AND PROBLEM-SOLVING METHODS ON STUDENTS PERFORMANCE IN BASIC SCIENCE IN JUNIOR SECONDARY SCHOOLS OF KADUNA STATE, NIGERIA

BY

Jummai Habu DAWAKI

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM,
FACULTY OF EDUCATION,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

ASSESSMENT OF THE EFFECTS OF ACTIVITY-BASED AND PROBLEM-SOLVING METHODS ON STUDENTS PERFORMANCE IN BASIC SCIENCE IN JUNIOR SECONDARY SCHOOLS OF KADUNA STATE, NIGERIA

BY

Jummai Habu DAWAKI
BSc. (Ed) Integrated Science, M.Ed. Curriculum & Instruction (ABU)
P14EDFC9003

**A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PATIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DOCTOR OF PHILOSOPHY DEGREE IN EDUCATION (CURRICULUM AND INSTRUCTION) IN THE DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM, **

FACULTY OF EDUCATION,
AHMADU BELLO UNIVERSITY,
ZARIA-NIGERIA

NOVEMBER, 2019

DECLARATION

I declare that the work in this Thesis entitled ASSESSMENT OF THE EFFECTS OF ACTIVITY-BASED AND PROBLEM-SOLVING METHODS ON STUDENTS' PERFORMANCE IN BASIC SCIENCE IN JUNIOR SECONDARY SCHOOLS OF KADUNA STATE, NIGERIA has been performed by me in the Department of Educational Foundations and Curriculum. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this Thesis was previously presented for another degree or diploma at this or any other Institution.

Dawaki
Jummai Habu Dawaki

30TH NOV 2019
Date

CERTIFICATION

This thesis entitled "**ASSESSMENT OF THE EFFECTS OF ACTIVITY-BASED AND PROBLEM–SOLVING METHODS ON STUDENTS' PERFORMANCE IN BASIC SCIENCE IN JUNIOR SECONDARY SCHOOLS OF KADUNA STATE, NIGERIA"** by Jummai Habu DAWAKI (Mrs) meets the regulations governing the award of Doctor of Philosophy degree in Education (Curriculum and Instruction) of Ahmadu Bello University, and approved for its contribution to knowledge and literary presentation.

Prof. H.O. Yusuf — Date: 30/4/19
Chairman, Supervisory Committee

Prof. A. Guga — Date: 30/4/19
Member, Supervisory Committee

Dr. A. A. Dada — Date: 13/12/19
Member, Supervisory Committee

Dr. M.I. Harbau — Date: 07/02/2020
Head of Department
Educational Foundations and Curriculum

10 FEB 2020

Prof. S. Abdullahi — Date
Dean, Postgraduate School

DEDICATION

This work is dedicated to my husband, Rev. Habu Dawaki, my sister, Ladi P. Dogo and my aunt, Lydia Mamman Magaji.

ACKNOWLEDGEMENTS

I would like to appreciate the giver of life, the lover of my soul, my destiny changer the one that lifted me from the miry clay and set my feet on solid rock to stand, my LORD and Saviour Jesus Christ who gave me the opportunity to complete this work all glory and honour be ascribed to Him. I would like to express my sincere and heartfelt appreciation for the motivation, encouragement, guidance corrections and support given to me by my supervisors Prof. H. O. Yusuf, Prof. A. Guga and Dr. A. A. Dada. Many thanks to my lecturers and members of defence panel, Prof. R. B. Bako, Dr. M.R. Bawa, Dr. S. U. El-Yakub, Dr. (Mrs) W. A. Ehinmidu, Dr H.Y. Audi, Dr. A. F. Mohammed, and Dr. A. M. Aminu for their constructive criticism. Thank you Prof. Bawa for opening my eyes to understand clearly the two side of the coin of the study 'effect of Activity-based and Problem solving methods.'

My special thanks to my husband for his encouragement and unwavering support, trust and motivation and above all, your love makes me pass through challenges of this work easily. Special thanks to my children (biological) Ndola, Minkir, Kuna, Hamagham and Yarang, (non biological) Isaac, Joseph, Mature, Grace, Jemimah, Innocent, Naima, Comfort, Gift, Eunice, Ibrahim for their care, support, love and understanding. Thanks to my sister and her husband Dr and Mrs. Dogo for sharing their resources with me. Special thanks to my siblings and their spouses Mr. and Mrs. Yohanna Kamuzaza, Mr. and Mrs. Bulus Jafun, Brigadier General and Mrs. Caleb Dalhat, Mr. and Mrs. Abdul Jafun, Mr. and Mrs. Addo Jafun. Mr. and Mrs. Aji Jafun, Rev. and Mrs. Samaila Jafun, Mr. and Mrs. Ibrahim Jafun, Mr. and Mrs. Assah, Mr.and Mrs. Bashir Garba.

I also appreciate my parents in the Lord, Bishop Fred and Funbi Addo. My biological mother Nana Hauwa, and Nana Hajara (my mother-in-law) my uncles and their wives Dr and Mrs. Magaji, Dr and Mrs Sulai for their prayers encouragement and support. Uncle

Jasper and Yakubu deserve a special thanks. My classmates Dr. Emmanuel Alasoluyi, Dr. Tukur, Dr Jummai, Saidu, Atiku, Caroline, and Bello for their relationship that I enjoyed. Mr and Mrs Midat thanks for your care, love and support, you made me feel at home whenever I am with you. Reverend and Dr Mrs Akamu, Pastor and Mrs. Laiki, Pastor and Mrs. Kenedy, Pastor and Mrs. Magaji, Pastor Amma Mohammed. I really appreciate the encouragement, help and support. My appreciation goes to my colleagues at College of Education Billiri, Mrs. Chomo, Mrs. Fatosin, Mr. Ibrahim, Mr Hassan, Mrs Dukku Mr Kalabons and Prof. Ashron. Dr. M. Sulai, of Gombe State University, thanks for being there to help and encourage me. My appreciation goes to Pastor Daniel La'aki for his immense contribution in making sure the work is error free, may God enlarge your knowledge. A special thanks to my friend and her husband Mr. and Mrs. Joseph Ogoluwa and Mrs Tina Jarumai, Thank you for all the support.

TABLE OF CONTENTS

Cover Page		i
Title Page		ii
Declaration		iii
Certification		iv
Dedication		v
Acknowledgements		vi
Table Of Contents		viii
List Of Tables		xi
Operationl Definition fo Terms		xiii
List of Abbreviations		xiv
List of Appendices		xvi
Abstract		xvii
CHAPTER ONE: INTRODUCTION		
1.1	Background to the Study	1
1.2	Statement of the Problem	6
1.3	Objectives of the Study	9
1.4	Research Questions	9
1.5	Hypotheses	10
1.6	Significance of the Study	11
1.7	Scope of the Study	15
CHAPTER TWO: REVIEW OF RELATED LITERATURE		
2.1	Introduction	17
2.2	Conceptual Framework	17
2.2.1	Concept of Basic Science	18

2.2.2 Concept of Activity-Based Method 20
2.2.3 Concept of Problem-Solving Method 22
2.2.4 Concept of Academic Performance 24
2.3 Theoretical Framework 25
2.3.1 Theory of Progressivism 26
2.3.2 Theory of Constructivism 31
2.4 Nature of Basic Science 36
2.4.1 The New Basic Science and Technology Curriculum 39
2.4.2 Objectives of the Basic Science Curriculum 43
2.5 Teaching Methods in Basic Science 46
2.5.1 Teacher-Centred Approach 47
2.5.2 Demonstration Method 56
2.6 Student Centred Approach 59
2.6.1 Project Method 61
2.6.2 Discovery/Inquiry Method 65
2.6.3 Activity-Based Method 74
2.6.4 Problem -Solving Method (PSM) 80
2.7 Empirical Studies 92
2.8 Summary 110

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction 112
3.2 Research Design 112
3.3 Population of the Study 113
3.4 Sample and Sampling Techniques 115
3.4.1 Determination of Sample Homogeneity 116

3.5	Instrumentation	116
3.5.1	Table of Specification	117
3.5.2	Validity of the Instrument	118
3.5.3	Pilot Study	118
3.5.4	Reliability of the Instrument	119
3.6	Procedure for Data Collection	119
3.7	Treatment Plan	120
3.7.1	The Treatment Plan for Activity-Based Method	120
3.7.2	Treatment Plan for Problem–Solving Method Experimental Group 2	121
3.7.3	Control of Extraneous Variables	123
3.8	Method of Data Analysis	124

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1	Introduction	125
4.2	Description of Study Variables	125
4.3	Response to Research Questions	126
4.4	Hypotheses Testing	133
4.5	Summary of Findings	140
4.6	Discussion of Findings	141

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1	Summary	147
5.2	Conclusion	149
5.3	Recommendations	150
5.4	Contributions to Knowledge	151
5.5	Suggestions for Further Studies	152
References		153
Appendices		163

LIST OF TABLES

Table		Page
1:	Enrolment in Public Junior Secondary Schools by level, Gender and LGA	114
2:	Kaduna State, Nigeria Senatorial and Educational Zones	115
3:	Sample Distribution	116
4:	Table of Specification	117
5:	Treatment Plan	123
6:	Group of Respondents	125
7:	Pre-test and post-test performance of students taught using Activity-based and method	126
8:	Pre-test and Post-test performance of students taught using Problem Solving	127
9:	Performance of students taught Basic Science using Activity-Based and Problem-Solving methods	128
10	Performance of students taught Basic Science using Activity-Based and Conventional Method	129
11:	Effect of Problem-Solving and Conventional Method on the academic performance of students	130
12:	Performance of students taught Kinetic Theory of matter using Activity-Based, Problem-Solving Methods and Conventional Method	131
13	Performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Methods	132
14	Summary of pre-test and post-test paired sample t-test on the performance of students taught Basic Science using Activity-Based Method	133
15	Summary of pre-test and post-test paired sample t-test on the performance of students taught Basic Science using Problem–Solving Method	134
16	Summary of independent sample t-test on the performance of students taught Basic Science using Activity-Based and those taught using Problem Solving	135

17:	Summary of independent sample t-test on the performance of students taught Basic Science using Problem–Solving Method and those taught using Conventional Method	136
18	Summary of independent sample t-test on the performance of students taught Basic Science using Activity-Based Method and those taught using Conventional Method	137
19:	Summary of Analysis of Variance (ANOVA) on the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method	138
20	Summary of Scheffe Multiple Comparison Test on the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method	144
21:	Summary of Analysis of Variance (ANOVA) on the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method	145

OPERATIONAL DEFINITION OF TERMS

Assessment -Opinion or judgement about something that has been thought very carefully

Effects A change which is a result or consequence of an action.

Activity-Based - As instructional method that engages students in the learning process which allows students to do meaningful learning activities by themselves.

Problem Solving Method –Ability to define problems and generate and implement solutions through a step by step strategy that allows the learners to construct their own knowledge and the teacher serves as a facilitator.

Basic Science - Is one of the foundational Science subject being taught at Junior Secondary School level.

Students Performance - Learning outcomes of students, this includes knowledge skills and ideas acquired and obtained through their course of study.

JSS -Junior Secondary schools. A place which provides education to students between the ages of 11-14 after

LIST OF ABBREVIATIONS

3H's	-	Hand, Head, and Heart
AAAS	-	American Association for Advancement of Science
ABM	-	Activity-Based Method
BEC	-	Basic Education Curriculum
DAE	-	Drug Abuse Education
DTE	-	District Teacher Educator
EE	-	Environmental Education
ERC	-	Educational Research Centre
FRN	-	Federal Republic of Nigeria
HLPC	-	High–Level Policy Committee on Curriculum Development
ICT	-	Information and Communication Technology
JSCE	-	Junior Secondary Certificate Examination
JSS	-	Junior Secondary School
MDGs	-	Millennium Development Goals
MLA	-	Mastery Learning Approach
NCCE	-	National Commission for Colleges of Education
NCE	-	National Council on Education
NCE	-	Nigeria Certificate in Education
NCEMSS	-	Nigeria Certificate in Education Minimum Standard for Sciences
NECO	-	National Examination Council
NEEDS	-	National Economic Empowerment and Development Strategies
NERDC	-	Nigerian Educational Research and Development Council
NOUN	-	National Open University of Nigeria
NPE	-	National Policy on Education

NTI	-	National Teachers' Institute
PFLE	-	Population and Family Life Education
PSM	-	Problem -Solving Method
SPSAT	-	Science Process Skill Acquisition Test
SSS	-	Senior Secondary School
STAN	-	Science Teachers Association of Nigeria
STI	-	Sexually Transmitted Infection
UBE	-	Universal Basic Education
UBEC	-	Universal Basic Education Commission
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
WAEC	-	West African Examination Council
WASCE	-	West African School Certificate Examination

LIST OF APPENDICES

Appendix 1: Time table of Lesson Plan 175

Appendix 2: Topics to be covered on weekly basis 176

Appendix 3: Lesson Plan 177

Appendix 4: Basic Science Multiple Choice Questions 248

Appendix 5: Performance of Junior Secondary School Students in Kaduna State, Nigeria 253

Appendix 6: Training Manual for Research Assistant 254

Appendix 7: Proof of editing 255

Appendix 8: Letter of Introduction 256

Appendix 9: Validation Form 257`12

ABSTRACT

The study assessed the effects of Activity-Based and Problem-Solving methods on students' academic performance in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria. The study was carried out with Seven objectives: determine the Pre-test and Post-test performances of students taught Basic Science using Activity-Based and those taught using Problem-solving method; determine the performance of students taught Basic Science using Activity-Based and Conventional method; examine the effect of Problem-Solving and Conventional method on the performance of students in Basic Science in Junior Secondary schools in Kaduna State, Nigeria amongst others. The study adopted quasi experimental research design. The target population of the study was made up of 119, 238 Junior Secondary 2 Students in Kaduna State, of Nigeria. The sample size for this study consisted of 3 intact classes of 218 Junior Secondary School students. Purposive sampling techniques was used to choose the sample size. The instrument used for data collection in the study was adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination, 2010-2014. The validated instrument was pilot tested and a reliability coefficient of 0.79 was obtained. The statistical tools used for data analysis included descriptive statistics mainly mean and standard deviation which was used to respond to the research questions raised in the study. The t-test was used to test hypotheses 1, 2, 3, 4 and 5, and two-way Analysis of Variance (ANOVA) was used to test hypotheses 6 and 7. The hypotheses formulated for this study were retained or rejected at 0.05 level of significance. The study established among others that, Students taught basic science using activity-based method had a higher mean score and performed significantly better in the post-test (P-value .002 <0.05), Students taught basic science using Problem-Solving method had a higher mean score and performed significantly better in the post-test (P-value .002 <0.05). The post-test mean performance of students taught Basic Science using Activity-Based method is slightly higher than the post-test mean performance of students taught Basic Science using Problem-Solving method (p-value .004 O.05) Students taught basic science using activity-based method had a higher mean score and performed significantly better than their counterparts taught using conventional method (P-value .0030.05). It was concluded that the activity-based method was more effective to teach Basic Science as the method enabled students to achieve higher mean score and performed better than their counterparts taught using both problem-solving and conventional methods. Recommendations were that; Teachers and school Managers, should provide and encourage the use of both Activity-based and Problem-solving methods as they both have been proved to be effective empirically in enhancing students' academic performance; Basic science teachers should be encouraged to use Activity based method because of its positive effect in enhancing students' academic performance; and Teachers should be encouraged to make their classrooms active learning classrooms by ensuring that their students are exposed to meaningful Problem-solving activities that will make them active learners not passive listeners or receivers.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

The Junior Secondary School education is the education children receive immediately after primary education and before Senior Secondary School education. The objectives of Junior Secondary Education are to: provide the child with diverse basic knowledge and skills for entrepreneurship and educational advancement; develop patriotic young people equipped to contribute to social development and the performance of their civic responsibilities; inculcate values and raise morally upright individuals capable of independent thinking, and who appreciate the dignity of labour; and inspire national consciousness and harmonious co-existence irrespective of differences in endowment, religion, colour, ethnic and socio-economic background. At the Junior Secondary Schools the subjects taught are grouped into core and electives and one of the core subjects the students are introduced to is the Basic Science. The Basic Science forms the foundation for Science subjects expected to be offered at the Senior Secondary School level like Biology, Chemistry, and Physics. In addition, Basic Science is a prerequisite for offering Science at the senior secondary school and subsequently at the Tertiary level (Federal Republic of Nigeria -FRN, 2013).

Basic Science comes from the two words Basic and Science. Basic is simply fundamental or foundation and Science is defined by Bajah (1983) in Shafiu (2014), as a process of description and classification of all forms and processes of life and matter. Basic Science therefore is an introductory course to the study of the Sciences in Senior Secondary School. United Nations Educational, Scientific and Cultural Organization (UNESCO) cited by Akani (2016), explains Basic Science as a science in which concepts and principles are presented so as to express the fundamental unity of scientific thought and avoid premature or undue stress on the distinctions between the various scientific fields,

and offers the basic training in scientific skills required for survival, sustainable development and societal transformation.

Basic science is considered paramount and necessary for all students as the present modern civilization is a Scientific civilization where the modern society is completely drawn by the Scientific environment where Science has become integral part of our lives and living in many ways: health, agriculture, nutrition, energy production, transportation and education just to mention a few. No wonder the Federal Republic of Nigeria in the National Policy on Education (FRN, 2013), stated that Science Education shall emphasize the teaching and learning of science process and principles, so that it can achieve the overall objectives of Basic Science curriculum which are to enable the learners: develop interest in Science and technology; acquire basic knowledge and skills in science and technology; take advantage of numerous career opportunity offered by Science and Technology, and become prepared for further studies in Science and Technology. For these objectives to be achieved what comes to mind is the need for the use of effective teaching methods.

Teaching is an interactive process through which knowledge and skills are shared with students with a view of improving understanding and ability to bring about desirable learning. Thus, teacher initiates the communication and interactions through proper instructional process and methods. The Federal Republic of Nigeria (FRN, 2013), in the National Policy on Education emphasized the adequate choice of teaching method and strategy by teachers so as to solve educational problem and enhance students learning.

There are varieties of teaching methods depending on the situation, learner's level as well as the subject matter. The teaching methods can be teacher centred, learner-centred or a mixed approach. In this approach, the teacher is the most active person in the classroom and does most of the talking (Sawant & Rizvi, 2015). One of the methods of teacher

centred used among others is the Conventional (Talk and Chalk) method which is said to be used largely by many Science Teachers (Atadoga & Onaolapo, 2008 in Dawaki, 2014). About 80% of scientific information or principles that students receive from their teachers came through this method as the educational system puts so much premium on paper qualifications, Science Teachers embraced the conventional lecture method as it helps in coverage of School syllabus as information is more easily disseminated and allow easy handling of large classes.

The Conventional method involves verbal presentation of ideas, concepts, generalization and facts by the teacher who does most of the activities in form of talking while students are either passive listeners or slightly involved. The method is said to be ineffective in teaching Basic Science as it does not promote active learning of science through 'minds on, hands on' more so, the Conventional lecture method of chalk and talk that is largely used by most teachers are challenged for their inability to foster critical thinking, holistic learning environment among learners and does not consider individual differences existing in each class as their abilities vary considerably and thereby not meeting the different needs of the students (Gadzama, 2012; Shafiu, 2014; Maheshwari, 2017). John (2014), pointed out that the learner should be capable of learning rather than the learner being made a dumping ground for every information the teacher intends to pass across which makes learning uninspiring. Kenedy (2017), stated that in most advanced countries gone are the days where the teacher stands at the front of the classroom before a blackboard leading a class as a sole conveyer of information. Rather the students are involved in the learning of science process skills such as observation, measuring, inferring, interpreting data, formulating questions/hypotheses in addition to cultivating scientific attitude that the students are expected to display while working such as

curiosity, open-mindedness, empiricism which is finding out things by doing and parsimony.

Thus, the Researcher introduced both Activity-Based and Problem-Solving methods of teaching and learning in that conventional method does not consider individual differences existing in each class as their abilities vary considerably and thereby not able to meet the different needs of the students. The call for the Student-Centred approach which according to (NTI, 2012), appealed to the needs and interest of the learner, thereby motivating continuous learning. The focus is on learner, encourage participation and interaction throughout the lesson period, gender sensitive, collaborative as well as encourage critical thinking. The student-centred method therefore is said to be the current thinking about teaching that is active, constructive in which the teacher assumes the role of a guide by putting the learner at the centre of the learning process, guiding the learner and promoting learner development.

Though both methods Activity-Based and Problem-Solving are related being Child-Centred as seen above but are distinct in the following ways: Problem-solving method gives freedom to students to look at the problem based on their perspectives thereby leading to various solutions. But Activity-based method uses prescribed routes to achieve set objectives; Problem-solving method, both the teacher and students set the objectives. Under activity-based methods, the teacher sets the objectives for the lesson and the students carry it through with activities through instructions; The problem-solving method starts with a problematic situation, which the students will brainstorm and explore the various ways to solve the problem through gathering of relevant information through observation, investigation and testing while in Activity based method students work on given topic with their mind and hands on activities to be carried out in a step by step procedure to reach conclusion; In problem-solving students take responsibility for

their learning, as students learn by working on problems, new knowledge is eminent in this method while Activity–based is following how Scientist work using the Science Processes; Problem-solving knowledge is used in the context in which it can be applied or use in real-life problems whereas Activity based might not be looked in that context; Problem-solving method involves the identification of a problem for students to solve with minimum guidance from the teacher. It is a type of teaching and learning where students work with classmates to solve complex and authentic problems that help develop content, Problem solving exposes students to the task of reasoning, self-assessment of skills, reflective ability, it helps students to task their thinking abilities in order to find solutions to problem. On the other hand Activity-Based, involves learning by doing, through activities and experience. According to Kochhar (2012) is the first and most natural form of learning. Active learning appeals to many senses involved in the learning process just as Confucious in Dawaki (2014), stated that when you hear you forget, when you see you remember, but when you are involved you understand. Activity-Based method is defined as a method whereby the learners are actively involved in the learning process rather than passively absorbing information and copying notes. Festus (2013), opined that Activity-Based learning has to do with reading, writing, discussion, practical activities, encourage critical thinking, communication, analysis and synthesis. The teacher only acts as a facilitator and learners are at the centre of the learning process by their high involvement in practical activities and discussion.

The sequence of Problem–solving and Activity-Based methods, where the learner uses the prior experience and obtain knowledge through the activities carried out under the guidance of the teacher, might result in meaningful learning that might increase performance. That is why the researcher seeks to find out whether activity-based and problem-solving method might have a positive impact over the Conventional lecture

method on students' performance in Basic Science. Since studies by various researchers such as Abdullahi (2013), and Ezeaghasi (2014) revealed that Conventional lecture method does not promote effective Science learning and as a result it might lead to poor performance in the various Science subjects. The poor performance of students in junior secondary schools in Basic science in Kaduna State, Nigeria, as stated by Ministry of Education Resource Centre (Appendix 3), for instance, the percentage pass at credit level in the year 2010, 2011, 2012, 2013 and 2014 are 29%, 42%, 34%, 46% and 37% respectively. In the light of this background, the researcher seeks to find out the effects of Activity-Based and Problem-Solving methods on students' performance in Basic Science in junior secondary schools in Kaduna State, Nigeria.

1.2 Statement of the Problem

Appropriate teaching method used by teachers at a given time, age and need of the students, hold a successful key for conducive teaching and learning situation, in the classroom, whenever a teacher misses this the tendency of misleading the students in the course of lesson delivery is possible. There has been an outcry, from the general public, the media, the civic society and education stakeholders concerning the decline and poor performance of Basic science students, one of the public outcry was recently expressed by Kaduna State Ministry of Education. This was because of the poor percentage pass at credit level in the year 2010, 2011, 2012, 2013 and 2014 as 29%, 42%, 34%, 46% and 37% respectively (Ministry of Education Resource Centre, 2016).

It should be noted that the nature of Science is far more than an understanding of Science content but rather development of a range of process skills and values to enable students to solve problems. This is due to the challenges presently facing the teaching of Science as the teachers employ teaching method that is Teacher-Centred, where the students are

required to memorize more in a passive way. It is sad observing that most Science Students after completion of their secondary school could not solve simple problems of scientific processes such as simple measurement involving fundamental quantities and their units, inability to read simple instrument such as thermometer as observed by the researcher while teaching science education at Nigeria Certificate in Education level.

The study is of the opinion that the challenge facing the teaching of Basic Science subject is the poor teaching methodology employed by teachers, a visit to some of the schools have shown that Basic Science Teachers are still a custom with the Conventional method of teaching. It is in view of this, the study is motivated to explore other teaching methods such as Activity-Based and Problem-Solving methods that could enhanced the performance of Basic Science Students.

Furthermore, majority of students in secondary schools are unable to make connections between what they are learning and how that knowledge could be used. This could be due to extreme emphasis on content coverage using the Conventional Lecture method comprising of "talk and chalk" method neglecting the Activity method and Problem-Solving which might enhance teaching and learning. This negligence and 'shy-away' attitude from activity-oriented and problem-solving method of teaching might be an abstraction which makes the students less active and more prone to rote memorization as observed by Obiekwe (2008), in Nwagbo and Chukelu (2011).

Bloom taxonomy as explained in Yusuf (2012), asserted that teaching and learning should essentially be in respect of knowledge and understanding possessed by the students, attitude, interest and changes in behaviour, developed thinking, feeling and belief and also skills acquired. Since the entire learning outcome to be assessed usually fall within cognitive, affective and psychomotor domains of behaviour as such teaching and learning should cover the three domains in teaching of Basic Science. This is to

inculcate understanding of scientific knowledge, scientific attitude that enhances interest as well as motivate the students which in turn may lead to enhancing academic performance. However, what is obviously obtained is basically the cognitive domain leaving the psychomotor that is concerned with manipulative skills which are to be used in manipulating scientific equipment and carried out some activities to solve problems that could stamp in learning.

Basic Science being the foundational science that is taught at the Junior Secondary Schools level served as the prerequisite for Senior Secondary School subjects such as Biology, Chemistry and Physics. It has been argued that Junior Secondary Students must be well grounded in Basic Science for them to be able to study the core Science Subjects (Biology, Chemistry, Physics) (Olarewaju in Dawaki, 2014). Teaching methods affects the response of students and determine whether they are interested, motivated and involved in a lesson in such a way as to engage in learning. As such the teaching method must be effective to prepare them for the task ahead. However, report from Educational Resource Centre on the performance of students in Basic Science at credit level and above in Kaduna State, Nigeria is less than 40%, from 2010-2014 (Appendix 3). The study therefore aimed at ascertaining whether the performance of the students in Basic Science can be improved when Activity-Based and Problem-Solving methods are used in teaching the Junior Secondary Class Two Basic Science. Thus this study is aimed at Accessing the effects of Activity-Based and Problem-Solving methods on students' academic performance in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria.

1.3 Objectives of the Study

This study was designed to:

1. determine the Pre-test and Post-test performances of students taught Basic Science using Activity-Based method in Junior Secondary Schools in Kaduna State, Nigeria;
2. determine the Pre-test and Post-test performances of students taught Basic Science using Problem-Solving method in Junior Secondary Schools in Kaduna State, Nigeria;
3. Investigate the effect of Activity-Based and Problem-Solving methods on students' performance in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria.
4. determine the performance of students taught Basic Science using Activity-Based and Conventional method in Junior Secondary Schools in Kaduna State, Nigeria;
5. examine the effect of Problem-Solving and Conventional method on the performance of students in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria;
6. ascertain the performance of students when taught Kinetic Theory of Matter using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria; and
7. determine the difference in the performance of students when taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria.

1.4 Research Questions

This research provided answers to the following questions:

1. What is the Pre-test and Post-test performance of students taught Basic Science using Activity-Based method in Junior Secondary Schools in Kaduna State, Nigeria?

2. What is the Pre-test and Post-test performance of students taught Basic Science using Problem-Solving method in Junior Secondary Schools in Kaduna State, Nigeria?
3. What is the effect of Activity-Based and Problem-Solving methods on the academic performance of students in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria?
4. What is the performance of students taught Basic Science using Activity-Based and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria?
5. What is the effect of Problem-Solving and Conventional Method on the academic performance of students in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria?
6. What differences exist in the performance of students taught Kinetic Theory of matter using Activity-Based and Problem-Solving Methods and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria?
7. What differences exist in the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria?

1.5 Hypotheses

The following null hypotheses were formulated for the study and were tested at 0.05 significance level:

$H0_1$: There is no significant difference between the Pre-test and Post-test of Students taught Basic Science using Activity-Based method in Junior Secondary Schools in Kaduna State, Nigeria.

$H0_2$: There is no significant difference between the Pre-test and Post-test of Students taught Basic Science using Problem-Solving method in Junior Secondary Schools in Kaduna State, Nigeria.

$H0_3$: There is no significant difference between the performance of students taught Basic Science using Activity-Based and those taught using Problem-Solving in Junior Secondary Schools in Kaduna State, Nigeria.

$H0_4$: There is no significant difference between the performance of students taught Basic Science using Activity-Based Method and those taught using Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria.

$H0_5$: There is no significant difference between the performance of students taught Basic Science using Problem–Solving Method and those taught using Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria.

$H0_6$: There is no significant difference in the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria.

$H0_7$: There is no significant difference in the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Methods in Junior Secondary Schools in Kaduna State, Nigeria.

1.6 Significance of the Study

The findings from this study would be relevant to the following stakeholders: teachers of science subjects, Authors of books, Educational Planners and Curriculum developers, Ministry of Education Officials, Examination bodies, the Parents, Students and future researchers.

The study would help teachers to employ the appropriate teaching strategies in their classrooms, which involves group learning and cooperation among students, and positive interaction which are almost lacking in the Conventional approach of teaching that is part and parcel of Activity-Based and Problem-solving. Teachers will benefit in the sense that the Activities design for the teacher to facilitate both activity-based and problem –solving will enable the teacher to acquire process skills which makes both teaching Concepts and application easier.

The findings from this study is expected to provide bases for helping Educational planners and Curriculum designers and developers in Nigeria in reviewing Curriculum with particular reference to Activity-Based and Problem-Solving in the schools to improve teaching and learning in Junior Secondary School. The National Policy on Education (2013) which emphasizes the acquisition of appropriate skills, abilities and competence both mental and physical for the individual to live and contribute to the development of the society. Thus, the study will help the curriculum developers as to suggest relevant teaching methods for teaching different topics of the curriculum.

Professional bodies like the Nigerian Educational Research and Development Council (NERDC) and Science Teachers Association of Nigeria (STAN) shall also benefit in terms of developing innovative Science teaching packages. This result can equally be used to improve teaching and learning so as to improve better understanding and consequently improve students' performance.

The Government would also benefit from this research work because the findings shall serve as a guide to Government policy formulation and implementation on school materials needed for instruction. The School Administrators would be opportune through this research to properly address teaching and learning difficulties in Science and other related field by engaging in thorough supervision and ensuring that teaching using

appropriate pedagogy is used by the teachers. The study will be a source of literature to future researchers who are interested in investigating teaching Methods.

The students would benefit from the study by acquiring both knowledge and the process skills acquired from the Activity-Based and Problem –Solving methods. This will equip them in problem solving of scientific nature and enhance their academic performance. It will also assist text books writers in fitting activities as well as problem-solving methods of acquiring both skills and Knowledge.

It will afford other future researchers to look at areas not covered by this study, so as to bring different teaching methods in the teaching of Basic Science, so as to bring about expected performance in the subjects thereby enhancing the standard of education in Kaduna in particular and in Nigeria in general. This will also help to gather information relating to this present study to further develop and add knowledge to the existing literatures. Basic Science teachers who are the key partners and instrumental for the implementation of Basic Science curriculum will increase their skills of teaching, and always use the best teaching method they are expected to use at any given topic, this will ultimately bring about a tremendous improvement in the learning experience of the student, thereby greatly enhancing the general performance of students in Basic Science. It will equally be important to Basic Science teacher, it will motivate their dedication to work, it will arose their interest in teaching of the subjects thereby bring about performance in the life of students, it will equally help them to use different teaching method.

The findings of this study will hopefully be beneficial to the inspectorate unit of ministry of education, it will placed a burden and, the modalities on the supervision of these teachers on regular basis so as to ensure that teachers not only do their job of teaching and knowledge impartation but they always use the right teaching method at any given

time. Parent Teacher Association who are equally stakeholders will equally have adequate knowledge of activity based and problem solving method used in teaching their children it will equally afford them the opportunity more ways of supporting their schools either with more teaching resources, human resources, hiring of part-time teachers to teach their children.

The school administrators who are the heads of these schools and the first inspectorate to these teachers will equally benefit from the study. The findings of this study will enable the school administrators to have adequate knowledge of activity based and problem solving method used in the conduct of teaching and learning, it will equally help them to derive and ensure that teachers should use activity based and problem solving method given each topic, age of the students, the kind of instructional material at the disposal of the teacher. It will equally help the school administrators to have adequate knowledge of teachers who have required qualification in Basic Science and to place these teachers where they are expected to teach. Non-governmental organizations will greatly benefits from this study, it will enable them to have reliable information concerning different teaching method can be appropriate in the course of teaching and learning, this will enable them to provide support in terms of providing more funds to these junior secondary schools in Kaduna state.

The researcher work will help Basic Science studies teachers with knowledge and application procedures for AB and PS, also the remedies to some possible application problems that might be encountered by the teachers.

The research work will bring to the limelight the advantages of using NERDC AB & PS in Basic Science classroom. Also, the research work will serve as a wake-up call to teacher training institutions nationwide on the need to put more emphasis on AB & PS method during teacher training programme especially its practical applications for better

results. The research work will further contribute to the development of knowledge and scholarship in the field of education. To the researcher who would want to explore on the study, the research work would serve as a source of inspiration and factual information.

The research work will be useful to educational planners in the sense that it will provide the information on how the inquiry method is planned, and will assist curriculum implementers that is school teachers with application procedures for inquiry method. The study also serves as a call to colleges of education and universities to train the teachers on the advantages of using inquiry method in the teaching and learning process. The study as a matter of fact, will be of help particularly in the reorganization and restructuring the methodology, teaching materials as well as the process of evaluation in Basic Science.

1.7 Scope of the Study

The study assessed the effects of Activity-Based method, Conventional method and Problem-Solving method on students' performance in Basic Science in junior secondary schools in Kaduna State, Nigeria. The study is limited to three teaching methods: Activity-Based, Problem-Solving and Conventional method in teaching Basic Science. The students involved for the study were Junior Secondary Schools Two (JS2). The Junior Secondary Class Two was chosen because unlike JS3 who would be writing the junior secondary certificate examinations (JSCE) and unlike JSI that are just entering into the school, the JS2 students are more settled in school. This research was conducted using three public schools sampled from three out of the twelve education zones in Kaduna State, Nigeria. The instrument used was an adopted test of multiple choice for Basic Science Junior Certificate Examination from 2010 to 2014. The lesson plan covered nine (9) weeks and the Basic Science teachers served as research assistants. The study investigated the following variables: determine the Pre-test and Post-test performances of students taught Basic Science using Activity-Based, and those taught using Problem-

solving method; determine the performance of students taught Basic Science using Activity-Based and Conventional; examine the effect of Problem-Solving and Conventional; Investigate the effect of Activity-Based and Problem-Solving; ascertain the performance of students when taught Kinetic Theory of Matter using Activity-Based, Problem-Solving and Conventional; and determine the difference in the performance of students when taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter present the literature review. The chapter began with the following headings: Conceptual framework, Concept of Basic Science, Concept of Activity-Based Method, Concept of Problem-Solving Method, Concept of Performance, Theoretical framework, Theory of Progressivism, How progressivism is related to the study, Theory of Constructivism, Nature of Basic Science, The New Basic Science and Technology Curriculum, Objectives of Basic Science Curriculum, Teaching methods in Basic Science, Teacher-Centred approach of teaching Basic Science, Conventional Talk and Chalk method, Demonstration method, Student-Centred approach, Project method, Discovery/inquiry method, Activity-Based method, Problem-Solving method, Features of problem-solving method , Empirical Studies and Summary.

2.2 Conceptual Framework

Concept is an idea or representation of the common element or attribute by which groups or classes may be distinguished. Aggarwal and Thakur (2003), in Jarumai (2015) viewed concept as any general or abstract intellectual representation of a situation, state of affairs or objects, a thought, an opinion, an idea or a mental image. Anyakoha (2009), defined concept as an idea, thought, or devolution of abstract system of thoughts by which Science investigates, interprets, and understands particular segments of reality of phenomenon. Conceptual framework is viewed by Regoniel (2015), as "researcher's synthesis of literature on how to explain a phenomenon. It is the researchers understanding of how the variables in the study connect with each other. It identifies the variables required in the research investigation .It is the researchers map" in pursuing the investigation." Michiko (2009), stated that conceptual framework is needed in a research

to help outline the possible course of action or to present a preferred approach to an idea or thought. Jarumai (2015), asserts that a conceptual framework for research purpose is a schematic description and illustration of the causative mechanisms and relationships deducible from the research problem, which is embedded in the definition of the research problem and the statement of the hypotheses. Conceptual framework is used in research as outline of possible courses of action or to present a preferred approach to an idea or thought. Conceptual framework acts like map that gives coherence to empirical inquiry, as used in the context of this research; it involves the explanation of the terminologies used for the purpose of the research. The concepts examined in the study include concept of Basic Science, concept of Activity-Based, concept of Problem-Solving, and concept of performance.

2.2.1 Concept of Basic Science

The concept of Basic Science formally called Integrated Science is defined differently by various individuals and organizations based on how they see it depending on perception, experience and what the Basic Science represents in the individual environment. Some of the definitions include: Idris (2014), who viewed Basic Science as a subject that emphasizes on acquisition of modern Science and such that enable young people to have access to new knowledge by bringing change in minds and skills in order to behave rationally and creatively toward problem generated by change. Afuwape (2012), cited UNESCO-UNICEF definition of Integrated Science (Basic Science) as an approach to the teaching and learning of Science in which concept and principles are presented so as to express the fundamental unity of Scientific thoughts and avoid premature or undue stress on the distinctions between the various scientific fields. Furthermore NTI (2000) Integrated science module viewed Integrated science or Basic science as a way of

teaching science where the course must assist the learner to gain the following: the concept of fundamental unity of science; the commonality of approach to problems of a scientific nature; an understanding of the role and function of Science in everyday life, and the world in which the child lives. Bawa (2011), defined Basic Science as a science which is made up of subject matter from various disciplines, de-emphasizes boundary between science discipline, blends subject matter from various disciplines, provide science process skills and scientific approaches to solving problems relating to the environment and culture, making use of learning theories in the organization and presentations of subject matter and provides adequate foundations for further studies in science.

On the other hand the concept Basic Science could be seen and explain from the two words 'Basic' and 'Science'. Firstly Basic according to Ediger and Rao (2011), which is also in agreement with FRN (2013), has to do with foundation of a thing upon which the whole things rest or is made. It is considered, Basic because it is based on the following features: It is based on the culture of the land ii, it lays down the minimum educational standards which every Nigerian Child is entitled to receive without any distinction iii, it is closely related to basic needs and interest of the child and iv, it comes first in the period of our education. Secondly Science is defined by Abimbola (2013), as a body of knowledge, a way of investigating natural phenomenon and a way of thinking in an attempt to understand nature. According to Omorogbe and Ewansiha, (2013), Science has three interrelated aspects which are Content, Process and Attitude. The content can be physical, life, and Earth science, The Science process are the various mental and motor processes skills which the Scientist use to arrive at new knowledge. These processes are so vital to science that no knowledge will result if they are not put into use. More so

learners need to fully understand how the Scientist works as well as prepare himself/herself for a career in Science and Technology.

The processes of Science involves the fifteen inquiry skills proposed by American Association for Advancement of Science (AAAS) in Omofo (2012), which include observing, classifying, predicting, measuring, communicating, inferring, organizing data making operational definitions, formulating questions and hypotheses, experimenting, and formulating models. Attitudes concerned are open mindedness, curiosity, empiricism and objectivity. This is very important because acquiring scientific attitudes give the science student a better understanding of the nature of science and the scientific process and more so the students can transfer the attitude learned to situations he comes across in everyday life. A combination of these two words has produced what is called Basic Science which according to FRN (2013), is structured to provide a complete range of experiences for all students in the first three years of junior secondary schools regardless of whether or not they proceed to the Science class at the senior secondary level or not and at the same time give sufficient background knowledge for specialized study in Science subjects.

2.2.2 Concept of Activity-Based Method

Activity-Based core premises is the requirement that learning should be done based on doing some hands-on experiment and activities. Active learning is generally defined as any instructional method that engages students in the learning process which allows student to do meaningful learning activities and think about what they are doing. Akkus (2015), viewed Activity- Based as a teaching and learning method which include all in-class and out of class activities which will help students to reach desired goals, to gain

value, attitude, knowledge and skills, to foster their cognitive, affective and motor skills and to actualize learning by doing.

Shah and Rahat (2015), and Okwudishu (2011), in Festus (2013), opined Active learning to be a method where the teacher only acts as a facilitator and learners are at the centre of the learning process by their high involvement in practical activities and discussion. It is the mode of learning guided by the assumption that (i) Significant learning takes place when the subject matter is perceived by the learners as relevant to their own purpose, (ii) Much significant learning is acquired through doing, (iii) Learning is facilitated by the learner's responsible participation in the learning process, (iv) Self-initiated learning involving the whole person- feeling as well as intellect – is the most pervasive and lasting type of learning. Okwudishu (2011), further offers the following benefits of Activity-Based as: (i) reinforces course content, (ii) develops team building skills, (iii) enhances learners self-esteem (iv) promotes participatory learning, (v) allows for creative problem solving, (vi) and promotes the concept of discovery learning. Others benefits are that it energizes and invigorates the participants, strengthens learners bond, offers variety that accommodates divers learning styles, allows for practical application of course content, enhances communication with diverse learning, offers an enjoyable and exciting learning environment, helps improve learners retention and motivation, provides an avenue for learners recognition and reward, and promotes fun.

McGrath and MacEwan (2011), enumerated four basic characteristics that Activity-Based embraces which include: the students are more actively involved in the learning process; emphasis is on experiential; 'heads on' as well as 'hand on', congruent with relational epistemology. Nigeria Certificate in Education Minimum Standard for Sciences (2012), gives a brief checklist for an Activity- Based approach to learning Science as Students should be: (i) handling materials, living and non-living; (ii) designing, making

or manipulating apparatus using a variety of materials including 'junk' items; (iii) moving around freely and finding the materials they need; (iv) discussing their work with each other and the teacher; (v) busy doing things they feel are important; (vi) trying to work out for themselves what to do, from step to step, and not expecting to be told what to do; (vii) puzzling over problems; (viii)comparing their ideas or observations with those of others; (ix) embarking on Field Trips; (x) excursion to places where students can observe science in operation/action to enhance better understanding of science.

2.2.3 Concept of Problem-Solving Method

In a Problem solving method, Students learn by working on problems. This enables the students to learn new knowledge by facing the problems to be solved Problem-solving method is a teaching method that help students to discover, it place students at higher task of probing into issues, it help students to develop the skills of analysis over issues. The problem–based learning is a well-developed approach used in education and is applied extensively nowadays. Hmelo-silver (2004), in Scott (2017), stated that this method of teaching is Students-Centred, the teachers taking the lesson in small groups in which they take a facilitative role, and organizing the lesson within the framework of various problems. Barrette (2010), has explained Problem-Solving Method as a situation in which learners' struggle for a solution within the framework of certain problems that have been carried out independently or as group discussions and controlled by a teacher. Cui (2016), opined that Problem-Based is where students work with class mates to solve complex and authentic problems that help develop content knowledge as well as Problem-Solving/ reasoning, communication and self- assessment of skills. The problems also help to maintain students' interest in course material because the student realizes that they are learning the skills needed to be successful in the field.

Maurer and Neuhold (2012), viewed Problem-Solving Method as the constructivist answer to Conventional learning theories which is based on three main pre-conditions (it is student-Centred, it follows an active process of knowledge construction, and it is collaborative.) for successful and comprehensive learning process as explained below:

i. Learning is Student-Centred and Active process_ Problem-Based has it that students are grouped in small groups and using Process skills where the students are actively involved in their own learning. Bokunjie (2009), in Pagander and Read (2014), has it that the group of participating students discuss facts about the problems, hypotheses about cause and effect and state the learning objectives. The text with the problem to be identified and solved is then introduced to the students and unknown terminology is explained and clarified

ii. Defining the Problem:-The second step consists of group discussions of what the problem is and which methods can be used to find the solution. The identified problem is then written down.

iii. Brainstorming: - Another group discussion is held where the students use their prior knowledge to come up with ideas for different hypothesis to explain the problem. During this step all students are encourage to speak their mind and all ideas are valued and noted.

iv. Structuring and Hypothesis:- From steps two and three above different possible explanations of the problem are given eventually leading up to one final structured hypothesis which is written down in the hypothesis cause and effect. Learning

v. Objectives:-When the hypothesis is chosen and formulated the students must agree on achievable and comprehensible learning objectives for the task. These objectives will be the necessary knowledge the student needs to acquire before

they will be able to continue on working with their hypothesis. These learning objectives are written down in the 'learning objectives'.

vi. Searching for Information:-The search for information is done individually and with emphasis on mutual learning objectives. This will provide the student with more profound knowledge regarding the problem they are working on.

vii. Synthesis:-During the final step the members of the group share the results of their individual findings, including structures, functions, and causes.

viii. Feedback:-Feedback is given both from the students and the teacher regarding their individual and group process the organization of the task, and the teacher's guidance.

In terms of content, on the other hand, students are at the centre of identifying their learning objectives and defining their learning goals. It is assumed that deep learning takes place because they set and understand the relevance of the problem to be solved at hand, students learn best when they set their own goals.

2.2.4 *Concept of Academic Performance*

Academic performance is the scholastic standing of a student at a given moment which states individual's intellectual abilities; which can be measured by grades obtained from examinations or continuous assessments (tests or quiz) (Adeyemi, 2008 in Aniaku, 2012). Similarly and Aubrey (1970), in Ibrahim (2015), sees academic performance as activities that ensure that goals are consistently being met in an effective and efficient manner. The author concluded by saying that, academic performance is the effectiveness and improvement of students towards specific goals set up to be achieved. Ahmad (2007), in Ibrahim (2015), observed that the influence of methods of teaching and effectiveness on

the learning outcome of students as measured by students' academic performance on subject of several studies; is a significant predicator of students' academic performance.

In Nigeria, the level of students' academic achievement in the senior secondary school is determined by grades obtained from external examination that is, Senior School Certificate Examination conducted by external examination bodies WAEC, GCE and NECO respectively. The pattern of grading candidates score in the examination is such that distinction grades were represented by A1-B3, credit grades C4-C6, ordinary pass D7-D8 and failure grade F9 (Adeyemi, 2008). This is similar to the grading of the JSCE examination with A as distinction, C-as credit and D-as pass. A sample of students JS National Examination Council result in Basic Science in the study area 2010-2014 indicate that majority of the students obtain grades within the range of D – F. This result indicates poor performance in Basic Science since the least requirement for further studies in the tertiary institutions is C6. The poor student performance in Basic Science is linked to the use of Conventional lecture method in the teaching and learning (Aniaku, 2012).

2.3 Theoretical Framework

A theory is a logical explanation for events, which occur in nature based on facts, observation, or experimentation. In other words it is a set of generalized statements supported by experimental evidence. Kerlinger (1987), in Wright (2017), defined a theory as a set of interrelated constructs, definitions and propositions that present a rational view of phenomena by explaining or predicting relationship among those elements. According to Olaitan and Nwoke (1999), in Jarumai (2015), theoretical framework is defined as a set of related statement that are arranged as to give functional meaning to a set or series of events which in turn could serve as a based to help a study to achieve its goals.

Olorundare (2014), opined that such related statements can be in the form of functional or descriptive definitions, assumptions, operational constructs, hypothesis, postulates, laws, generalizations or theorems. Thus, the underlying theoretical framework of this study is that of Progressivism and Constructivism.

2.3.1 Theory of Progressivism

Progressivism focuses on personal experiences, children's interests and their needs. The proponents of this theory propose ways of teaching and learning through basing instruction on the needs, interest, and developmental stages of the child. John Dewey was one of the main proponents of the theory of progressivism among others such as Kalpatrick, Parker, and Dewey (1916), in Olorundare (2018), stated that students should be involved with real problems so that they gain ownership to the problems and how they solve it. Students should be asked meaningful questions that make them creative and critical thinkers. This was established in the 1920s in United State of America. The progressive curriculum designs among others are activity-centred and problem-centred curriculum. (Morshead, 2010; Samkange and Samkange, 2012), opined that progressivism emphasizes a number of qualities that are important for the development of the child. These include: experimental learning, emphasis on problem-solving, critical thinking, group work and development of social skills. Nwangi, Barchok and Ogola (2015), believe that education should focus on the whole child, rather than on the content or the teacher.

Radu (2011), viewed John Dewey as the father of progressivism who believed in promoting the child Centeredness and the concept of experience as the basis of instruction. He further attested to the fact that Progressivism is a student-Centred philosophy that believes that ideas should be tested by experimentation, and learning

comes from finding answers from questions. This philosophy values the scientific method of teaching, allows individuals to have their own beliefs, and promotes the interaction of students as valuable to the learning process. Radu (2011), further enumerates six educational values of Progressivism and basic principles on which it operates:

i. The process of education finds its genesis and purpose in the child.
ii. Pupils are active rather than passive.
iii. The teacher's role is that of an advisor, a guide, a fellow traveller, rather than an authoritarian and classroom director
iv. The school is a microcosm of the larger society.
v. Learning should be integrated. Classroom activity should focus on solving problems, rather than on artificial methods of teaching subject.
vi. The social atmosphere of the school must be cooperative and democratic.

Kennedy (2017), however opined that progressivism in education is a reaction against the conventional or traditional style of teaching. Its pedagogy values experience over learning facts at the expense of understanding what is being taught; and its philosophy embraces the idea that students should be taught how to think and the process of learning by doing is at the heart of this style of teaching by taking advantage of hands-on. According to Labaree (2015), Progressivism means pedagogical progressivism, in which instruction is based on the needs, interests and developmental stage of the child; it means teaching students the skills they need in order to learn any subject, instead of focusing on transmitting a particular subject; it means promoting discovery and self-directed learning by the student through active engagement; it means having students work on projects that express student purposes and that integrate the disciplines around socially relevant themes; and it means promoting values of community, cooperation, tolerance, justice and

democratic equality. In the shorthand of educational jargon, this adds up to 'child-Centred instruction', 'discovery learning' and 'learning how to learn'.

New World Encyclopaedia (2017), stressed that students learn best in real life activities with other People. A Progressives' teacher provides not just reading and drills, but also real World experiences and activities that relate to the actual lives of the students. Teaching and Learning should test ideas by active experimentation. Learning is rooted in the questions of learners that arise through experiencing the world. Therefore learning is active and not passive (Arends, 2011). Students should be taught how to solve problems in the class room for them to acquire the necessary skills to help them solve problems that they may encounter in their everyday life. Guga and Bawa (2015), stated that life is faced with many problems and as such the work and activities of students in schools should be related to and conducted in such a way that they will face such problems with relative ease. The learner is a problem solver and thinker who make meaning through his or her individual experience in the physical and cultural context. Effective teachers provide experiences so that students can learn by doing. Curriculum content is derived from student interests and questions. The scientific method is used by progressives' educators so that students can study matter and events systematically and first hand. The emphasis is on process-how one comes to know.

According to Kohn (2008), progressivism has the following features:

i. Attending to the whole child; progressive educators are concerned with helping the children become not only good learners, but also good people.
ii. Community: learning is not something that happens to individual children rather children learn with and from one another in a caring community and that's true of moral as well as academic learning.

iii. Collaboration: Here the students work with each other and emphasis is placed on collaborative problem solving.

iv. Social justices: A sense of community and responsibility for others is not confined to the class room. Indeed, students are helped to locate themselves in widening circles of care that extend beyond self, beyond friends, beyond their own ethnic group and beyond their own country. Opportunities are offered not only to learn about but also to put into action, a commitment to diversity and to improving lives of others.

v. Intrinsic motivations: When considering educational policies and practices, the progressive educators are likely to ask, "What is the effect on students 'interest in learning, their desire to continue reading, thinking and questioning?"

vi. Deep understanding: The curriculum is organized around problems, projects and questions which invite them to think deeply about issues that matter and help them understand ideas from inside out rather than list of facts, skills, and separate disciplines.

vii. Active learning: Here the students play a vital role in helping to design the curriculum, formulate the questions, seek out answers, think through possibilities and evaluate how successful they and their teachers have been. The students active participation in every stage of the process consistent with the overwhelming consensus of experts that learning is a matter of constructing ideas rather than passively absorbing information or practicing skills.

Three of the major principles of the progressivism philosophy of education are pragmatism, experimentalism, and individualism. Pragmatism refers to the practicality of what is being learned, the extent to which the concept being learned is relevant or meaningful to the learner, and the process through which the learner acquires a piece of

knowledge. Progressivism argues that education should be presented to students in such a way that the content being learned is practical and will enhance students' skill sets inside and outside of the classroom. Progressivism is also concerned with the concept of "hands on experience" in which the learner is exposed to problem solving in a natural and contextual setting so that the concept being learned can be accurately applied to situations encountered in the real world. Progressivism also argues that educational content should be connected to what the student already know so that the student can build upon his or her prior knowledge. Experimentalism "holds that men, their skills and intelligence, are the sole reliable guide to their own destinies". This principle ties into the philosophy of progressivism because a major theme in this philosophy is the active participation of the individual in his or her own growth and development (John, 2009).

The progressives would say that participation is important because the extent to which a person is active in his own growth and development can positively or negatively affect the course of his life. Individualism refers to the extent that educational content is tailored to the individual needs of each student. Progressivism argues that because each student is unique and learns in a specific way, educational content should be presented in such a way that meets the needs of all students.

It can therefore be questioned as to how progressivism is related to the study. According to Dewey as stated in Morshead (2010), learning is essentially a reconstruction of experience students learn as they engage in activities that reconstruct their experience. The concept of experiential learning is one that progressives feel enhances the students experience the most, that by actively engaging in an activity that puts the knowledge to use, the students develop a stronger understanding of the task at hand. The researcher viewed both Activity-based and Problem-solving methods as exploring the goals of

learning which the present study is using to find out their effects on students' performance in Basic science

The goals of education at the secondary level as stated earlier being to prepare the individual for useful living within the society, the progressives collaborative environment that requires team work, critical thinking, creativity which focuses on developing important skills within students helping them better prepare for college and life as a productive member of the workplace, regardless of the chosen career path. This is also one of the relationships of the study with progressivism.

2.3.2 Theory of Constructivism

Constructivism is the brain child of the cognitive scholars namely Piaget, Brunner and Vygostky. Bada (2015), viewed the constructive conceptions of learning to have their historical roots in the work of Dewey (1929), Brunner (1961), Vygotsky (1962), and Piaget (1980). Roya and Haier (2015), cited Piaget's, Thomas and Fosnot's definition of Constructivism by reference to four principles: (i) learning depends on what the learner already knows; (ii) new ideas occur as the learner adopt and change old ideas; (iii) learning involves inventing ideas rather than mechanically accumulating facts; (iv) meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with old ideas.

Odagboyi, Sambo, Musa, and Onche (2014), stated that Constructivism is a Psychological term emphasized in the curriculum where it stresses students individually, or collectively to be central or at the heart in ongoing learning activities. And that learning is based on the belief that knowledge is not a thing that can be simply given by the teacher at the front of the class room to students in their desk. Rather, knowledge is

constructed by the learners through an active, mental process of development, where the learners are the builders and creators of meaning and knowledge.

Funderstanding (2011), defined constructivism as a philosophy of learning founded on the premise that, by reflecting on people's experiences, they construct their own understanding of the world they live in. Also they generate rules and mental models which they use to make sense of their experiences. Funderstanding (2011), underlines several guiding principles of constructivism as: learning is search for meaning, meaning requires understanding wholes as well as parts; in order to teach well, teachers must understand the mental models that students use to perceive the world and the assumptions they make to support those models; the purpose of learning is for an individual to construct his or her own meaning not just to memorise the "right" answers and regurgitate someone else meaning. Mogashoa (2014), states that constructivism is a theory of learning that likens the acquisition of knowledge to a process of building or constructing. Each learner should actively participate in the learning processes as everyone constructs his or her own knowledge. The beliefs about knowing and learning that emphasizes the active role of learners in constructing their own knowledge, is viewed to be the result of a learners attempt to use his or her existing knowledge to make sense of new experiences. Nayak (2014), stated that constructivism means that individuals actively construct knowledge they possess. This construction of knowledge is a lifelong, effortful process requiring significant mental engagement by the learner. And the teacher in this case needs to probe the knowledge that the learner have previously constructed and evaluate. Although constructivism does not prescribe how to teach, it does carry implications for curriculum and instruction. It suggests that students would benefit from learning opportunities that not only expose them to new information or experiences but also enable them to:

i. examine their own ideas,

ii. determine the extent to which the new experiences make sense in light of these ideas,

iii. consider a number of possible alternative explanations for what they have experienced, and

iv. evaluate the usefulness of a number of different perspectives.

All of the above processes are more likely to take place if students are actively involved in doing something other than listening. Constructivism is a student-Centred philosophy that emphasizes hands on learning and students actively participating in lessons. Active participation is actually the heart of constructivism theory. Hunkins (2009), and Savage (2009), in Ngusa and Makewa (2014), gave the following characteristics that have connection to active participation in constructivism point of view: i) students are allowed to ask questions. ii) students are allowed to analyze, interpret and predict information. iii) the learner is the key player in the teaching- learning transaction. iv) the learners cannot passively accept information by mimicking others' wording or conclusion. v) students connect new learning with already existing knowledge. iv) learners actively seek solutions to problems and share ideas of what they constructed themselves. Constructivists believe that students should be able to discover lessons on their own through hands on activity because it is the most effective way of learning and is considered true learning. Stöblein (2009), stated that the constructivist view of teaching and learning where each person "constructs" their own knowledge and learning process based on previous experience. This theory asserts that learning takes place when psychological environment of an individual interacts with a particular structure. For construction students are imperative to have variety of activities in an active classroom.

Ifegbo (2012), in Obi, Ukaegbu and Iwuji (2017), asserted that the Constructivist are of the opinion that learners learn best when they work in groups to share different perspectives. Working in groups enables the learners to bring their previous knowledge to bear on the task and learning is more effective when students collaboratively and actively engage in the learning process instead of learning in isolation. Constructivists advocate that students are active learners who attempt to construct meaning and arrive at understandings of new situations based on their prior knowledge and experiences; either formal or informal. This construction occurs readily when students are provided with meaningful learning opportunities which allow them to generate links by relating new material they are learning to understandings derived from what they already know. According to Savery and Duffy (2001), in Turco (2010), viewed constructivism as a philosophical view on how students come to understand or know. Savery and Duffy (1995), in Borich (2011), has broken constructivism into three sections:

i. Understanding is in students' interactions with the environment

This is the core concept of constructivism. Constructivists cannot talk about what is learned separately from how it is learned, as if a variety of experiences all lead to the same understanding. Rather, what we understand is a function of the content, the context, the activity of the learner, and, perhaps most importantly, the goals of the learner. Since understanding is an individual construction, it can be inferred that it cannot be shared; rather the degree to which individuals' understandings are compatible should be tested. An implication of this proposition is that cognition is not just within the individual but rather it is a part of the entire context that cognition is distributed.

ii. Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned

In a learning environment, there are goals for learning and the learner has a purpose for being there. That goal is not only the stimulus for learning, but it is a primary factor in determining what the learner attends to, what prior experience the learner brings to bear in constructing an understanding, and, basically, what understanding is eventually constructed.

iii. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings

The social environment is critical to the development of individual understanding as well as to the development of the body of propositions also known as knowledge. At the individual level, other individuals are a primary mechanism for testing our understanding. Collaborative groups are important because various understandings can be tested and examined as a mechanism for enriching, interweaving, and expanding understanding of particular issues or phenomena. Exchange interaction between the teacher and the students.

The theory is quite applicable to the study in that Science teachers are presently being encouraged in Nigeria to concentrate on how to shift their classroom learning environment from the traditional to the constructivist or student-Centred learning environment. Constructivist strategy is one of the numerous student-Centred strategies recommended by the Science Teachers Association of Nigeria (STAN, 2011), and National Educational Research and Development Council (NERDC, 2007) which are bodies responsible for developing the Basic Education Curriculum (BEC). These student-Centred strategies help create learner-Centred learning environments which stimulate learning and improve students achievement in science classrooms.

More so in the constructivist classroom, the focus tends to shift from the teacher to the students. The classroom is no longer a place where the teacher ("expert") pours

knowledge into passive students, who wait like empty vessels to be filled. In the constructivist model, the students are urged to be actively involved in their own process of learning. The teacher functions more as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding, and thereby their learning. And, in the constructivist classroom, both teacher and students think of knowledge not as inert factoids to be memorized, but as a dynamic, ever-changing view of the world we live in and the ability to successfully stretch and explore that view.

2.4 Nature of Basic Science

Science is a body of knowledge and a process of acquiring knowledge. One of the major goals of science is to understand the world. How scientists go about understanding the mysteries of the world like good detectives as they use special methods or processes peculiar to science such as honesty; asking questions (divergent and convergent)-questions of what, how, when, where, and why? The natures of basic science therefore are those qualities or elements that make science what it is. Thus, science is organized into a system in which there are linkages between the elements. According to National Teachers' Institute (2000), in their Integrated Science Module One Basic Processes and Skills in Integrated Science outlined three basic elements of Science to describe the nature of Basic Science which are as follows:

i. the processes or methods of science;
ii. the products of science;
iii. the human at attitude to science.

a. **The processes or methods of science:-**These are what scientists do to generate new knowledge or develop science concepts. While developing areas of knowledge, they employ certain science process skills which are the various mental and motor processes which the scientists use to arrive at new knowledge.

These processes are so vital to science that no knowledge will result if they are not put into use. The NERDC (2013), incorporated eleven out of the fifteen process skills when developing the Basic science project of which are as follows: observing; classifying; inferring; predicting; measuring; communication; interpreting data; making operational definitions; formulating questions and hypotheses experimenting and formulating models. According to Colker (2002), in Jackman (2011), process skills allow students to process new information through concrete experiences through inquiring and asking questions which is inbuilt and can encourage their natural curiosity and exploration.

b. **Products of Science:-** are the outcomes of scientific investigations. They constitute the library of scientific knowledge. They are in forms of: facts, concepts, theories and laws of science.

i. **Facts:** These are singular observations about nature. For example, 'it is raining', 'the car is moving', 'a leaf is green', 'there is a colour change from white to pink', and so forth. All these are facts. Scientific assumptions are based on facts. A scientific fact is not considered valid unless it is observable and demonstrable. Facts are building blocks of scientific concepts.

ii. **Concepts:** Concepts are meanings attached to scientific terms such as, ecology, heredity, esterification, pressure, gravity etc. each concept represents series of related facts. The function of scientific concepts is that they are used to formulate scientific laws and theories. A concept can be empirical, theoretical or rational. Empirical concepts are observable phenomena such as plant, diffusion, volume and so forth. Theoretical concepts are unobservable phenomena such as atoms, electrons and so forth. A rational concept relates two or more concepts together such as greater than, equal to and so forth.

iii. **Laws:** These are observable regularities in nature. They are generalization used to describe, predict and explain events in nature. Examples are Newton's Law of motion, law of gravity, Boyle's Law, Mendel's law of inheritance and so forth. There are empirical laws and theoretical laws following the nature of concepts used in formulating them. Empirical laws predict only while theoretical laws predict and explain.

iv. **Theories:** A theory is defined as a generalization requiring further experimental testing. It is usual to regard scientific laws as generalization of observable phenomena, while scientific theories are generalization of unobservable phenomena in nature such as Dalton's atomic theory.

c. **Ethics of Science:**-These are the moral constraints of science. They include objectivity, curiosity, scepticism, willingness to change opinion, humility, precision, open-mindedness etc. for example, one would not expect a scientist to 'cook-up or panel beat' result in order to conform to a preconceived idea or model. The in-congruent result may be the beginning of a new invention. The psychologists and educators agree that there is no particular way of acquiring these attitudes. It evolves as one carries out scientific activities using the process skills. The scientific attitudes emerge the way other professing attitudes emerge that is, by practice and rational decision. However the human attitudes of science must remain in focus at any point of investigation, since in science knowledge and skills are taught that is cognitive and psychomotor, so it is very important to consider the realm of affective domain as being very important. Attitude just like interest and values fall within the affective objectives of teaching. Attitudes relate to the emotional aspect of personality. It pertains to the feeling and thinking of the

mind that a person holds towards an idea or a phenomenon. When it relates to science it is called scientific attitude. Shafiu (2014), viewed scientific attitude as the attributes a scientist has and usually would display while carrying out the processes of science.

It should be noted that the National Policy on Education emphasizes that teaching and learning of Science should be based on the nature of Science. Fensham (2004), in Holbrook (2011), stated that the National Policy on Education emphasizes the teaching and learning of scientific processes and principles where students' learn science subjects so as to: become a scientist; gain factual knowledge and skills; be able to manipulate scientific equipment; and pass a subject knowledge examination, develop social values (moral, ethical) related to honesty, integrity and in interpretations of its meaning.

More so, science is about doing, therefore using both Activity-Based and the Problem-Solving method to teaching science requires students and teachers to be inquisitive and autonomous. This works well with students, as young people are naturally active, curious and exploring. As the researcher maintained that students enjoy science when it is student-centred, active and focused on investigation. The belief that to make learning science truly student-centred, relating it to real-life problems and possible solutions, there is a need to design a science course that would prepare these future teachers to think critically, identify and use appropriate resources and be creative.

2.4.1 The New Basic Science and Technology Curriculum

The Basic Science and Technology curriculum is a modern curriculum which, if well implemented, would enable the learner live fruitful and fulfilling life in the 21st century. The Junior Secondary School curriculum has special features which the Science Teacher should be aware of in order to effectively implement the curriculum. NERDC (2013),

enumerated special features of the Basic Science and Technology curriculum to include: infusion of special contents based on current local and global issues that shape national development and economic growth, such as entrepreneurial education; infusion of contents to deal with some local issues that are negatively influencing the Nigerian society such as security education, disaster risk reduction education, safety education and drug abuse education. For instance, contents on drug use and Drug Abuse and Effects of Drug Abuse are infused in Junior Secondary School 1 and 3.The implementers of the curriculum are demanded to follow the following hints: NERDC (2013), Prepare all the lessons before the time of the lesson to make sure that the necessary resources are provided to make the lesson Activity-Based; Use plenty of resources from the Scholl and Community of the Learners; Organise visits to local workshops like the blacksmiths, motor mechanics, watch repairers, and telephone handset repairers.

Okebukola (2017), in Rufa'i (2018), provided collection of definitions of 'curriculum' through diverse literature. Some of these definitions include: the courses offered by an educational institution; the set of standards, objectives, and concepts required to be taught and learned in a given course or school year; a socially-constructed body of knowledge that articulates the needs, values, objectives and aspirations of a society through the teaching and learning process for the accomplishment of desired outcomes; what is taught in school; set of subjects; aims, objectives, teaching content, teaching strategies, assessment methods, and other components of learning and teaching; programme of studies; comprehensive overview of what students should be learning, how they will learn it, what role the teacher should lay, and the framework in which learning and teaching will take place; and everything that goes on within the school including extra-class activities, guidance, and interpersonal relationships. The 9–year Basic Science and Technology Curriculum according to Obioma, (2013), is the product of re-alignment and

restructuring of the revised curricula for Primary Science and Junior Secondary School Integrated Science. In selecting the contents of the curriculum three major issues shaping the development of nations worldwide, and influencing the world of knowledge today were identified. These are globalization, information and communication technology (ICT) and entrepreneurship education. The desire of Nigeria to be identified with contemporary development worldwide, called for the infusion of relevant contents of four non – school curriculum innovations in the areas of;

i. Environmental Education (EE),
ii. Drug Abuse Education (DAE).
iii. Population and Family Life Education (POP/FLE)
iv. Sexually Transmitted Infection (STI) including HIV/AIDS.

Infusion of content occurred in every class from Basic 1 – 9. Also some introductory technology topics have been introduced at the Lower and Middle Levels, while leaving the Upper Level with purely science topics. The decision of the Federal Government to introduce the 9–year Universal Basic Education (UBE) Programme is to enable the Government attain Education for All (EFA) and the Millennium Development Goals (MDGs) by the year 2015. The MDGs are to: eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality; improve maternal care; combat HIV/AIDs, malaria and other diseases; ensure environmental sustainability and develop a global partnership for development. As well as the critical targets of the National Economic Empowerment and Development Strategies (NEEDS), which can be summarized as: value re-orientation, poverty eradication, job creation, wealth generation and using education to empower the people. There was therefore, the need to review, re-structure and re-aligned the then existing curricular for Primary and Junior Secondary Schools (JSS) to fit into the 9-year

Basic Education Programme. The National Council on Education (NCE) at its meeting in Ibadan in December 2005 directed the Nigerian Educational Research and Development Council (NERDC) to carry out this assignment. The NCE also approved a new curriculum structure namely: Lower Basic Education Curriculum (Primary 1-3), Middle Basic Education Curriculum (Primary 4-6) and Upper Basic Education Curriculum (JSS 1-3).

Obioma (2007), in Hamza and Mohammed (2011), explained that a High–Level Policy Committee on Curriculum Development (HLPC) made up of critical stakeholders and coordinated by NERDC took the initiative to provide the guidelines for re-structuring the curriculum. Between January and March 2006, the NERDC convened a meeting of experts and also organized several workshops to produce the 9–year Basic Education Curriculum, which will ensure continuity and flow of themes, topics and experiences from primary to junior secondary school levels. The curricula reflect depth, appropriateness and inter–relatedness of curricula contents. Also emerging issues which covered value orientation, peace and dialogue, including human rights education, family life, HIV/AIDS education and entrepreneurial skills were incorporated into the relevant contents of the new 9-year Basic Education Curriculum. In general, the curriculum pays particular attention to the achievement of the MDGs and the critical elements of NEEDS.

If the vision of UBE is to bring about socio-economic development, as explained by Tahir (2005), in Akpopiniova and Odebala (2016), the role of science and technology education in the UBE programme cannot be said to be over emphasized. The world-over, it is generally agreed that development could only be meaningful if and when it is science and technology driven. As such, countries of the world are now categorized as developed, developing or underdeveloped as a result of their scientific and technological attainments. Hence, the incorporation of Basic Science and Technology as a co-subject in the 9 -year

Basic Education Programme. Hamza and Mohammed (2011), therefore, highlights on the various ways through which the new UBE Basic Science and Technology Curriculum can be delivered to bring about the desired development and its sustainability.

2.4.2 Objectives of the Basic Science Curriculum

Education is said to continue to be highly rated in the National development plans because education is the most important instrument of change; for any fundamental change in intellectual and social outlook of any society has to be preceded by educational revolution (FRN, 2013). The National Policy further emphasizes that since no education system may rise above the quality of its teachers, teacher education shall continue to be given major emphasis in all educational planning and development as such all teachers in tertiary institutions shall be required to undergo training in methods that is techniques of teaching. Thus science education and science methodology becomes the foundational courses offered at NCE level or any Science Education courses offered at University level. That is why the knowledge of the objectives of Basic Science becomes necessary.

The overall objectives of the new Basic Science and Technology Curriculum outlined by Adeniyi (2007); Nigerian Educational Research and Development Council (NERDC) (2013), are to enable the learners to:

i. develop interest in science and technology;
ii. acquire basic skills in science and technology;
iii. apply their scientific and technological knowledge and skills to meet societal needs;
iv. become aware of numerous career opportunities provided by science and technology (in the world of works).
v. become prepared for further studies in science and technology.

vi. avoid drug abuse and related vices, and

vii. be safety and security conscious.

These objectives have to be seriously taken into consideration while teaching or helping learners to learn Basic Science and Technology. For instance, when teaching Basic science and Technology, it is very important to relate the aspects taught to uses or applications in the society, so that the learners would know how and where to use the knowledge and skills they have acquired to interpret their environment , as well as solve their personal problems or problems in the society (NERDC 2013). In order to achieve a holistic presentation of science and technology contents to learners, the thematic approach to content organization was adopted. Consequently, four themes were used to cover knowledge, skills and attitudinal requirements, these are: you and environment; living and non-living things; you and technology; you and energy.

At the Upper Basic Level however, theme "You and Technology" was changed to "Science and Development". The topics under each theme were sequenced in spiral form beginning with the simple to the complex across the 9–year of Basic Education in order to sustain the interest of learners and promote meaningful learning. The use of guided inquiry method of teaching and learning is implied in the activities prescribed under each topic in order to promote learning by doing and skills development. The theme "Science and Development" was added to expose students to developments 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 Nigeria Certificate in Education Minimum Standard for Sciences (2012), stated that in preparing teachers of Integrated Science (Basic Science), the principal objectives include:

i. enabling students gain the concept of the fundamental unity of science;
ii. installing in students a commonality of approach to problems of a scientific nature that is the scientific method;
iii. increasing students' understanding of the role and functions of science in everyday life and in the world in which they live;
iv. making students well informed and scientifically literate;
v. enabling students acquire and demonstrate the intellectual-competence and professional skills necessary to the teaching of Integrated Science (Basic Science) in Primary and Junior Secondary Schools, as an inquiry based subject, in conformity with National Curriculum;
vi. developing in students the ability to impart and encourage in their pupils the spirit of inquiry into living and non-living things in the environment;
vii. developing the ability and motivation in students to work and think in an independent manner;
viii. enabling students carry out scientific investigations emphasizing co-operation, development of appropriate scientific processes and skills and improving their written and oral communications skills;
ix. to develop in students the interest to pursue higher studies in integrated science.

National Teachers' Institute (2000), in their Integrated Science Module One stated that the National Core-Curriculum for JSS Integrated Science (Basic Science) are geared towards equipping the learners with the following skills: (i) observing carefully and thoroughly; (ii) reporting completely and accurately what is observed; (iii) organizing

information acquired by the above processes; (iv) generalizing on the basis of acquired information; (v) predicting as a result of these generalizations; (vi) designing experiments including controls where necessary to check prediction; (vii) using models to explain phenomena, where appropriate; (viii) continuing the process of inquiry when new data do not conform to prediction.

2.5 *Teaching Methods in Basic Science*

Throughout the history of teaching, there have always been arguments concerning which method of teaching is the most efficient and effective to teach students as well as how the students learn and acquire new knowledge. This debate has led to the development of several learning theories and methods of teaching whose founders all state that their method is the most efficient and suitable one. These methods are all base upon different theories of learning and how new information is acquired (Pagander & Read, 2014).

Teaching method can simply be referred to as an approach or method or a combination of carefully designed class room interactions that could be followed meticulously to teach a topic, concept or an idea (Olarundare, 2011). Teaching methods could be Conventional, Teacher-Centred, or Student-Centred. It should be noted that the primary purpose of teaching at any level of education is to bring about a fundamental change in behaviour of the learner (Tebabal & Kahssay, 2011). According to Ayeni (2011), in Ganyaupfu (2013), viewed teaching as a process that involves bringing about desirable changes in the learner so as to achieve specific outcomes. Adunola (2011), in Ganyaupfu (2013), opined that to facilitate the process of knowledge transmission, teachers should apply appropriate teaching methods that best suit specific objectives and level exit outcomes.

Teaching demands participation. The teacher should always encourage the learner to question and comment so that their understanding may be tested and newly acquired

skills practiced. The teacher tries to exploit the learner's experiences in the teaching and learning process. This is because no learner is empty; they may have knowledge and it is left for the teacher to find out whether their knowledge concept is correct or is a misconception. Kyiracou (2010), identifies that, the teacher is responsible for planning, guiding and evaluation of learning programmes. In this wise, the teacher serves as the director of learning, planning interesting and meaningful learning experiences for students, using a variety of instructional materials and procedures, providing for individual differences and monitoring, recording and reporting student's growth and achievement.

Daily observation of science teachers in their classrooms indicate that most of the teaching skills science teachers acquired before certification are not put into use. Ajaja (2007), in Agboghorama and Oyovwi (2015), stated that science teachers continue to teach science using the conventional method despite the recommended Activity-Based through discovery/inquiry methods that are meant to help students' solve problems.

2.5.1 Teacher-Centred Approach

Teacher Centred is an approach to teaching that places the teacher as the director of learning and is mainly accomplished by the conventional lecture, no practice of basic skills and constructive feedback (Stephan, 2014). According to Ekeyi (2013), the approach is least practical, more theoretical and memorizing. It does not apply activity based learning to encourage students to learn real life problems based on applied knowledge. Since the teacher controls the transmission and sharing of knowledge, the teacher may attempt to maximize the delivery of information while minimizing time and effort. As a result, both interest and understanding of students may get lost. To address such shortfalls, Zakaria, Chin and David (2010), specified that teaching should not

merely focus on dispensing rules, definitions and procedures for students to memorize, but should also actively engage students as primary participants. Some of the teacher-centred approaches are the Conventional Lecture Method as well as Demonstration method.

Conventional chalk and talk method

The Conventional method which comprises of 'talk sand chalk', copying of notes and memorization is said to be used largely by many Science teachers. Eighty percent of the scientific information or principles that students receive from their teachers come through lecture method according to Atadoga and Onoalapo (2008), in Dawaki (2014), this is because the Nigerian educational system put so many premiums on paper qualifications which are earned through public examinations. Science teachers embrace the lecture method as it leads to an easy coverage of the school syllabus as information is more easily disseminated and allows easy handling of large classes which dominates most of our junior secondary school level.

Alasoluyi (2017), stated that the conventional (talk and chalk) method is the oldest and the most popular and extensively used. It involves an organized verbal presentation of a body of content centred on behavioural objectives. It uses oral form of communication and usually to the entire class. When the method is properly used, it can assist in introducing activities for motivating students, for summarizing at the end of the unit and for explaining difficult points. It can be useful in bridging gaps between topics to be studied and for presenting information. Furthermore the conventional talk and chalk method is found to be satisfactory in attaining the objective of teaching knowledge and transferring information but when the objective is to develop concepts and skills other methods are preferable.

Shafiu (2014), stated that lecture method is a common strategy teachers employ in the teaching of Basic Science. It is also referred to as talk and chalk or textbook method. In the course of employing the method, the teacher dominates the teaching with very little participation on the part of the learners. Here the teacher is seen as the repository of all knowledge while the students are passive recipients of knowledge transmitted by the teachers in the process of learning. The method has the advantage of covering a wider area within a short time but it is not student Centred and students do not gain mastery of concepts.

Akinbobola and Afolabi (2009), viewed expository (lecture) teaching as merely presenting ideas and information meaningfully and effectively so that the learner can derive other meanings from what she/he is presented with. Factual information is most easily learned if it is organized and sequenced logically. Hence, the contents of material must be presented in a logical order, moving from generic to specific concepts, so that learners can form cognitive structures and encode new information. The expository approach is a teacher-centred student-peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials. Iheonu (2005), in Ibe (2013), indicated that in using this approach, the teacher talks about science while the students read about science. Clear and good command of language and ability to write clearly and boldly on the blackboard makes lecture method effective.

Advantages of conventional method

The voluminous nature of Science Curriculum kept Conventional method to be at the centre of Science Teaching. Below are some of the advantages as listed by Paris (2015), in Alasoluyi (2017).

i. **Teacher control:** The lecture is delivered by one authoritative Teacher who has full control of the direction of the lesson and the tone of the class room. Here the Teacher alone is able to shape the course, and so conventional method remains highly consistent when it comes to what kind of information is to be delivered, and how it is delivered.

ii. **New materials:** Lectures are literally just long-winded explanations of information, deemed important by teachers. As such, students can absorb large quantities of new materials.

iii. **Effortless:** The Conventional method makes the learning process mostly effortless on the part of the students, who need only to pay attention during the lecture and take notes. It is the clearest, straight forward and uncomplicated way to expose students to large quantities of information.

iv. The conventional method is one of the most efficient teaching methods for presenting many facts or ideas in a relatively short time. Material that has been logically organized can be presented concisely in rapid sequence.

v. It is particularly suitable for introducing a subject. To ensure that all students have the necessary background to learn a subject. As such basic information can be presented using lecture method. A brief introductory lecture can give direction and purpose to a demonstration or prepare students for a discussion.

vi. The conventional method is a convenient method for instructing large classes as well as large amount of scientific information can be given;

vii. It is often useful to supplement material from other sources or for information difficult to obtain in other ways. If students do not have time for research or if they do not have access to reference materials, the conventional method can fill the bill. In subject areas where information is available in widely scattered places

(text books, journals tapes), the conventional method allows the instructor to summarize and emphasize pertinent material. Report, current research and information which changes frequently may not be easily available in written form, and the conventional method can give students the most up to date information.

viii. The lecture allows a large number of students to receive information from real experts on a subject. In general a person who can speak from actual experience or a scholar who has carefully analysed the results of research will have great credibility with students. The conventional method is often the most effective way of communicating the energy and enthusiasm of a person who has actual experience in a field, thus motivating students.

Disadvantages of conventional method

Many of the listed advantages could be seen as the other side of a coin while the other side is seen as the disadvantages which according to Alasoluyi (2017), are listed thus:

i. **One-way**: People who are against the conventional method see it as a one way street. Teacher dictates information to students who have little or no opportunity to provide their own personal input or protest the information being delivered.

ii. **Passive**: It does not promote meaningful learning of science as it appeals to only the sense of hearing. As has been noted earlier, more effective learning goes on when many senses are involved. The sense of hearing alone easily leads to forgetting.

iii. **Strong speaker expectations**: The conventional method can be disadvantageous to the teacher as well. Not all teachers can be expected to have the same level of public speaking skill. Just as being lectured to might not be the learning method of choice for many students. Being the one that is expected to do the lecturing might not be the best way for every instructor to present their course material.

iv. Most of the classes in our schools consist of mixed stability groups. In each class, the abilities of the pupils vary considerably; therefore, the lecture method cannot meet the different needs of the pupils. Some pupils learn better through the manipulation of objects while others will learn easily through hearing and seeing objects and events.

v. The most visible limitation of the lecture method is that the students easily become restless and disruptive as they become board and their attention is easily distracted; Lecture method encourages rote learning and regurgitation of information without necessarily aiding understanding;

vi. The conventional method does not provide teachers with an opportunity to estimate student progress before an examination. Students are passive and spoon-fed. It is teacher-centred

Guidelines for use of conventional talk and chalk method

Kochhar (2012), enumerated some guidelines for the use of conventional methods as follows:

i The teacher should choose the occasions for the lectures with great care such as a new chapter, the presentation of additional material, the summarizing of an extensive topic and the classification of a complex problems are some of the best occasions for the use of this method.

ii Conventional method should be carefully planned, on the lines of a development lesson plan;

iii It should be built around one central topic with auxiliary sub-topics;

iv it is always best to prepare a synopsis of the lecture as it is useful both for teacher and the taught to avoid pointless digression.

The teacher must be very careful about the delivery of the lecture. He must speak clearly and slowly, naturally and directly so that the students are able to keep pace with him; Instead of continuous talking, the teacher should be interspersed with occasional developmental questions to the students; the teaching should make extensive use of verbal imagery and other oral illustrations. The examples and illustrations should be geared to the cultural background and intellectual level of the class; the conventional method should be full of humour. It should be enlivened by analogies, comparisons, stories and incidents that bear upon the topic; Conventional teaching should utilize concrete illustrative devices such as chalkboards, models, slides, motion pictures and other audio-visual materials whenever possible; the conventional method should be followed by a written test to measure the success of the lecture. The success of any teaching device can be known through the learning process.

Impact of conventional method on science performance

The conventional method as mention earlier formed the majority of the teaching method used by most teachers. Though Ajewale, Ayobasile and Okebukola in Kaka (2007), in Festus (2013), observed that lecture method is not suitable for the nature of science; and more so the age of the students in the JSS, mostly falls within the Jean Piaget concrete developmental stage where the child should be at the centre of his/her learning. The conventional method does not allow students participation thereby hindering active involvement of the learners in the teaching and learning processes. This method has been described as ineffective by researchers and educationists worldwide (Hagerty, 2000; Chukwuneka, 2009). This implies that if the teachers do not begin to employ activity-based learning in the basic science classroom the students may not attain effective learning. Then schools will still continue to grope in the darkness of poor performances of students. Now there are intensive workshops for teachers in Nigeria on the utilization

of Activity–Based Learning strategies. But many teachers are still struggling to adjust to this emerging pedagogy. Hence, teachers of sciences in schools need to be acquainted with the strategies for activity-based learning in their classroom.

Teaching as being practiced today in Basic Science using the conventional lecture method has been found to be ineffective. The teachers do not give learners the opportunity to think and contribute to the learning process (Festus, 2013). According to Stoblein (2009), in Festus (2013), the thinking required by students attending a conventional pedagogy class has been low level of comprehension that goes from the ear to writing hand and leaves the mind not actively involved. The activity based learning pedagogy is expected to make students feel responsible for their learning and support their own personal development. The ineffectiveness of Conventional method of teaching comes to focus through the students results in examinations. For instance, the results of Junior Secondary Certificate Examination for 2010, 2011 and 2012 of Kaduna State, Nigeria which serves as a representation for Nigeria as published by the Educational Resource Centre of the Federal Ministry of Education showed less than forty percent credit and above passed. Hence, there is need now for a new emphasis for a shift from Conventional or lecture teaching method to active learning process in the basic science. The Conventional pattern as is the pattern in which the teacher revises the previous day's lesson first, then the teacher-directed explanations is used to present materials for the new lesson without much involvement of the learners. Using this method, the researcher has observed that:

i. the teacher is very active while the students are passive in the teaching and learning processes;
ii. the teacher tells students formulae and concepts in the various topics of Basic Science and students just try to listen and copy;

iii. *retention and recall of concepts by students are not enhanced. Hence students* forget concepts few days after lesson. Or they try and memorize and write the examination as the certificate is required for further education after which when ask about the concept or application it becomes difficult because learning did not take place in the real sense of it.

Etherington (2011), cited Llewellyn (2005), where it was argued that most of the science conducted in schools is of the traditional cookbook variety where students passively follow a procedure that resembles a ready-made recipe. As a consequence, the Conventional surface approach to learning science has paid little attention to the application of scientific concepts (Selcuk, 2010). Omorogbe, and Ewansiha (2013), found out that ineffective method of teaching where students do not learn and achieve scientific goals but are just allowed to repeat scientific knowledge could be attributed to the poor performance of students in Science. Omofo (2012), stated that effective learning is what brings about better performance and this is achieved when students learn to develop conceptual understanding and thinking skills and ability to solve problems. Hofstein and Naaman (2011), noted that the Conventional approach to teaching science is more often evident in particular branches of science, such as chemistry laboratory investigations. Fui (2010), stated that chemistry (science) is unpopular and irrelevant in the eyes of students. Etherington (2011), cited Hackling,(2005); Ronis, (2008); Zoller (1993), opined that the Conventional teaching of science also does not promote higher order cognitive skills; Therefore this has led to gaps between students' and teachers' expectations of science. This makes students become passive followers of teachers' instructions and worksheets on structured practical exercises, and have found it difficult to be autonomous decision makers (Hackling, 2005 in Etherington, 2011). It appears that the pedagogy of science is not changing, because teachers are afraid of the classroom management involved and the

facilitation of critical discussion and need guidance (Ngeow & Kong, 2001 in Etherington, 2011).

2.5.2 Demonstration Method

It is said that the best way to teach "how" is to "show how". In demonstration method, the teacher really performs the task of teaching both large and small groups in the classroom. This method is important for science teaching as science is not only a theoretical subject but have a considerable portion of practical work also. By carrying out the successful demonstration activities in teaching process, a teacher can provide concrete experiences to the student. This simply means to display something, when a science teacher shows the action of carbon (IV) oxide on a blue moist litmus paper, he is presenting a demonstration. Also the teacher can demonstrate the dissection of toad or a rabbit to the pupils or even plan a manipulation of equipment and material in order for the students to observe scientific phenomena. Most exercises in science classes which teachers carry out when they say "we are having practical or experiment", can be identified strictly as demonstration. Demonstrations can be very effective for illustrating concepts and skills in class, but can result in passive learning without careful attention to engaging students. Ameh, Daniel, and Akus (2007), in Ekeyi (2013), viewed this type of teaching method in which the teacher is the principal actor while the learners watch with the intention to act later. Here the teacher does whatever the learners are expected to do at the end of the lesson by showing them how to do it and explaining the step by step process to them. Mundi (2006), in Daluba (2013), described demonstration method as a display or an exhibition usually done by the teacher while the students watch with keen interest. He further gave an added advantages to include the following: It saves time and facilitate material economy; the method is an attention inducer and a powerful motivator

in lesson delivery; students receive feedback immediately through their own products; it gives a real-life situation of course of study as students acquire skills in real-life situations using tools and materials; it helps to motivate students when carried out by skilled teachers and it is good in showing the appropriate ways of doing things. Atadoga and Onolapo (2008), stated that one of the ways of introducing various skills to the students is through demonstration and 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. Also, 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/students to observe a scientific phenomenon. David (2015), opined that effective demonstration follows three steps of learning cycle thus: Introduction which is the stimulus step; the assimilation step which is the demonstration and development of understanding by the learner; and the application step where the learner understands the logical step by step procedures in carrying out the learning process.

Issues to consider when planning a demonstration

Some suggestions for a successful demonstration are enumerated by Kochhar (2012), as follows:

i Plan the demonstration in great detail and rehearse it. An outline can be prepared with the cooperation of the students;

ii make sure that all the materials and illustrations are nearby when the demonstration begins;

iii break down the demonstration into a simple step by step pattern so that it can be easily understood by the class;

iv proceed with the demonstration slowly so that all students may easily grasp the details;

v whenever possible, involve students in the demonstration;

vi ascertain after each step whether the students have grasped the meaning, contents and explanation. If they have not, the relevant parts should be repeated;

vii verbal explanations should heighten the interest and increase learning;

viii observation guides may be used which should require the students not only to look but also to analyse, record, tabulate, or otherwise be actively involved in observing;

ix plan follow up activities which permit sharing of impressions, analyzing, records, drawing generalisations and making applications;

x and make assignment based on the demonstration as this will help evaluate student learning.

Advantages of demonstration method

This method of teaching covers the limitation found in conventional talk and chalk method in that the students do not only listen but see what is being taught practically. Among others below are list of some of the advantages of demonstration method as stated by Abdullahi, (1982), in David (2015):

i. demonstration motivates the students; Demonstration method can be used to introduce a lesson, and to climax a lesson .It is an attention–inducer and a powerful motivator when it is employed to start a lesson. To bring a lesson to its climax, an exciting demonstration is an excellent method to bring a lesson to an end

ii. the method is effective when teaching certain techniques or skills, theory and practical;

iii. it is less costly in time and materials Where materials and time are important factors for a particular topic, demonstrations save time. Materials are also economized as a large number of students in a class require many times that amount of materials needed by the teacher in his demonstration. In terms of time, equipment can be arranged before the demonstration begins and the time spent in fixing up apparatus during the lesson is saved;

iv. Through demonstrations, the teacher shows how to avoid breakages and accidents and shows the correct use of apparatus as well as how to secure reliable measurements and results. Demonstrations are particularly valuable in repeating experiments which students have performed thus acting as an excellent review

Disadvantages of demonstration method

The demonstration method has a few listed disadvantages which stand as not too helpful in the teaching and learning process by David (2015):

i. One of the obvious limitation of the demonstration method is that it does not allow the students to develop manipulative skill and the students do not satisfy their psychological demands for carrying out activities on their own;

ii. Students always have difficulty in seeing details of the object being demonstrated or apparatus being used. Visibility is usually poor.

iii. Less scope is offered in demonstration for students to become familiar with equipment and material and also for observing and recording events.

iv. Sight alone cannot provide most of the scientific information that the students need.

2.6 Student Centred Approach

Student centred approach is also known as Learner-centred approach. It is a concept and a practice in which students and teachers learn from one another (Nsengimana, Habimana

and Mutarutinya, 2017); a learner oriented rather than content oriented; a means that places learners' at the heart of the learning process and meeting their needs. The concept is understood as active learning which occurs when students solve problems, answer questions, formulate questions on their own, discuss, explain, debate, role play or brainstorm in a class; cooperative or team based learning and collaborative learning (Dawaki, 2014), which takes place when students work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability. Other scholars use the term inductive teaching and learning, which includes inquiry based-learning, case-based instruction, problem-based instruction, project-based learning, and discovery learning. Nsengimana, Ozawa, and Chikamori (2014), observed that learner-centred learning as described in knowledge-based science curriculum is characterized by a number of features including discovery approach, active participation of students, and engagement in experimentation and other science processes.

Gengle, Mohammed, and Badau (2017), opined that in learner-centred teaching, learners actively participate in decision making process about what to learn, how to learn, what kind of help is required and how to decide how much to be learned. According to Gengle, Mohammed, and Badau (2017), proposed a global shift away from instructions that are fundamentally teacher-centred. This means that the student-centred method encompasses the teaching that shifts the focus of instruction from teacher to the student. This method of teaching puts the students' interest first, acknowledging student voice as central to learning experience. Learner-centred teachers do not employ a single teaching method. This approach emphasizes a variety of different types of methods that shifts the role of the instructors from givers of information to facilitating student learning.

Weimer (2012), enumerated five characteristics of student (learner) centred approach as:

i. learner-centred teaching engages students in the hard, messy work of learning;

ii. learner-centred teaching includes explicit skills instruction where the students are taught how to think, solve problems, evaluate evidence, analyze arguments, generate hypotheses.

iii. Learner-centred teaching encourages students to reflect on what they are learning and how they are learning it. All those learning skills are essential to mastering materials in the discipline.

iv. learner-centred teaching motivates students by giving them some control over learning processes;

v. learner-centred teaching encourages collaboration.

Some of the methods that use learner-centred approach are discussed thus:

2.6.1 Project Method

Project method hails from a tradition of pedagogy which asserts that students learn best by experiencing and solving real world problems. According to Barron and Darling-Hammond (2008), project based method essentially involves the following: i) students learn knowledge to tackle realistic problems as they would be solved in the real world. ii) it increases student control over his or her learning. iii) teachers serve as coaches and facilitators of inquiry and reflection iv) the students usually, but not always work in pairs or group.

A project is a teaching and learning method where an individual student or group of students carries out an activity on a component of a particular topic in a subject in order to attain a desired goal. Most of the time students are given considerable autonomy over how, where, when and in what order the task will be carried out (Sakala, 2013 in Alasoluyi, 2017). A project can be said to be a set of organized activities in which

students are allowed to investigate or research on their own. It can be used for individualized instruction as it can be used on a group of students. Students can be grouped into twos, fives or tens in order to carry out a project. This could be making models of ear, skin, eyes, etc., making compost from garbage to serve as fertilizers, charts, exhibitions on how to purify muddy or pond water for drinking. The use of project method for teaching and learning can be in the form of preparing charts, booklets, collection of various insects of different leaves, carrying out special enquiries, and making models (NOUN, 2016).

Project method has been widely supported in science education and today it is an important component of science education. Many current curricula emphasize project-based teaching as a favoured method for "motivating students and facilitating greater retention of learning" (Barak & Raz, 2000 in Cakici and Turkman, 2013). Project-based *studies in science courses improve students' deeper understanding of science.*

Project-based science teaching is grounded on constructivist approach, where learner constructs knowledge personally, through relating new knowledge to prior experience, or socially, through interaction with people around, such as friends, teachers, family and so forth (Bates, 2005 in Çakici and Turkmen, 2013). Project-based learning supports the constructivist principles; working collaboratively with others, reflecting on what have been learned, personal autonomy and active engagement. Therefore, project-based learning is viewed as a type of inquiry learning. Rather than rote procedures, it encourages students to construct their own knowledge and understanding.

Project-based teaching is based on challenging and driving questions that involve students in problem-solving and decision making process (Thomas, 2000 in Holm, 2018). Through project-based teaching, students find solutions to real world problems by asking open-ended questions, designing and conducting investigations, researching problem,

gathering information, drawing conclusions based on the findings, and reporting results (Schneider, Krajcik, Marx and Soloway, 2002 in Cakici and Turkman, 2013). Projects represent students' emerging understandings and allow students to engage in investigations. And by examining work of others, students learn to improve the quality of their work and to communicate more clearly.

Project-Based Teaching and learning organizes learning around the creation of a presentation or a product that is usually shown to an audience. This could include the creation of an original play, a video, or an aquarium design judged by local architects (Barron & Darling-Hammond, 2008). According to Thomas (2000), in Harris (2014), Project-based teaching and learning involves: complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations. Thomas (2000), in Scott and Friesen (2013), further elaborates that:

i. Projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline.
ii. Projects involve students in a constructive investigation.
iii. Projects are student-driven to some significant degree.
iv. Projects are realistic, not school-like.

2.6.1.1 Advantages of project-based method

Through project teaching and learning method, students find solutions to real world problems by asking open-ended questions, designing and conducting investigations, researching problem, gathering information, drawing conclusions based on the findings, and reporting results (Schneider, Krajcik, Marx, & Soloway, 2002 Cakici and Turkman,

2013). Alasoluyi (2017), stated that the project method covers all levels of the domains that is, cognitive, affective and psychomotor and enumerated the following as the advantages of project method:

i. prepare students for the work place. Students are exposed to a wide range of skills and competencies such as collaboration, project planning, decision-making, and time management.
ii. increasing motivation. Teachers often note improvement in attendance, more class participation, and greater willingness to do homework.
iii. connecting learning at school with reality. Students retain more knowledge and skills when they are engaged in stimulating projects. With projects students use higher order thinking skills rather than memorizing facts in an isolated context without a connection to how and where they are used in the real world.
iv. Providing collaborative opportunities to construct knowledge. Collaborative learning allows students to bounce ideas off each other, voice their own opinions and negotiate solutions, all skills that will be necessary in the work place.
v. Increasing social and communication skills.
vi. Increasing problem-solving skills.
vii. Enabling students to make and see connections between disciplines.
viii. Providing opportunities to contribute to their school or community.
ix. Increasing self-esteem. Students take pride in accomplishing something that has value outside the classroom.
x. allowing students to use their individual learning strengths and diverse approaches to learning.

Disadvantages of project method

Most studies carried out on project methods are shown to be effective in increasing student motivation by engaging them in their own learning. However the major disadvantage is that of complexity as well as diversity of its features and the lack of a universally accepted model or theory (Alasoluyi, 2017). Some of the disadvantages are listed thus:

i. it requires a great deal of time which may be expensive.
ii. it disrupts the time-table and is too difficult to evaluate.
iii. it requires the maintenance of students' interest over a long period.

2.6.2 Discovery/Inquiry Method

This 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/she should be left to discover it". Modern science curricula stress students' involvement in science activities through discovery experience. Abdi (2014), opined that in inquiry-based science education, the learner becomes engaged in many of the activities and thinking processes that scientists use to produce new knowledge. Science educators encourage teachers to replace traditional teacher-Centred instructional practices, such as emphasis on textbooks, lectures, and scientific facts, with inquiry-oriented approaches that (a) engage student interest in science, (b) provide opportunities for students to use appropriate laboratory techniques to collect evidence, (c) require students to solve problems using logic and evidence, (d) encourage students to conduct further study to develop more elaborate explanations, and (e) emphasize the importance of writing scientific explanations on the basis of evidence pointed out in order to build the inquiry-based classroom environment must construct a community of practice like the

scientists work. In authentic inquiry-based activities, the students take action as scientists did, experiencing the process of knowing and the justification of knowledge.

Shafiu (2014), noted that discovery method involves an unstructured exploration in the laboratory in which a student through his mental processes such as observing, measuring, classifying and so forth, can draw general conclusions from data which he has gathered. From the standpoint of instruction, two types of discovery methods are recognized, namely guided and unguided Inquiry

Guided Inquiry

This means careful planning, close supervision, ongoing assessment and targeted intervention by an instructional team of teachers through the inquiry process that gradualy leads students toward independent learning (Crede and Kuncel 2008 in Ibe, 2013). Its ultimate goal is to develop independent learners who know how to expand their knowledge and expertise through skilled use of a variety of information sources employed both inside and outside of the school (Ibe, 2013). Guided-inquiry requires students to find out things for themselves. This cannot be done where the teaching method is lecture oriented and study habit inactive. The use of guided inquiry method for teaching biology in combination with an active study habit will motivate and interest students in a lesson. It focuses students' attention and initiates problem solving.

Guido (2017), opined Inquiry-based learning and teaching from the learner's point of view to focus on investigating an open question or problem, where evidence based is used for reasoning and creative problem-solving to reach a conclusion, which the students will defend or present. And from the teacher point of view, inquiry- based teaching focuses on moving students beyond general curiosity into the realms of critical thinking and understanding. The teacher must encourage students to ask questions and support them through the investigation process understanding when to begin and how to

structure an inquiry activity. Inquiry-based teaching and learning is the art of developing challenging situations in which students are asked to observe and question phenomena; pose explanations of what they observe; devise and conduct experiments in which data are collected to support or contradict their theories; analyze data; draw conclusions from experimental data; design and build models; or any combination of these. Hattie (2009) found that this approach resulted in improved student performance in a number of areas while noting that much of the research on inquiry-based teaching has happened in science.

Bransford, Brown and Cocking (2000), in Scott and Friesen (2013), viewed inquiry-based science education as where children become engaged in many of the activities and thinking processes that scientists use to produce new knowledge. Science educators encourage teachers to replace traditional teacher-centred instructional practices, such as emphasis on textbooks, lectures, and scientific facts, with inquiry-oriented approaches that (a) engage students' interest in science, (b) provide opportunities for students to use appropriate laboratory techniques to collect evidence, (c) require students to solve problems using logic and evidence, (d) encourage students to conduct further study to develop more elaborate explanations, and (e) emphasize the importance of writing scientific explanations on the basis of evidence. Sandoval and Reiser (2004), in Abdi (2014), pointed out in order to build the inquiry-based method, the classroom environment must construct a community of practice like the scientists work. In authentic inquiry-based activities, the students take action as scientists did, experiencing the process of knowing and the justification of knowledge.

Of note, inquiry-based teaching increased the amount of time students spent in labs and decreased teacher-led discussions in classrooms. Research Council Washington (2000), in Scott and Freisner (2014), defined scientific inquiry as a process where students:

i. identify questions and concepts that guide investigations (students formulate a testable hypothesis and an appropriate design to be used);

ii. design and conduct scientific investigations (using major concepts, proper equipment, safety precautions, use of technologies, etc., where students must use evidence, apply logic, and construct an argument for their proposed explanations);

iii. use appropriate technologies and mathematics to improve investigations and communications;

iv. formulate and revise scientific explanations and models using logic and evidence (the students' inquiry should result in an explanation or a model);

v. recognize and analyze alternative explanations and models (reviewing current scientific understanding and evidence to determine which explanation of the model is best); and

vi. communicate and defend a scientific argument (students should refine their skills by presenting written and oral presentations that involve responding appropriately to critical comments from peers). Accomplishing these six abilities requires K–12 teachers of science to provide multi-investigation opportunities for students.

Barrow (2017), states that "when students practice inquiry, it helps them develop their critical thinking abilities and scientific reasoning, while developing a deeper understanding of science". The findings of Barrow (2017), are in support of The National Research Council (2000), with regards to inquiry learning.

Guidelines for use of discovery

Maikudi (2015), cited Gerver and Sgroi (2003), description of eight critical steps necessary in developing successful guided-discovery problems. These steps are...

i. **Selecting the content:** Choose content that is new but derivable using skills and knowledge that the students already possess. For example, in the altitude

of the moon problem, students could draw based on their knowledge of Earth's seasons and daily rotation, the phases of the moon, and the altitude of objects in the sky as they figure out why there are variations in the altitude of the moon and the length of time it is up.

ii. **Stating the aim:** Clearly state the objectives of the lesson without spoiling the "Aha!" component. In the moon problem, I stated the objectives as a series of questions but they can also be stated as a bulleted list or an introductory paragraph.

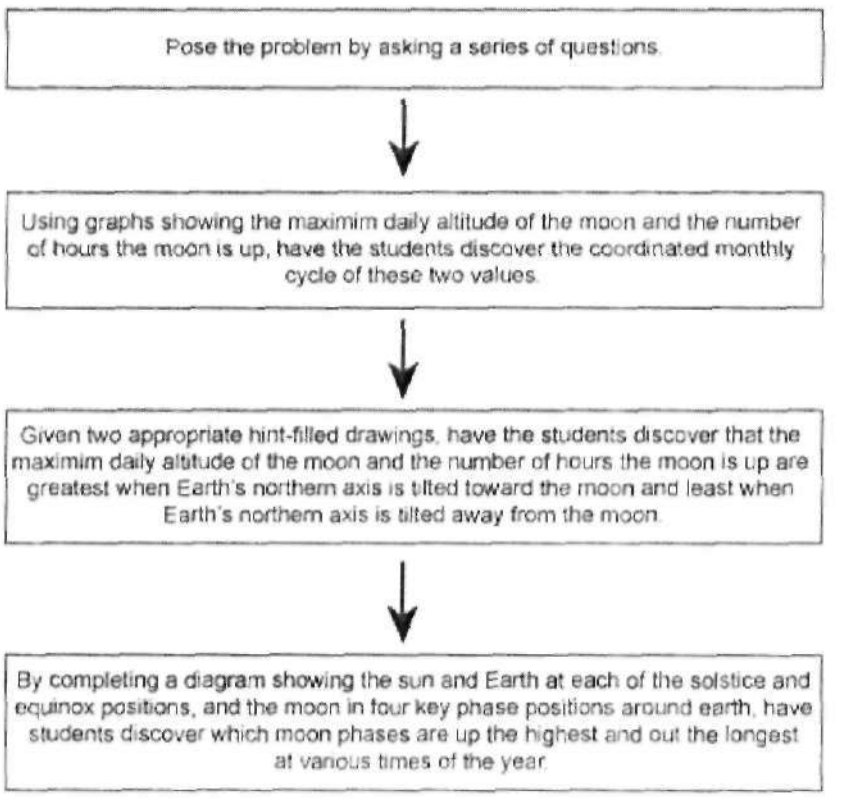
iii. **Identifying the prerequisites:** Identify the knowledge and skills that students will need in order to successfully complete the problem. Then test to make sure the students have them. In the moon problem, students need to be able to:

   a. Identify the phase of the moon, given a drawing of the relative positions of the sun, moon and Earth.
   b. Identify the appropriate solstice or equinox, given a drawing of the relative positions of the sun and Earth and the tilt direction of Earth's axis.
   c. Use the circle of illumination to determine the proportion of each day that an object in the sky is visible.
   d. Determine the altitude of an object in the sky, given a drawing of the horizon and the light rays emanating from that object.

In prior class sessions, students learn and repeatedly practice these skills. Testing of these skills is accomplished through student presentations and whole-class discussions. Note that prerequisite skills need not be highly developed; they can still be rudimentary, in which case the guided-discovery problem serves a dual role

as both a way to learn new concepts and an opportunity to practice and improve previously acquired skills.

iv. **Setting up a graphic organizer:** In designing the lesson, it is very helpful to make a schematic outline that reveals the flow and logic of the lesson. Here, for example is the graphic organizer for the moon problem as cited by Sgroi (2003), in Maikudi (2015).



Organizing one's thoughts in this way helps one design the lesson in a logical sequence. Structure the activity so that students build an understanding of each underlying concept individually before putting all of the concepts together into a comprehensive model. As possible, include one or more hands-on activities. Analogous models are especially powerful but use them with care - they should really actually show what is intended for them to show. Design the lesson so that

the students must confront common misconceptions as they work. For example, while the researcher undertook an activity on seasons, students were confronted with the fact that Earth is closest to the sun in January, directly contradicting the common misconception that seasonal temperature differences are caused by Earth's distance to the sun.

v. **Writing the lesson:** At the beginning of the lesson, trigger students' curiosity by making the problem puzzle-like, a mystery to be solved. A real-life scenario can also heighten engagement by showing students the relevance of the material to be learned. Make the lesson challenging, but not frustrating or anxiety-provoking. Each step should be small enough to feel doable by the student. When incorporating hands-on activities, keep procedures simple and provide clear instructions; the focus should be on understanding what happens, not on doing the experiment "right." Keep the students engaged by keeping busy work, such as repetitive calculations, to a minimum. The heart of a guided-discovery problem is the leading questions that the students answer along the way. Here is where proper scaffolding is crucial. When well-written, these questions trigger the "Aha!" moments that make guided-discovery problems so exciting and effective. Writing these questions is a delicate balancing act of providing just enough help. If too little help is given, the students feel overwhelmed and give up in frustration. If too much help is given, the students are robbed of the thrill of discovery. The students should "gradually see the concepts unfurl" Geever- Sagroi (2003), in Maikudi (2015), stated that specific questions are asked and should be made very clear what is asked. Avoid asking too much at once; each question should be just a small step toward the final goal. As appropriate, have students' complete partial diagrams or tables. Multiple-choice questions can be an effective way to restrict the options available to the students and thus focus their

thinking. Frequently ask students to justify their answers, revealing their reasoning. If the remainder of the activity depends upon the correctness of a particular answer, instruct the students request a teacher check before they move on.

vi. **Using a naive proof reader:** Before springing a brand-new guided-discovery problem on your students, have a colleague or student work through the activity and uncover any pitfalls such as unclear directions, missing steps, hidden assumptions, or errors.

vii. **Writing a follow-up activity to check for accountability:** A guided discovery problem should be an essential part of the course curriculum, not a fun but irrelevant tangent. Students will not take such lessons seriously unless they know they will be held accountable for the concepts learned. Once, after doing very poorly on an essay question based upon a guided-discovery problem that took the form of a simulation game, a student complained that she had considered it "just a fun game, not something we had to learn." The follow-up activity need not be an exam; it could be another guided-discovery problem that builds on the first, an essay assigned as homework, or a presentation to the class.

viii. **Field testing and revising:** Inevitably, the guided-discovery problem will not be perfect the first time, or even the second, third, or fourth. As soon as possible after the lesson, write down what worked, what did not, and what should be done differently next time. Jot down any ideas for making the lesson more enjoyable or more profound. When that has been done and, especially when a lesson has been carefully revised while it was still fresh in the researcher's mind, having been prepared properly for the next class.

Advantages of discovery method

The discovery method of teaching and learning claims the following advantages as outlined by Kanno (2018):

i. Promotes individual and cooperative learning in the classroom and the environmental laboratory.

ii. It triggers curiosity on the part of the learner through relevant stimulus guided by the teacher.

iii. It is an activity-based learning by–doing and exploration method where students are encouraged to cultivate the desire to learn more and excel.

iv. Learning is based on set induction and prior of previous relevant knowledge of the students which is usually employed as a base for the acquisition of new knowledge. experience;

v. highly motivating as it allows individual the opportunity for experiment and discover something for themselves;

vi. It promotes effective participation of every student in the classroom This is consequent upon the fact that it is mandatory that each student should pay adequate attention to be able to decode the prompts, clues and guides from the teachers during the process of learning basic concepts.

vii. There is great emphasis on cooperation and collaboration among students as well as among teacher and students.

viii. It concretizes learning and knowledge in the sense that students are more likely to retain the facts they discovered by themselves more than those they were told or given by the teacher.

Disadvantages of discovery method

In as much as discovery method of teaching is prevalent innovative instructional means, it has some disadvantages as highlighted by Kanno (2018). These are some of the disadvantages:

i. It requires a lot of planning before implementation;
ii. There may be inadequate instructional resources for the teachers students for precipitating due learning. It is not cost effective;
iii. Unsuccessful attempts at arriving at needed solution may have a negative impact on students;
iv. Creations of misconception;
v. Lack of adequate fund for the provision of all resources and activities may deter progress.
vi. Students that are bright usually tend to overshadow the other students.
vii. It may not be effectively employed to manage large classes

2.6.3 Activity-Based Method

This is a method where the learner is actively involved in the teaching –learning process. It must be realized that whatever a child does by himself, however rough or imperfect, is more important than the neat and perfect one done by the teacher for him in the learning process (Kowoser & Berman, 2014). Akpan (2004), in Gadzama (2012), said that Activity-Based Method comprises of all activities of the 3 H's (hand, head, and heart) leading to better knowledge of the physical and social environment The activities link home, school and community in Science. Activity based method is anything which is carried out with a purpose in the social environment involving physical and mental actions which help in the establishment of stimulating environment for creative

expression. Inakwe (2002), in Iwuji (2012), viewed Activity-Based Method as that which enables students to learn with the same vigour that marks their natural activity. Activity-based learning involves reading, writing, discussion, practical activities, engagement in solving problems, analysis, synthesis, and evaluation. David (2007), in Iwuji (2012), introduced element of joy, team spirit, respect of each other's opinions and reduces abstractness in science concepts. Danjuma (2017), in Mari (2001), stated that in Activity–Based method the work is done in friendly manner, gladly with motivating spirit and active throughout the whole lesson. It can be pointed out that students enjoy wholesome living in stimulating environment where desirable attitude, interest, and skills are formed.

Features of Activity- based method

One of the best ways to understand a thing is to get ones hand on it. Activity- Based Method revolves around students learning through 'hands-on mind-on' just like the great philosopher Confucious put it "I hear and I forget," "I see and I remember," "I do and I understand." Kochher (2012), succinctly brings out the features of this method when stating that the first and most natural form of learning is "learning by doing," "by activity,", and "experience."

Ravi (2015), stipulated that learning by doing is one of the best ways students learn as they perform activities related to the subject's topics. The students are spontaneously active by nature. Therefore they should be acquainted with facts while they engaged in activity related to those facts by which they can develop their natural abilities and qualities. Dawaki (2014), stated that "involvement is the key to intellectual development and for the school student this includes direct physical manipulation of objects". Thus the students learn best through their activities.

Learning through or by activity involves active participation of the learner in the learning process, teaching science should be activity-oriented and any teaching that neglects the

activity-based aspect of science teaching renders "empty" knowledge. Activity therefore encourages active participation of students to construct their knowledge. Ben-Yunus (2008), emphasized that student should be challenged through meaningful activities to find solutions to simple problems that are within their range of ability.

Experience (experiment) as one of the features of Activity-Based Method is gained through activities carried out by an individual or a group through exercise and experimental approaches for the purpose of making personal observation of processes, products or events. Experience the adage goes is the "truest and best master and whose lessons we never forget". Knowledge acquired through actual experience is far more permanent than knowledge through words (Ediger and Rao, 2011).

Okwudishu (2011), in Festus (2013), viewed Activity teaching and learning method as an approach where the teacher only acts as a facilitator and learners are at the centre of the learning process by their high involvement in practical activities and discussion. It is the mode of learning guided by the assumption that (i) Significant learning takes place when the subject matter is perceived by the learners as relevant to their own purpose (ii) Much significant learning is acquired through doing. (iii) Learning is facilitated by the learner's responsible participation in the learning process (iv) Self initiated learning involving the whole person- feeling as well as intellect – is the most pervasive and lasting type of learning.

Activity-based method and students' performance in basic science

Research study by Festus (2013), suggested that the use of activity-based learning techniques have positive impact upon students' learning. For example several studies such as Bawa (2011), Gadzama (2012), have shown that students prefer strategies that promote active learning rather than traditional lectures. Also, Emaikwu (2012), reported

that the performance of students taught using activity –based learning method was better than those taught using lecture method and discussion method.

The issue of poor performance in science has been of great concern to many scholars (Yero, 2009). While Peter (2009), observed that the performance of students in science courses in Nigeria when compared to students from other countries of the world is very unsatisfactory. While Idris (2014), Gadzama (2012), and Shafiu (2014), found out in their separate studies that there is a decline in student's performance in Basic Science. Similarly previous performances in science have not been encouraging but rather disheartening. This can be traced back to as far back as 1986 when the then Minister of Education Professor Jibril Aminu expressed utmost disappointment over the students performances in Science WAEC Examination. Ezekwesili (2007), the then Minister of education of that time mentioned that the specific challenges facing the education sector include: inadequate infrastructural facilities, weak quality assurance mechanism, high gender disparity in the North and drop out in the East among others. However a number of researchers such as Atadoga (2003), Bichi (2002), and Mari (2001), have attributed the low performance in Science to poor laboratory facilities, teachers qualification, work load and teaching method.

Dawaki (2014), observed that globally there is a general concern on the performance in Science, Technology and Mathematics but the problem is so pronounced in developing countries rather than the developed countries. In Nigeria, the researcher observed that most teachers are reluctant to use teaching methods shown by researchers to be more effective than the Conventional lecture method as such even the science curriculum is not properly implemented. Nzewi and Njuku (2006) in Mokiwa and Agbenyeku (2019), opined lack of emphasis on pedagogic skills that will enable teachers to adopt learner-

centred methods, inability to sustain motivation and interest of students stand as a factor militating against student effective performance in science.

Impact of activity-based method on teaching and learning

One of the best ways to understand something is to get ones hands on it, and just like the great philosopher Confucius puts it "I hear and I forget, I see and I remember, I do and I understand". Activity-Based Approach revolves around students learning through "hands-on mind-on" activities since most students in the junior secondary schools are within the range of concrete operational stage and their thinking being concrete rather than abstract, concepts which are difficult for most students to grasp by hearing them explain, becomes less difficult with the use of Activity- Based method (Dawaki, 2014).

Activity-based approach provides opportunities for experiential learning which involves links between the thinking and the doing. It is assumed that students who handle the learning activities successfully have learnt the concept to perform that particular activity. A study conducted by Khan, Mohammed, Ahmed, Saeed, and Khan (2012), on Impact of Activity-based teaching on students' academic achievement in Physics in their introduction cited many researchers who gave the meaning of what Activity-based means.

Activity-Based Method (ABM) is a learning method in which students are engaged in the learning processes. This teaching method, in the words of Harfield, Davies, Hede, Panko and Kenley (2007), in Anwer (2019), stated that "students actively participate in the learning experience rather than sit as passive listeners". Learning activities if based on real life experience help learners to transform knowledge or information into their personal knowledge which they can apply in different situations. Anwer (2019), says that active learning method is different from Conventional method of teaching on two points. First, active role of students, secondly, collaboration among students. Anwer further

defined Activity –Based learning as the learning process in which "students are actively involved in doing or in seeing something done. Activity –Based Method, frequently involves the use of manipulative materials, meaningful learning, engages activity." According to Churchill (2003), in Ul-haq, Khurram and Bangash (2017), ABM helps learners to "construct mental models that allow for 'higher-order' performance such as applied problem solving and transfer of information and skills".

In ABM, the learner examines learning requirements and thinks how to solve a problem at hand. The students do not learn about the content. Rather they learn about the process to solve the problem. As they go towards the solution of the problem, they also learn about the content (Churchill, 2003 in Khan, Muhammad, Ahmed Saeed, and Khan 2012). Nayak (2014), opined that Activity- Based method gives room to students to talk about what they are learning, write about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves". Student's motivation is high if these activities are personally relevant to the students.

Several literatures such as, Akinoglu and Tantogan (2007), Shafiu (2014), and Cavanagh, Aregon, and Graham (2016), opined that active learning is the key for improved educational attainments, The more students are involved in the learning process, the more they learn the content and so the more they are able to know the topic. Meltzer and Thornton (2013), remarks in 'Research-based Active-learning Instruction in Physics', that activity-based learning greatly improves students learning and understanding of scientific concepts. Choo (2007), in Khan, Muhammad, Ahmed Saeed, and Khan (2012), noted the positive impact of ABM on the students as well as teachers in a vocational institution.

Batdı (2014), reported that activity based learning has effective and positive results in terms of increasing the interest and positive attitudes towards the course. Çelik (2018),

stated that activity based learning activities improve students' academic achievements and attitudes towards activities. Çelik (2018), study also obtained results that demonstrated that activity based education may be utilized more than traditional education in teaching the mathematics subject of integers. Additionally, some study results reported that prospective teachers provided opportunities for entertainment in the learning process, and they had a positive approach in terms of using activities in the learning process for making learning easier and supporting persistent learning (Kösterelioğlu, Bayar, and Kösterelioğlu 2014).

In an "active-learning classroom" students are active learners not the passive receivers. According to Stöblein (2009), in Khan, Muhammad, Ahmed, Saeed and Khan (2012), this approach provides a way to integrate learning within students' knowledge and by exposing them to a variety of activities, helps them learn how to learn. He describes ABM as a "successful teaching model" in the field of science. These activities, if carried out in an effective manner, develop skills like Team-working, Communication, Design, Leadership, Project management, Research, Problem-solving, Reflection and Life-long learning in the learners. These activities, if based on the real life experiences, can help students to apply the same in their practical life and hence prepare students for future life. In Activity –Based teaching/learning environment, the teacher is a facilitator, motivator, guide and a coach not a sage on the stage (Stößlein, 2009).

2.6.4 Problem-Solving Method (PSM)

The problem-solving method attempt to train the minds of the students by confronting them with real problems and giving them the opportunity and freedom to solve them. This method generally referred to as a way in training the students to solve problems. This enables students to think and solve problems mentally (Kochhar, 2012).The method

is based upon the process of finding out the results by attacking a problem in a number of definite steps. So, the students are involved in finding out the answer to a given problem using Kochhar (2012), outlined steps of the problem-solving as follows:

i discovering, considering, discussing, selecting and stating the specific problem or question;

ii collecting, organizing, comparing and judging significant information in the light of the defined problem;

iii Exploring the problem and framing some possible solutions;

iv drawing preliminary conclusions for further exploration and study; and

v evaluating findings and establishing conclusion

Kochhar (2012), further listed some essentials qualities of problem-solving to include among others:

i. Problem-solving should be in line with the needs and interest of the students;

ii. The problem should be valuable and timely;

iii. It should impart functional and rich learning;

iv. The students should feel that the problem is their own. The teacher can motivate students in a manner to make the students think out the problem under study themselves;

v. Students should identify the problem and means of execution to avoid wastage of time;

vi. Conclusions and generalizations, once found should be stated very clearly so that these can be further used in the solution of new problems.

The problem-solving method involves the identification of a problem for students to solve with minimum guidance from the teacher. De Witte and Rogge (2012), observed that Problem-Solving Method has predominantly been adapted in colleges and

universities - particularly in the medical education programs, but also, though to a lesser extent, in other fields and disciplines such as; economics, management, chemistry and psychology.

Problem-Solving according to White (2001), in Bhounsule, Samuel, Walke, and Bandodkar (2015), is a type of teaching and learning where students work with class mates to solve complex and authentic problems that help develop content knowledge as well as problem-solving, reasoning, communication, self-assessment skills. According to Trevedi (2013), PSM is a teaching and learning method where the students actively participate in the learning experiences in the process of finding solutions to problems, the students, who learn through their mistakes and successes become creative and develop reflective or critical thinking. Tiwari, Rathor, and Singh, (2014), asserted that problem-solving method provide maximum freedom of thought and action to the students to make their own decisions in tackling problems whenever, they are provided with a specific questions or task and are directed to seek out a variety of alternative solutions. On the other hand, Problem-Solving Method is any learning environment in which the problem drives the learning that is before students learn some knowledge they are given a problem. The problem is posed so that the students discover that they need to learn some new knowledge before they can solve the problem. Students acquire knowledge skills and understanding through a staged sequence of problems presented. Problem-Solving is a student-Centred method of teaching that involves learning through solving unclear but genuine problems.

Problem-Solving Method consists of placing before the learners a true-to-life, specific and well defined problem requiring solutions. Such problems would have grown out of the learners' experiences and the problem solving skills acquired helps in moulding their

existing knowledge and skills. The learner is able to pay attention to details which may later influence the outcome of the problem and identifies similarities and differences between typical situations. The learner is guided to identify problem, have a fair knowledge of what he intends to accomplish and how to gather necessary data for the solution to the problem. Borich (2011), opined that the problem–solving identifies and provides for students in advance a sequential advance organizer such as:

i. Identification of the problem requiring solutions
ii. Definition and delimitation of the problem
iii. Collection of necessary data required to solve the problem
iv. Formulation of hypothesis for solution
v. Testing of the hypothesis
vi. Checking whether the result leads to the solution otherwise the procedure is revised and the process repeated until the problem is solved or he gives up.

It is the duty of the teacher to ensure the learner is guided at every stage of the process. Borich (2011), further explain that when planning a problem –solving lesson the teacher should remember to do these things:

i clearly define the problem. Although the solution may not be in sight, the problem should be described in detail and placed within a meaningful context close to the learners every day experience;

ii make clear to the learners that they are to predict how to solve solve the problem. Predictions should be achievable within a realistic time frame and available resources and can be altered as new information is obtained;

iii indicate that learners are expected to access, evaluate, and utilize data from a variety of sources. And will need to critically examine the sources and reject those that are less credible or opinion rather than fact; require

that solutions fit the problem and be accompanied by clearly stated reasons as to their value or effectiveness. Examples can be implemented more quickly at less cost and with superior results.

Features of problem-solving method

Science educators implemented problem-Solving method as early as the 1930s, Hang (2012), emphasized the necessity of teaching science through problems that are relevant to students, using problem-solving instructional strategies and suggested that science concepts are learned more meaningfully through problem-solving.

Hmelo-Silver (2004), in Scott (2017), suggested that Problem-Solving Method is an instructional approach that offers the potential to help learners develop flexible understanding and lifelong learning skills. Among the numerous descriptions about PSM, The key features of PSM are: Interdisciplinary, self-directed learning, situatedness of knowledge, collaboration, motivational orientation, self and peer assessment, problem-based and authentic assessment. Among them, ill-structured, real world problems, problem-solving, motivational orientation and collaboration were key features identified to support science learning. Therefore, the role of each of these features in the PSM process will be re-examined and the ways these features can be incorporated into the learning process to support science learning will also be discussed. While the content and structure of PSM courses may differ, the general goals and learning objectives tend to be similar. PSM begins with the assumption that learning is an active, integrated, and constructive process influenced by social and contextual factors. Idris (2016), listed the features of problem –solving method as:

i it consists of students-centred learning;

ii learning occurs in small groups;

iii teachers act as facilitators, or guide;

iv problem stimulates the development and use of problem-solving skills of intellectual curiosity; new knowledge is obtained through self-directed learning.

Advantages of problem-solving method

Problem solving method has the following advantages as discussed by Guido (2017), and summarized by the researcher thus: Development of long-term knowledge retention by encouraging students to discuss and answer questions about new concepts as they are learning them; usage of diverse instructional types that meets diverse learning needs and styles of the students by addressing real-life issues that required real-life solutions; continuous engagement where the teacher joins the groups and give guardians and certainly inject excitement in to the class; the problem solving method can helps develop skills they can transfer to real-world scenarios and can allow learning to be more profound and durable; and improvement of teamwork and collaboration. More advantages are outlined by the researcher as found out during the usage of the method on the experimental group 2.

i. it stimulates intellectual curiosity and motivates to search further thereby encourages creativity among learners;
ii. It really engages learner leading to real understanding and so increases the amount of experience in learning;
iii. It prepares the students in solving-problems. This allows the learner to relate class work to true-to-life situation there by enabling the learner to solve problems in actual life;
iv. It stimulates thinking, reasoning and imagination of the students;
v. It develops a habit of doing work independently in the students;

vi. It allows the learner to learn at his own pace; and

vii. The learner learns from his successes and failures.

Disadvantages of problem-solving method

The following are the disadvantages of problem-solving method as stated by Guido (2017):

i. Potentially poorer performance on tests.

ii. Student unpreparedness.

iii. Teacher unpreparedness.

iv. Time-consuming assessment as assessing students' performance throughout problem-solving exercise demands constant monitoring and note-taking.

v. Varying degrees of relevancy and applicability as it can be difficult to identify a tangible problem that students can solve with content they're mastering.

vi. Confusion can set in leading to loss of interest by the learner.

vii. Learner may not benefit much from the process if too much guidance is given by the teacher.

Problem-solving method and its performance on basic science

De Witte and Rogge (2012), in their Research Problem –Based learning in Secondary School Education came up with this literature about PBL and student outcomes. Some studies indicate that PSM has positive impacts on the students' knowledge and skills, other studies finding more complex results, indicating that PSM students do better in terms of problem solving skills while they do equally good in terms of acquiring knowledge. Moreover, Colliver (2000), in DeWitte and Rogge (2012), remarked that the positive effects of PSM on test scores may be attributable to selection bias (as most reviewed studies are non-randomized). More recent studies analyze the effects of PSM on several categories of student outcomes. Dochy, Segers, Van den Bossche, and Gijbels

(2014), for instance, performed a meta-analysis (using both a vote counting and a combined effect size method) to look upon the link between PSM and students' knowledge and knowledge application. They observed (i) a negative impact of PSM on students' knowledge base and (ii) a positive and statistically significant effect of PSM on students' knowledge application. With respect to the former result, Dochy, Segers, Van den Bossche, and Gijbels (2014), indicated that this should be treated with caution as it is strongly influenced by outliers.

Dochy, Segers, Van den Bossche, and Gijbels (2014), also looked at the impact of PSM on three levels of knowledge (that is, understandings of the concept, understanding of the principles that link concepts and linking of concepts and principles to conditions and procedures for application). They found the most positive effects at the level of knowledge which concerns understanding principles that link concepts. Smits, Verbeek, and De Buisonje (2002) in Strobel and Barnevald (2009), focused particularly on the effects of PSM on student knowledge as found in studies in medical education and concluded that overall the evidence that PSM has positive effects is rather weak.

Procedures for the use of problem-solving methods in basic science

Problem-Solving can be described as a method which does not simply find solution to a problem but also expresses the method as that which problems are used to ease learning (Awang and Ramly 2008). The critical educational task today iss the ability to identify and solve problem thereby enhancing effective and meaningful learning of Basic Science concepts. The following procedures for problem solving approach are outlined by Meziobi, Fubara, Mebiobim. (2008);

i. the teacher may introduce and clarify the problem in which the problem is stated.

ii. students are then left on their own to provide tentative suggestions or solutions to the problems through working individually, in pairs or in group.

Problem-based curricula provide a learning environment in which competence is fostered not primarily by teaching to impart knowledge, but through encouraging an inquisitive style of learning. Isa (2012), suggested that when using problem solving the teacher is charge with the following duties: encourage the students to explore and test new ideas; encourage the students to prove and share their findings with other student; raise new and more questions to guide the students to look for more ideas; point out to the class, the creative and original work of any student; and be in full control of the class throughout the lesson. Scientific concept would be meaningfully learnt if they are to be transferable to problem- solving situation.

Problem-solving method and classroom learning environment

One must reconsider what students really need to learn and the environment in which they learn. Much of the enthusiasm for the Problem-Solving Method to learning comes from instructors who feel revitalized by the creative energy it releases. Nwangi, Barchok and Ogala (2015), opined that students should be taught how to solve problems in classroom for them to acquire the necessary skills to help them solve problems that they may encounter in their everyday life.

Problem-Solving Method is more satisfied with their teaching and the classroom as a learning environment than students taught using the conventional method. De Witte & Rogge (2012), pointed out that students that use Problem-Solving Method for their lectures/teaching find it more nurturing and enjoyable. Moore-West *et al.* (1989), in De Witte & Rogge (2012), looked upon how students perceive and appreciate their learning environment. They found that students rated their experiences higher in terms of

flexibility, emotional climate, meaningfulness, nurturance, student interactions, and hospitability. Dochy, Segers, Van den Bossche, and Gijbels. (2014), showed that students in the Problem-Solving Method were satisfied with the problem solving, applicability, and group discussions aspects of the Problem-Solving Method.

Problem-solving method and student motivation

Self-directed and active learning is believed to engage students in developing a higher level of autonomous study motivation, a larger variety of learning skills, and better learning outcomes. Based on the self-determination theory and the concepts of autonomous motivation and controlled motivation, Vansteenkiste, Soenens, Sierens, Luyckx, and Lens (2009), distinguished between four motivational profiles of students and found that the" good quality motivation" group of students (that is, the students with high autonomous and low controlled motivation) displayed the most optimal learning pattern relative to all other groups of students. It also seems that an active learning environment stimulates students to adopt deeper learning strategies in the study of the course content (Wilson & Fowler, 2005 in Baeten, Kyndt, Struyven, and Dochy, 2010). That is, whereas conventional students are typically more studying the course for reproduction, PSM students are more likely to study the course for meaning (with more focus on understanding the material rather than on just being able to memorize the material for the short term). De Witte & Rogge (2012), observed that this result was also found at different levels of education (that is, not only in higher education). For instance, using a meta-analysis, Dignath, Buettner, and Langfeldt (2008), examined the effects of self-regulated learning interventions (such as, PSM) on students' motivation in primary schools. The results of this analysis showed a considerably positive effect.

However, there are also studies who found more mixed results. Mairin and Kenneth (2017), cited Phipps, Phipps, Kask, and Higgins (2001), examined the students'

perceptions of cooperative learning (like PSM) and, in particular, the impact of such learning approaches on student motivation. In their study, about half of the students believed that techniques of cooperative learning were rather ineffective in terms of increasing student motivation. That is, approximately one out of two questioned students perceived the active learning approaches to have a positive influence on the students' motivation; the other half was not at all convinced from this. So, as with the effects of PSM on student outcomes and student perception and satisfaction with the classroom learning environment, the findings of previous studies on the association PSM-student motivation is not conclusive.

Nevertheless, PSM students are also identifying aspects of PSM that are less positive. In particular, Struyven, Dochy, and Janssens (2008), showed that while the perceptions of students in the conventional courses were almost uniformly positive, the experiences of students that followed courses with student-activating teaching approaches were more disperse with both extreme positive and extreme negative perceptions. Students were generally positive about, such as, the challenging and activating nature of the assignments. They were more negative about the time pressure and workload associated with the assignments, the increased responsibility, and the possibility of group difficulties and lacking co-operation with some group members.

Impact of problem-solving method on teaching and learning

Problem-Solving method is a constructivist approach that emphasizes the importance of contextualized learning provides students with real-life problems which are tackled in a group with the students helping each other. The Problem-Solving Method contrasts with the Conventional learning approach by placing emphasis on active student participation in learning and it uses small group instruction as a means to deliver knowledge. The uses of Problem-Solving Method, which are based on real-life situations and are loosely

structured, serve as a stimulus to develop students' critical thinking Borůvková, Emanovský (2016). Borůvková and Emanovský further described Problem-Solving Method as an active learning instructional method that uses real-life problems to facilitate student learning. Students first encounter the problem which serves as a stimulus for the application of problem-solving or reasoning skills and for the search for information or the knowledge needed. Drawing upon many definitions of Problem-Solving Method, Hartman, Moberg, and Lambert (2013), cited Barrows (2002), a pioneer of Problem-Solving Method, has identified the following key components within the Problem-solving context: Problems are ill-structured and presented as unresolved; students generate multiple thoughts on how to solve it. A student-Centred approach; students determine the key issues of the problems, define purpose and solve them. While Teachers act as facilitators and ask students meta-cognitive questions.

It is a constructivist, student-focused approach that promotes reflection, skills in communication and collaboration, and it requires reflection from multiple perspectives (Yelland, Cope & Kalantzis, 2008). Students are confronted with real-life scenarios or a problem that requires a solution. The problem is often ill defined and *messy*, so there is no clear path or procedure to follow. Students analyze the problem and the context and apply deductive and inductive processes to understand the problem and find a possible solution or solutions. They use *a priori* and *post priori* knowledge to reason intellectually and are active learners in collaboration with others in small groups (Carroll, Clark, Kane, Sutherland & Preston, 2009 cited in Etherington, 2011). Learners are required to utilize, wherever possible, the expertise of specialists and community members. The teacher's role is that of facilitator.

It aims at developing skills and habits of life-long, self-directed learning. Borůvková, Emanovský (2016), viewed problem-solving method where students work with

classmates to solve complex and authentic problems that help develop content knowledge as well as problem-solving, reasoning, communication, and self-assessment skills. These problems also help to maintain student interest in course material because students realize that they are learning the skills needed to be successful in the field. Almost any course can incorporate PSM, and most Faculty and students consider the benefits to be substantial.

2.7 Empirical Studies

A number of empirical studies were reviewed, the essence was to look at the gap created by other researchers, the gap that this present study would fill, the similarities and difference that exists in the previous studies and the present study. For example: Akkus (2015) carried out a study on Activity–based teaching in Social Studies education in University of Kazim Karabekir, Faculty of Education. The aim of the study was to determine pre-service social studies teachers' skills for planning and implementation of activity-based teaching change before and after the action; to determine the difficulties pre-service social studies teachers encounter during the planning and implementation of activity-based teaching process; to ascertain the differences between the knowledge and skill levels of pre-service social studies teachers about the directions subject before and after the action; and to determine the pre-service social studies teachers' views on the contributions activity-based learning made to their professional development. The research designed used was one of the qualitative research methods.

The sample size of the study consisted of 6 undergraduate pre-service teachers, 3 females and 3 males, studying in the fourth grade of Social Studies Teaching in Kazim Karabekir Education Faculty in Ataturk University in 2014-2015 fall (season) term. The findings of the study revealed that pre-service teachers' skills for planning and implementing

activity-based teaching improved remarkably and they gained some knowledge and skills regarding teaching profession and direction the following suggestions were given: The physical conditions of education faculties should be improved so that activity-based teaching implementations in teacher education can popularize. Materials, equipment and tools needed must be provided and classrooms and workshops should be designed in such a way that activity-based teaching is practiced. Also, pre-service teachers must be offered more opportunities for practice to experience activity-based teaching. Activity examples regarding social studies learning domain must be designed to develop pre-service teachers in many ways. Experimental studies must be carried out to determine the effect of activity-based teaching on pre-service teachers' cognitive, affective, and motor skills.

The previous study was similar to the present study in that one of the variables was also Activity- based but differs in the following ways: the study target was Pre-service teachers and the subject used was Social Studies and it was carried out in Turkey, while the researcher's own are students of secondary school and the subject covered is Basic Science and the study is in Nigeria.

Another study was carried out by Shah and Rahat (2014), on the title, Effect of activity Based Teaching Method in Science in Allama Iqbal Open University, Islamabad, Pakistan. The purpose of the study was to find out the effectiveness of activity base teaching method on the learning of science students; and explore the linkage between teaching technique and student learning. The study was an experimental study. The measuring instrument used was an achievement test (post-test). Total students of 50 which were divided into two groups, that is experimental and control groups. Each group consisted of 25 students. These groups were equated on the basis of marks achieved by the students in a test of 4th class science taken by District Teacher Educator (DTE). The control group was taught by lecture method and the experimental group was taught by

activity-based method. The study revealed that the performance of experimental group was better than the performance of the controlled group of the students. Furthermore there was significant difference between the performance of the experimental group as compared to the control group with reference to knowledge, comprehension, and application skill. Overall, the findings of the study showed that the activity based teaching was much effective than the lecture method of teaching Science at elementary level.

The previous study was similar to the present study as it was carried out on the effect of activity based teaching method in Science which was the same with the present study. The studies are related as the previous study was an experimental study. They are also different as the present study covers Basic Science and the study was in Nigeria.

Perveen (2010), investigated the effect of the problem-solving approach on academic achievement of students in mathematics at the secondary level in Pakistan. The pre-test and post-test equivalent group design was considered to be the most useful for this study. All the secondary school students constituted the population of this study. The students of 10th class of Government Girls High School, Rawalpindi, Pakistan were selected as a sample for the study. Sample size consisted of 48 students who were equally divided into an experimental group and a control group on the basis of pre-test. The pre-test and post-test research instruments were used for this study. These instruments were used for accessing students' performance which would reflect their level of knowledge in mathematics before and after the experiment.

The content validity of tests was insured by preparing chart of specification. The content validity was also checked by correlation coefficients which were found to be 0.5. Reliability of the achievement test was measured by the K-R-20 formula, and each item's scores of achievement tests correlated significantly with total scores, either at 0.01 or

0.05 levels. Test reliability was also calculated by Cronbach alpha which was 0.8 for total items. Treatment of the planned problem-solving approach is the guideline of Sherreen (2006), and Polya's (1945), both in Perveen (2010). The heuristic steps of the problem-solving approach. After the treatment, post-test was used to see the effects of the treatment. A two-tailed t-test was used to analyze the data, which revealed that both the experimental and control groups were almost equal in mathematics base at the beginning of the experiment. The experimental group outscored the control group significantly on the post-test. The results of this study strongly suggested that the presentation of mathematical concepts to secondary level studentds through the problem-solving sequence causes the learner to integrate the content conceptually in such a manner that the student can retain it more readily than if the concepts were presented to him in an expository sequence. It is also concluded that both methods of instruction were fairly presented and that no factors operated would tend to give either method a significant advantage. However, the relationship of the study to the present research was that it was an experimental pre-test, post-test and it was the same design with the present study. However the study was carried out in Pakistan and the subject mathematics while this present study was in Nigeria on the subject Basic Science.

Nwagbo and Chukelu (2011), carried out a study on effects of Biology Practical activities on students' process skills acquisition. The purpose of this study was to determine the effects of biology practical activities on students' process skill acquisition. Specifically, the study intends to ascertain; the differential effects of biology practical activities and lecture method on the acquisition of science process skills; the effect of practical activities on science process skills of male and female students; the interaction effect of method and gender on science process skills acquisition of secondary students. The design of the study was quasi-experimental; specifically the Pre-test, Post-test, Non

Equivalent Control Group Design was used. Two research questions and two null hypotheses guided the study. The sample consists of 111 students from two schools randomly selected from the 17 co-educational secondary schools in Abuja Municipal area council. Simple random sampling (balloting) was used for the study. Only two schools were randomly sampled, due to the experimental nature of the study. One of the schools sampled was assigned to experimental treatment while the other was for control. In each of the schools sampled a stream of SS 1 was randomly sampled for experimental treatment and control respectively. An instrument known as Science Process Skill Acquisition Test (SPSAT) was used for data collection. The instrument was developed by the researchers based on the biology topic taught: Animal Nutrition, which was from SS1 biology curriculum. The instrument, SPSAT consists of twenty items. The data collected were analyzed using mean, standard deviation and Analysis of covariance (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. There was no interaction between method and gender on students' process skill acquisition. The students in the experimental group had a higher mean Science Process Skill Acquisition Test (SPSAT) score in biology. This study was related to the present study as it was carried out using quasi-experimental which was used in the present study. The previous study was different as it was carried out on the effects of Biology Practical activities on students' process skills acquisition while the present study was carried out on the effects of Activity-Based and Problem-Solving methods on students' performance in Basic Science in junior secondary schools in Kaduna State, Nigeria. The previous study was also different as Analysis of covariance (ANCOVA) was used for data analysis while the

present study used t-test and Analysis of Variance (ANOVA) to test the formulated hypotheses.

Wong (2012), investigated the implementation of Problem-based Learning (PBL) in Junior Secondary Science Curriculum in Hong Kong. The goal of this research was to provide a systematic account of an attempt to implement PBL in Form 1 (Grade 7) Integrated Science classes. The study investigated the teachers' pedagogical actions, the aspects of the PBL environment that helped to motivate students in science learning, their pattern of discourse for science development and the possible differences of their learning outcomes compared with PBL and conventional learning conditions. A quasi-experimental and mixed-method approach was employed to gather data from two experimental classes (n = 62) and two control classes (n = 63). Data sources included field notes of classroom observations, audio recordings of students working in small groups on their PBL problems, interviews with teachers and students, and science tests administered immediately prior to each instructional unit (pre-test), at the conclusion of each unit (post-test), and before the school term ended (delayed post-test).

The study had five main findings: (1) PBL teachers used different strategies to help students who were new to PBL to adapt to the new pedagogical practice, to facilitate group confrontation, and to help students become self-directed learners, (2) Choice, challenge, control and collaboration seem to have motivated students' learning in the PBL classrooms, (3) Disagreements about the problem situations stimulated task-related cognitive activity and resulted in academic progress, (4) Students' questions during collaboration facilitated learning by directing their' inquiry and expanding their thinking, (5) Science test results showed that the PBL group performed as well as the Conventional learning group in knowledge acquisition, and that PBL helped the high achievers to retain information better than their peers in the Conventional learning group. The study

provided valuable information that showed how PBL can work in secondary school science classrooms. Implications for future research on PBL, and its practice in secondary school science, are also outlined.

The study was similar to the present research in that it was quasi experimental in its design. Also, it was one of the variables to be studied in the present research. However the study was different in that it was carried out in Hong Kong while the present study was carried out in Nigeria. Data sources included field notes of classroom observations, audio recordings of students working in small groups on their PBL problems, interviews with teachers and students, and science tests administered immediately prior to each instructional unit (pre-test), at the conclusion of each unit (post-test), and before the school term ended (delayed post-test), while the present research used an adopted objective test to be done by the students only. And the test was administered after the treatment.

Idris (2014), carried out a study on impact of Problem-Solving Strategy on academic achievement and retention of Basic Science concepts among varied ability students in Kaduna State, Nigeria. The objectives of the study includes to determine impact of problem-solving teaching strategy on academic achievement of Basic Science of varied abilities; investigate impact of Problem-Solving teaching strategy on retention ability among Basic Science students of different ability level; determine impact of Problem-Solving teaching strategy on achievement between male and female students of different ability level; and identify and categorise student into low, medium and high ability on exposure to teaching strategies. Quasi-experimental with pre-test, post- test and post-post test was used as the research design. A total population of 1444 students from which a sample size of 70 students comprising of 59 male and 11 female were randomly selected. The instrument used for data collection was Basic Science Achievement Test (BSAT) of

30 multiple choice items cutting across the topics. The reliability of the instrument was found to be r= 0.71 which showed that the instrument was reliable. Data collected was analysed using descriptive statistic of mean and standard deviation, while inferential statistic mainly t-test and two way ANOVA was used to test the hypotheses at 0.05 level of significance. The findings of the study include the following: The experimental group using Problem-Solving strategy achieved significantly better than the control group who were taught using lecture method; in terms of retention there was significant difference between students taught Basic Science using Problem-Solving teaching strategy than those taught using the lecture method in the control group; Male and Female students taught Basic Science concept using Problem-Solving have relatively equal academic achievement. Thus Problem solving was gender friendly; the academic achievement of the different ability levels (high, medium, and low) students who were taught Basic Science in the experimental group was higher than that of control group. And so the study recommended that Problem Solving teaching strategy should be employed by teachers to teach Basic science.

The relationship of the previous study with this study was that, the previous study was a quasi- experimental design and the data collected was analysed using t-test and two way ANOVA. It was also similar as it was one of the variables of the present study and it was carried out on the same subject Basic Science. However the study differs in that the study involved retention and was also carried out among varied ability levels high, medium, and low.

Iliyasu (2011), explored the effects of Problem-Solving method on Mathematics performance and attitude among Federal colleges of Education students in Kano and Zaria. The study was embarked to examine the effectiveness of Problem Solving method on mathematic performance and attitude among Nigeria Certificate in Education (NCE)

Students in Mathematics; to investigate the attitude of NCE students towards mathematics and then proffer appropriate suggestion and recommendations towards improving teaching of mathematics among NCE Students; determine the effect of Problem Solving method on gender related differences in Mathematics. The pre-test post-test quasi-experimental design was used. The total population of the study was 258, (Kano-129 and Zaria-129) from which the sample of 100 subjects were randomly sampled using stratified random sampling. Two instruments were used in the study. The first was Attitudinal Mathematics Questionnaire (AMQ) and secondly Mathematics Achievement Test (MAT). A 20 item multiple choice questions for MAT and 30 items of Attitudinal Mathematics Questionnaire. The reliability index for MAT was r=0.86 and AMQ has r= 0.86. Four null hypotheses were tested and the data collected were analysed using statistic such as mean, standard deviation, t-test, and Analysis of Variance. The level of significance adopted for the performance was 0.05 which form the bases of retaining or rejection.

The result showed that there was a significant difference in the mean scores performance of students exposed to problem solving and lecture method in favour of the experimental group which were taught using Problem Solving and the paper recommended provision of in service training in the effective use of Problem–Solving method in the teaching and learning of Mathematics. Though the study was similar as it conveyed one of the variables of the present study and the research design are the same being Quasi-experimental. However the study was carried out using tertiary institution specifically Colleges of Education in Kano and Zaria and the subject that was taught was Mathematics while the present study was carried out at the Upper Basic which is junior secondary schools and the subject was Basic Science.

Another study was carried out by Iwuji (2012), titled Effect of Activity-Based Teaching strategy on academic achievement and retention in Basic Science concepts among Junior Secondary School students of Giwa Education Zone Kaduna State, Nigeria. The objectives of the study include to: determine effects of using Activity-Based teaching Strategy on students academic achievement among Basic Science Students of junior secondary schools; establish whether Activity-Based teaching strategy of teaching Basic Science enhances retention ability among Basic Science Students of junior secondary schools; find out whether the effects of Activity-Based teaching strategy is appropriate for learning Basic Science concepts among male and female students. The design was Quasi-experimental with pre-test, post-test, post- post test on experimental and control groups. The study population consisted of 1333 students, comprising 547 males and 786 females and a sample 80 junior secondary two Basic Science students were randomly selected which composed 37 males and 43 females. Three hypotheses were tested using t-test statistic of p-value 0.05.

The result showed that students that are exposed to Activity-based achieved significantly higher than their counterpart taught using lecture method. Students exposed to Activity-Based Instructional strategy retained the learnt concepts significantly better than their counterparts exposed to lecture instructional strategy. There was no significant difference in achievement between the male and female students exposed to Activity-Based. On the bases of these findings recommendation was made that teachers of Basic Science should use Activity-Based Instructional strategy in their teaching among JS II students. However the relevance of the previous study to the present one was the variable Activity-based that was common as well some of the concepts of some topics in Basic Science and the students involved JS II. However the study differs in the sense that it was carried out in

Giwa Local Government Area of Kaduna State, Nigeria while the present study though in Kaduna State, Nigeria but three different Local Government Areas are involved.

Dike (2008), conducted a study on the effects of Problem-Solving strategy and lecture method on socio-cultural beliefs hindering science learning at the Junior Secondary School in Federal Capital Territory Abuja. The study objectives was to find out the effect of Problem-Solving strategy and lecture method on the socio- cultural beliefs of junior secondary students in the learning of Science; find out if there was any difference between the socio-cultural beliefs of male and female students when taught using Problem-Solving strategy; and find out if there was any relationship between the academic achievement and Socio-cultural beliefs of students in Basic Science after using the Problem-solving strategy to teach them. The pre-test post-test quasi experimental design was used. Two instruments were used for data collection which are: The Social Cultural Beliefs Scale (SCBS) Basic Science Achievement Test (BSAT). The SCBS was a 40-item questionnaire and BSAT A 40- item achievement test.

Shafiu (2014), conducted a research on impact of Science Process Approach strategy (SPAT) on students' perception, academic achievement and retention in Basic Science concepts in Zaria Kaduna State, Nigeria. The study objectives stated included to determine the impact of Science Process Approach strategy on Junior Secondary students achievement in some selected Upper Basic Science concepts; examine the impact of Science Process Approach teaching strategy on students' perception of Basic Science concepts; and investigate the impact of Science Process strategy on retention ability of junior secondary students in some selected Upper basic science concepts. Three research questions and hypotheses guided the conduct of the study. The hypotheses were tested at $P \leq 0.05$ level of significance. A pre-test post- test quasi experimental and control group design was used with a sample of 160 students selected from population of 2028. Two

validated instrument called BSAT and BSSQ with reliability coefficient of 0.86 and 0.83 respectively were used to gather data which were collected and analyzed using t-test for BSAT and Wilcoxon sign rank test for BSSQ.

The study revealed that there was a significant difference in the performance of the experimental group that was taught Basic Science using SPATS with those in the control group taught using lecture method. There was no significant difference in students' perception of Basic Science concepts before and after exposure to SPATS and there was also a significant difference in the retention ability of students taught using SPATS. Based on the above findings, the study recommended that Science a Process Approach Teaching strategy should be encouraged in the teaching and learning of Basic Science at the Junior Secondary for greater achievement, perception and retention. Both Federal and State Government Ministries of Education should intensify efforts toward sponsoring Basic Science Teachers for training on SPATS needed to improve academic achievement of students in the subject.

There are great similarities between both activity-Based and Problem –Solving to SPATS in that all are learners-Centred and used Science processes to achieve learning. Quasi experimental was also used as the experimental design. However they differ in that the previous study involved perception and retention of concepts in Basic science.

Okoli (2011), carried out a study on the comparative study using Problem –Solving and teacher demonstration methods on students' performance in Financial Accounting in Gombe State. The objectives of the study was to compare the performance of students taught with the conventional method; determine the differences in the performance of students taught with Problem-Solving method and those taught the teacher-demonstration method. Quasi-experimental research design was used. Here the study had two treatment groups Problem solving and Demonstration group. Test I and II (FAT I and II) were

administered to determine the performance of students. The findings of the study revealed that, Problem-Solving group performed better than the other groups. The present work was related to this work in that it has two variables even though it was only one of the variables that are the same which was Problem- Solving method. The design was also the same being quasi-experimental. However the study differed in the sense that it was carried out in Gombe state and is on Financial Accounting while the present research was carried out in Kaduna State, Nigeria on Basic Science.

Akinoglu and Tantogan (2007), investigated the effects of Problem-based active learning in science education on students' academic achievement, attitude and concept learning, in Istanbul, Turkey. The study was conducted with the aim to: find out about teaching 7th grade science classes by means of the problem-based Active learning model may bring about significant differences with regard to students' academic achievement; establish if teaching of 7th grade science classes by means of the problem- based Active learning Model bring about significance differences with regard to students' attitudes towards science class; and determine if teaching of 7th grade science classes by means of the Problem-based Active learning Model have any impact on students' concept learning. In the study both qualitative and quantitative research method were utilized. Quantitative data were obtained via the pre-test post-test, treatment- control groups test model. Qualitative data were obtained via document analysis. The research was conducted on 50, 7th grade students in 2004-2005 school years, in a public school in Istanbul. Three instruments were used which are achievement test, pen-ended questions, and an attitude scale for science education. The reliability coefficient of the achievement test was calculated to be KR20 =0.78. Cronbach alpha- value of the attitude scale was 0.89. In the case of data collected and the evaluations made in the research, it was determined that the implementation of Problem-Based Active learning model had positively affected

students' academic achievement and their attitude towards the science course. It was also found that the application of problem- based active learning model affects students' conceptual development positively and keeps their misconceptions at the lowest level.

The relationship of the previous study to the present research was that the previous study was an experimental study involving Problem-based Active learning based on Science Education. Also data collected was analyzed using t-test. The two studies also differs in the sense that the previous study was conducted at Istanbul, Turkey using the 7th grade science classes as respondents, while the present study was carried out in Kaduna State, Nigeria of Nigeria using JS II.

Tsoho (2011), conducted a research on effects of Problem-Solving and student-Centred teaching strategies on students Geometry performance and retention in JSS in Kano State. *The objectives of the study were to: compare the effectiveness of Problem-Solving* approach using student-Centred teaching strategy through student's performance in Geometry at the JSS; determine the effects of Problem-Solving and student-Centred teaching strategies on gender in Geometry at JSS. The population for the study constituted of 858 students and the sample for the study was 429 students representing 50% of the population. Analysis of covariance was used as a statistical tool for the four Null Hypothesis that were stated. The findings revealed that the male students performed *significantly better than the Female counterparts in Geometry Achievement test using* Problem-Solving method while the Female students significantly performed better than their male counterpart in Geometric Achievement Test using student-Centred learning strategy. Nevertheless the study was similar as they test both variables of the present research which are on Problem-Solving and Activity-Based. However the subjects differ in that it centred on concept of Geometry in Mathematics while the present study was on Basic Science.

Bawa (2011), explored the effects of Problem-Based teaching strategy on the Academic Performance in Basic Science among JS2 Students in Sanga LGA of Kaduna State, Nigeria. The objectives of the study include: to determine the effectiveness of the Process-based approach method of teaching Basic Science; determine whether the availability of Science laboratory has contributed to an extent, to the acquisition of science process skills, using the process-based approach method of teaching Basic Science; to find out whether the teaching method is gender friendly and promotes positive interaction leading to meaningful learning among JSS Students. Three research questions and Hypotheses were formulated to serve as a guide for the study. The population of the study was 1,835 students out of which 120 students were randomly selected and placed into Experimental and Control group. The research instrument was a forty 40-item Process-based performance test of process skills. The quasi-experimental design involving pre-test and post-test non-equivalent group was used. Data collected was analysed using descriptive and inferential statistics. Mean and Standard deviation were used to answer the research questions while t-test of independent sample was used to test the hypotheses. The reliability was found to be 0.76usng Cronbach alpha test.

The major findings in this study revealed that the problem skill-based teaching strategy was superior to the Conventional method of teaching as far as the acquisition of process skills is concerned, while there was no significant difference between male and female students in the acquisition of the process skills of science. The provision of instructional materials and facilities would enhance effective and improve learner's performance. However based on the findings the following recommendations were made: the government should change some of our class room practices and become more focused on helping students think scientifically rather than memorize facts; take into account how science was being taught and learnt in other parts of the world, most especially the

developed countries, so that the teaching of Science can improve and so develop our indigenous Science and Technology.

The study was relevant to the present study in that the subject matter was on Basic Science and the Science process methodology was what Activity-based used for instruction. Both used quasi experimental as the experimental design However the study differs in that the variables of the present are three while the previous study had two.

Another study conducted by Gadzama (2012), titled Effect of Science Process Skills Approach on academic performance and attitude of Science students with varied abilities thus the study investigated the effect of Science process skills on academic performance and attitude of integrated science students with varied abilities. The students that were involved in the study were 504 students for both experimental and control group. The research design used was a quasi- experimental and control group design employing pre-test and post-test. The finding among others showed that; there was significant difference in the scores of the experimental high, average and low taught integrated science using Science Process Skills and secondly there was significant difference in mean scores between and within the experimental groups. And also there are significant difference scores between and within control groups. The study was related to this research work in that the science process was what was used in both activity based and problem based method.

Khan, Muhammed, Ahmed, Saed, and Khan (2012), carried out a research on Impact of Activity-Based teaching on students' Academic Achievements in Physics at Secondary School level at Kohat, Pakistan. The aim of this study was to investigate the impact of activity- based teaching on the students' achievement in Physics at secondary level. Thirty (30) lessons were selected from 9th class Physics for this study. All the science students of secondary schools of Khyber Pakhtunkhwa, studying Physics at the 9th grade,

constituted the population. A sample of 50 students was randomly selected from Govt. Secondary School Behzadi Chakr Kot Kohat. Pre-test, Post-test Control Group Design of experimental research was selected for this research study. Two MCQs type achievement tests were used as research tools for the data collection. Experimental group was taught with the help of activities whereas the control group was taught the same lessons through Conventional method of teaching for the period of six (6) weeks. T-test was used to analyse the data. The results showed that the activity- based teaching is more effective for the development of higher order skills in the students.

The previous study was similar to the present study in the following ways: one of the variables used was activity-based. The topics used for the study were from physics topics in basic science. The design used was an experimental design and the instrument used to analyse the data was t-test and activity-based was found to be more effective than the conventional method. However, the study differed in that it was carried out in Behzadi Chakr Kot Kohat in Pakistan, while the present study was carried out in Kaduna, Nigeria.

Omeogun and Akani (2014), carried out a study on Effect of problem-solving and mastery learning strategies on Junior Secondary School Students' Attitude towards mathematics. The purpose of the study was to: find the relative effect of the mastery learning approach (MLA) and problem solving approach on junior secondary school students' attitude toward mathematics; determine the effect of gender on students' attitude toward mathematics; examine the interaction effect of treatment and gender on students' attitude towards mathematics. Quasi- experimental design of pre-test post-test non-randomised control group was used. The participants consisted of 225 male and 225 female students drawn from three junior secondary schools in education district of Lagos State through stratified random sampling procedure. The instrument has a reliability coefficient of 0.80. Data were gathered using Mathematics Attitude Scale MAS. Two

hypotheses were formulated and tested at 0.05 level of significance. The results showed that: the Problem –Solving Approach (PSA) proved to be effective in improving students' attitude (affective) toward Mathematics; there was a significant effect of gender on students' attitude towards mathematics; there was a significant interaction effect of treatment and gender on students' attitudes towards mathematics.

Based on the findings of this study, it was recommended that teachers should gear up effort towards influencing students to develop interest and positive attitude to the subject especially in this era of new technological development using good instructional materials, self-initiatives and improvisation that enhances the understanding of the subject. However, the study was similar to the present study in that one of the variables for the study was Problem- Solving and used quasi experimental design. But they differ in the subject area as the previous study was in Mathematics and this one was on Basic Science.

Adeniran (2013), conducted a study on Effect of Problem Solving Approach on the Performance of Students in Physics in Kwara state, Nigeria. The study was to find out the difference in the post test mean scores of the students taught physics using problem solving approach and the lecture method in Optics performance Test; and differences in post test mean scores of male and female students taught physics using problem solving approach. The research was a quasi-experimental, pre-test, post-test control group design. Two research questions and two research hypotheses were used for the study. The instrument consisted of 8-item essay questions in optics selected from past West African Examination Council (WEAC) Questions. The reliability coefficient was 0.73.The data collected were analysed using descriptive statistics of mean and standard deviation and ANCOVA. The results showed that, the students that were exposed to the Physics Problem Solving Approach (PPSA) performed significantly better than those exposed to

the lecture method (LM). Among the recommendations that were passed was that the government should provide practical experience of how to use physics problem solving approach to both the teachers and the students in schools. The present study was similar to the previous study as the study was on the effect of Problem Solving Approach on performance though it differed in that the recent study was on Basic Science while the previous one was in Physics.

2.8 Summary

This chapter has reviewed relevant literatures on the effects of Activity-Based method and Problem-Solving method on students' performance in Basic Science in junior secondary schools of Kaduna State, Nigeria, Nigeria. In view of the literature reviewed, Basic Science was seen as a subject that emphasizes on acquisition of modern Science and such that enable young people to have access to new knowledge by bringing change in minds and skills in order to behave rationally and creatively toward problem generated by change. This study was based on two theories, namely; the Theory of Progressivism and Theory of Constructivism. Relevant literatures were reviewed on the key variables of the study such as Activity-Based Method, Problem-Solving Method and Academic Performance. The study discussed issues related to the Nature of Basic Science, the New Basic Science and Technology Curriculum and objectives of Basic Science Curriculum. Also, the study highlights the features of Activity Method, advantages and disadvantages of Activity-Based Method. The study traced the historical development of Problem-Solving Method, its characteristics, advantages and disadvantages of Problem-Solving Method. The procedures for the use of Problem-Solving Method in Basic Science were vividly discussed. The study also reviewed relevant empirical studies and identified gaps in the area of methodology, population, sample and sampling technique and statistical

tools used for data analysis. All these identified gaps were adequately filled in the present study.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology used in carrying out the research work and was discussed under the following sub-headings: research design, population of the study, sample and sampling technique, determinant of samples homogeneity, instrumentation, table of specification, treatment package, validity of the instrument, pilot study, reliability of the instrument, procedure for data collection, treatment plan, control of extraneous variables and method of data analysis.

3.2 Research Design

The design of the study adopted was quasi experimental research design. This was a pre-test and post-test experimental group and control group design. Quasi experimental design was considered appropriate for the study because this was a type of design which permits the use of intact classes as the school authority may not allow strict randomization because it can disrupt the classes (Dawaki, 2014; Achor & Amadu, 2015). The design allows control of possible extraneous or confounding variable that may affect either internal or external validity. The Activity-Based Method was used for experimental group 1, Problem-Solving Method was used for experimental group 2 and conventional (chalk and talk) method was used for the control group. All the groups were pre-tested to determine the entry level. The research design is illustrated in Figure 1.

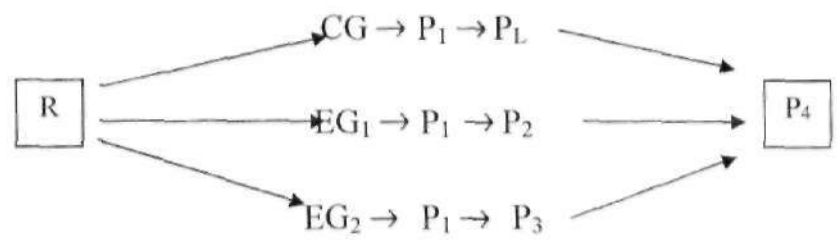


Figure 1: Illustration of Research Design

The symbols are denoted as follows:

R .... Research Design

CG .... Control group

EG_1 .... Experimental group1 (Activity-Based Method)

EG_2 .... Experimental group2 (Problem-Solving Method.)

P_1 ..... Pre-test for control and Experimental groups

P_2..... Treatment for Activity-Based

P_3..... Treatment for Problem-Solving

P_4 ..... Post test

From the above design it showed that both experimental group comprising of activity-based, problem-solving and the control group conventional method were exposed to pre-test. The experimental groups were given treatment and after the treatment questions were rearranged and administered as post-test.

3.3 Population of the Study

The target population of this study was made up of One hundred and nineteen thousand, two hundred and thirty-eight (119,238) Junior Secondary 11 Students in Kaduna State, Nigeria. This comprised of Sixty-five thousand nine hundred and sixty-six (65,966) male students and Fifty-three thousand two hundred and seventy-two (53,272) female students from the entire four hundred and twenty one Public Junior Secondary Schools in Kaduna State, Nigeria (Kaduna State, Nigeria Annual School Census Report 2015-2016). Table 1 showed the population distribution of students in each of the twenty-three (23) local Government Areas of the State. The State is also divided into three Senatorial zones namely Kaduna Central, Kaduna North and Kaduna South. There are twelve (12) Educational Zones under the state Ministry of Education as shown in Table 2. This was where the sample was selected.

Table 1: Enrolment in Public Junior Secondary Schools by level, Gender and LGA

S/N	L G A	No of Schools	Male	Female	Total
1.	Birnin Gwari	16	1788	849	2,637
2.	Chikun	20	3,433	3,477	6,910
3.	Giwa	16	2,477	1,348	3,825
4.	Igabi	23	5,678	3,913	9,591
5.	Ikara	13	2,690	1,493	4,183
6.	Jaba	14	0711	0623	1,334,
7.	Jema'a	21	2,304	2,118	4,422
8.	Kachia	30	2,715	2,307	5,022
9.	Kaduna North	17	4,337	5,269	9,606
10.	Kaduna South	14	4,858	5,418	10,276
11.	Kagarko	22	2,666	2,021	4,687
12.	Kajuru	15	1,790	1,381	3,171
13.	Kaura	15	1,300	1,181	2,481
14.	Kauru	17	2,649	1,808	4,457
15.	Kubau	16	2,369	1,479	3,848
16.	Kudan	06	1,744	1,003	2,747
17.	Lere	24	4,744	2,977	7,721
18.	Makarfi	13	2,565	1,283	3,848
19.	Sabon Gari	12	3,151	3,554	6,705
20.	Sanga	17	1,819	1,608	3,427
21.	Soba	16	2,379	0789	3,168
22.	Zangon Kataf	46	2,542	2,187	4,729
23	Zaria	18	5,257	5,186	10,443
Total		**421**	**65,966**	**53,272**	**119,238**

Source: Kaduna State, Nigeria Annual School Census Report 2015-2016

Table 1, depicted total students from public schools in JSS 1 as 2015/2016 session (Annual Schools census conducted by Kaduna State, Nigeria). The reason behind the usage of JSS 1 was because they were the present JSS 2 in 2016/2017 academic session from which the data was collected.

Table 2: Kaduna State, Nigeria Senatorial and Educational Zones

Senatorial Zones	Educational Zones	Names of School	Number of Students
Central Zone	Kaduna South	GJSS Television	**70**
	Kaduna North	GJSS Ungwa-Rimi	**72**
	Rigachukun	GJSS Rigachukun	**76**
	Brinin Gwari		
Northern Zone	Giwa		
	Anchau		
	Zaria		
	Lere		
Southern Zone			
	Gwadogwado		
	Kachia		
	Zango Kataf		
	Kafanchan		

Source: Kaduna State, Nigeria Ministry of Education.

3.4 Sample and Sampling Techniques

The sample size for this study consisted of the intact classes of two hundred and eighteen (218) junior secondary school students. The study purposively sampled out the following schools: Government Junior Secondary School Television from Kaduna south educational zone, used as Experimental group 1; Government Junior Secondary School Ungwan Rimi, from Kaduna North educational zone used as Experimental group 2; Government Junior Secondary School Rigachukun from Rigachukun educational zone was used as control group. The sample size was arrived at using purposive sampling technique which according to Hale (2015), in Alasoluyi (2017), stated that this type of design is often used when classes are naturally occurring.

Table 3: Sample Distribution

S/N	School	Number of Students	Group
1.	Government Junior Secondary School Television,	70	Experimental 1 Activity-Based method
2.	Government Junior Secondary School Ungwan Rimi, Kaduna	72	Experimental 2 Problem-Solving method
3.	Government Junior Secondary School Rigachkun, Kaduna	76	Control Conventional Talk and Chalk method
Total		**218**	

3.4.1 Determination of Sample Homogeneity

The students sampled for this research were from three different educational zones out of the twelve zones in Kaduna State, Nigeria. Their homogeneity was determined by considering the type of schools they attended which were co-education, no requirement for any examination taken since it was the continuation of Upper Basic class of the Universal Basic Education (FRN, 2013). They operated the same Curriculum, and used the same type of textbooks. The three groups were taught by the researcher with the help of their teachers as assistants. This was done to minimize the interference of extraneous variables.

3.5 Instrumentation

The instrument used for data collection in the study was an adopted test of multiple choice item titled Basic Science Achievement Performance Test (BSAPT) from Basic Science Junior Secondary Certificate Examination from 2010-2014 (Dagundura, 2016). The test items were used for the pre-test which covered the stipulated topics (see Appendix 2) for ten weeks from Basic Science curriculum of the third term work. Similarly, learners were given post-test questions with the numbering of the test questions changed. This instrument was made up of 50 objective test items with each

having five options, that is, A, B, C, D and E to choose the correct answers (See Appendix 4). The topics covered were Measurement, Work, Energy and Power, Energy Transfer, Simple machines, Maintenance of Simple machines, Tools for work, Kinetic theory of matter and Thermal Energy (Conduction, Convection and Radiation).

3.5.1 Table of Specification

The purpose of the Table of Specifications was to identify the achievement domains being measured and to ensure that a fair and representative sample of questions appear on the test. Table 4 presented the topics covered in the study.

Table 4: Table of Specification

Content Area	Class Duration on Topics	Number of Test Item	Kno	Com	App	Ana	Eva	syn
Measurements of masses, volume, density, and Force	2	5	2,10, 16	48	47			
Concept of Work , Energy, and Power	6	11	7	8	12, 26, 46	1, 5, 25, 27, 34, 45		
Energy Transfer	2	3			29, 31, 37			
Simple Machines , levers	1	10	33, 38,	20, 41, 50	3,18, 40	14, 42		
Maintenance of Machines	2	4	6	4, 13,	24			
Tools for work,	3	5	21, 22,		19, 35, 36			
Kinetic theory of matter(solid, liquid, and gas)boiling ,Evaporation and factors affecting evaporation	3	7	32, 49	17, 44		28	43	23
Thermal Energy Transfer of heat through Conduction, Convection, and Radiation	3	5	30	11, 15			9	39
Total		**50**	**12**	**11**	**14**	**9**	**2**	**2**

Source: Researcher formulated table of specification. Below are the keys for table of Specification. Kno = knowledge; Com = Comprehension; App = Application; Ana = Analysis; Eva = Evaluation; Syn = Synthesis.

3.5.2 Validity of the instrument

The Basic Science multiple choice questions were obtained by adopting test items from Dagundura (2016), Evergreen compiled Basic Science Junior Secondary Certificate Examination Test from 2010-2014. The items in the test covered all the units that were taught by the researcher. The questions were used to test the students' knowledge and comprehension, application of concepts. The test of multiple choice was validated by the researcher's supervisors in the Department of Educational Foundations and Curriculum, Faculty of Education, Ahmadu Bello University, Zaria. Other experts from Science Education Department, and Measurement and Evaluation expert from the Department of Educational Psychology and Counselling, all in Ahmadu Bello University, Zaria. The essence was to ascertain the face and contents of the instrument, in addition to ensure that the instrument developed was based on the variables of the study and consistency of the instrument. Having done that by the experts, the researcher subjected the instrument for pilot study. The scrutiny and proof reading was done to ensure that the content was in line with the educational objectives.

3.5.3 *Pilot study*

The pilot study was carried out in Government Junior Secondary School Ungwan Boro with 70 students as the experimental group1 and Government Junior Secondary School Tudun-wada Kaduna with 80 students as the experimental group 2 within Kaduna metropolis even though in different areas, but had the same characteristics as the sampled schools for the study. These schools were part of the population of the study but not among the schools selected for the study. The essence of carrying out a pilot study was to

ensure that the instruments (Basic Science Junior Certificate Examination questions) were not ambiguous. More so, the use of the intact classes helped the researcher to realised how difficult or easy the questions in the test instrument were for the actual students of the study. The benefits of the pilot study included: to identify problems or difficulties that might arise before the final administration of the instrument to the study sample; to determine the appropriateness of the instructions; to determine the difficulty and discrimination features of the items; to determine the reliability of the instrument; and to determine item characteristics. The fifty item instrument was administered to one hundred and fifty (150) students and the data collected were analyzed to determine the indices of difficulty and discrimination of each of the test items.

3.5.4 Reliability of the instrument

The result of the pilot test for both experimental groups 1 and 2, were recorded and a test-retest-reliability coefficient was used to analyse the instrument. The marks and recorded scores from the pilot study was subjected for reliability analysis, using Pearson Product Moment Correlation Coefficient (PPMCC) which was tested at 0.05 alpha significant level. The result of the reliability analysis showed a reliability index of 0.79. This implies that the instrument was reliable for use because the reliability index falls between 0.5 to positive one (+1). Reliability of an instrument is the consistency with which a test repeatedly measures what it is intended to measure. Bardoshi, and Erford (2017), a reliable test should have a reliability co-efficient that is close to one (1).

3.6 Procedure for Data Collection

A letter of introduction was collected from the office of the Head of Department, Educational Foundations and Curriculum, Faculty of Education, Ahmadu Bello University, Zaria. This was endorsed by the researcher's supervisors. The researcher

sought for permission from Kaduna State Ministry of Education which was used to obtain permission from the principals of the three sampled schools. This enabled the researcher to collect data that was used in conducting the study. The pre-test was administered to the three groups before the commencement of the treatment. Ten weeks was used for the activity-based method (treatment one) and problem-solving method (treatment 2), as well as the control group by the researcher with the help of the subject teachers' as assistants. After the treatment, the researcher administered the post-test and marked the scripts. This enabled the researcher to compare the student's performance in the experimental groups (Activity-Based and Problem-Solving methods), and the control group (Conventional method).

3.7 Treatment Plan

Treatment plan is a documentation tool that is considered essential to the implementation of well-rounded classroom instruction. A total of ten weeks was used to cover the whole exercises involved in the study.

3.7.1 The Treatment Plan for Activity-Based Method

The treatment plan for Activity-based was carried out as follows:

The lesson was carried out first by the students' leaders from each group and the teacher served as a guide or facilitator. All activities in all the topics covered were carried out by the leaders, while the researcher and the research assistants served as facilitators before the commencement of the class. This was because the class was too large and each group needed to carry out the activities. The leaders facilitated learning in the respective groups. The following are the procedures for the Activity-based:

i. The students were assigned into groups of eight (8) and were given the task or activities in line with the component and concept of the topic using their referenced text books;

ii. The students democratically elected their chairman who directed, guided and maintained order as well as attended the next preparatory class with the teacher and research assistants. While the Secretaries in all the groups wrote the outcome of the task for the leaders;

iii. The students used experiential learning which involved links between thinking and doing by: exploring objects and materials, raising questions, making careful observations, engaging in simple investigations and describing by comparing or classifying;

iv. In culminating activities students compiled, organised, wrote and recorded their observations. Here the students learned many things such as respect for each other's opinion and provided key highlights on the activities that was carried out and reported to the entire class;

v. The teacher's role was that of monitoring and guidance as the students carried out the activities and lastly,

vi. The teacher summarized the lesson and evaluated the students by asking questions.

3.7.2 Treatment plan for problem-solving method (experimental group 2)

The treatment plan for problem-solving method for experimental group two (2) adopted Maurer and Newhold (2012), proposed eight (8) steps for successful and comprehensive learning processes which includes:

i. The students were divided into nine (9) groups of eight (8) students for easy participation;

ii. Defining the problem that was posed to them: this step consisted of group discussions of what the problem was;

iii. Each group brainstorms based on their prior knowledge of the topic.

iv. Students formulated the topic's objectives;

v. The students searched for information using their local library as well as various textbooks related to the topic;

vi. Synthesis: the individual students shared the information that was gotten in their respective groups.

vii. Feedback was given by each group

viii. Evaluation was carried out asking the students questions.

Table 5: Treatment Plan

Week	Topics	Periods	Remarks
BT	Pre-test		Both Experimental and Control groups.
1	Measurement of masses, volume, density and force, *Differences between mass and* weight	3-4th	Experimental groups were taught using Activity-Based and Problem-Solving method, while Conventional (Lecture) method was used to teach control group.
2	Concept of Work, Energy and power	2-3rd	,,
3	Concept of Work, Energy and Power	4th	,,
4	Energy Transfer	4th	,,
5	Simple machines	4th	,,
6	Maintenance of Simple machines	4th	,,
7	Tools for Work (Agriculture, Engineering, Medicine, Traditional and Modern tools)	4th	,,
8	Kinetic theory of matter(solid, liquid and solid)	4th	,,
9	Thermal Energy Conduction, Convection and Radiation.	4th	,,
10	Revision	4th	,,
AT	Post-test		Both Experimental 1&2 and Control groups were exposed to post-test.

BT means Before Treatment while AT = After Treatment

3.7.3 Control of extraneous variables

To control the extraneous variables, the researcher and research assistants taught the students in both experimental and control groups. The researcher was directly involved in the administration of the instrument with the aid of their teachers as assistants. This was done in order to ensure errors that might arise from teacher's variables do not affect the findings of the study. Detailed explanation was given to the research assistants by the researcher prior to the commencement of the experiment. The lesson plans and Basic Science multiple choice questions were prepared by the researcher and not the research

assistants. These packages were not released to the research assistants before the commencement of the experiment.

3.8 Method of Data Analysis

The statistical tools used for data analysis were descriptive and inferential statistics. The descriptive statistics of mean and standard deviation was used to respond to the research questions raised in the study, while inferential statistics of t-test was used to test hypotheses 1, 2, 3 and 4. The reason for the use of t-test was based on the fact that t-test was an appropriate statistical tool that compares the actual difference between two means in relation to the variation in the data (Clarke & Cook, 2007 in Alasoluyi, 2017). While two-way Analysis of Variance (ANOVA) was used to test hypotheses 5 and 6. This inferential statistic was used to determine whether there was significant difference between two or more independent unrelated groups or variables. Therefore, the hypotheses formulated for this study was retained or rejected at alpha of 0.05 level of significance.

CHAPTER FOUR
DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents the result of data analysis based on the data collected in the study. Two hundred and eighteen (218) copies of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination (JSCE) were distributed to students in both experimental and control groups which were all correctly answered and returned. Also, tables were designed to show the mean and standard deviation in the research questions. Independent sample t-test was used to test hypotheses 1,2,3,4 and 5 while two-way Analysis of Variance (ANOVA) was used to test hypotheses 6 and 7. Therefore, all the Seven null hypotheses were accepted or rejected at 0.05 level of significance.

4.2 Description of Study Variables

The variables of the study were analyzed using frequencies and percentages. Table 6 presents the summary of the study groups.

Table 6: Group of the Respondents

Group	Frequency (f)	Percentage (%)
Experimental Group I (Activity-Based)	70	32.1
Experimental Group II (Problem-Solving)	72	33.0
Control Group (Conventional Method)	76	34.9
Total	**218**	**100**

Table 6 showed that 32.1% (70) of the respondents were used as experimental group I (Activity-Based method), while 33.0% (72) were used as experimental group II (Problem-solving method), and 34.9% (76) were used as control group (Conventional

method). This result showed that the population was fairly distributed with the control group having the highest frequency and percentage.

4.3 Response to Research Questions

The research questions raised in the study were analyzed using mean and standard deviation. The questions and the analysis were presented as follows:

Research Question One: What is the pre-test and post-test performance of students taught Basic Science using activity-based methods in junior secondary schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination (JSCE) was analysed using mean and standard deviation. Table 7 present the analysis of data collected in the study:

Table 7: Pre-test and post-test performance of students taught using Activity-based *and method*

Table 7: Pre-test and Post-test performance of students taught using activity-based

		Pre-test Scores		Post-test Scores		
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain.**
Activity-Based	70	8.25	5.41	55.61,	11.43	47.36

Table 7 showed the performance of students taught Basic Science using Activity-Based method in Junior Secondary Schools, Kaduna State, Nigeria. The mean scores as displayed on the table showed that students taught Basic Science using Activity-based had a pre-test mean score of 8.25 and post-test mean score of 55.61, this showed a mean gain of 47.36. This result indicated that Activity-Based method was very effective in improving students' performance. Hence, the answer to research question one was that the Post-test mean performance of students was significantly higher than the Pre-test mean performance.

Research Question Two: What is the pre-test and post-test performance of students taught Basic Science using Problem Solving methods in junior secondary schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination (JSCE) was analysed using mean and standard deviation. Table 8 present the analysis of data collected in the study:

Pre-test and post-test performance of students taught using Problem-Solving method

Table 8: Pre-test and Post-test performance of students taught using Problem-Solving

		Pre-test Scores		Post-test Scores		
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain.**
Problem-Solving	72	8.59	4.36	54.62	12.46	46.03

Table 8 showed the performance of students taught using Problem- Solving method in Basic Science in junior secondary schools, Kaduna State, Nigeria. The mean scores as displayed on the table showed that pre-test mean score of 8.59 and Post-test 54.62. This showed a mean gain of 46.03. This result indicated that Problem-Solving was very effective in improving the performances of students. Hence, the answer to research question two was that the Post-test mean performances of students was significantly higher that the Pre-test mean performance.

Research Question Three: What is the difference in performance of students taught Basic Science using Activity-Based method and those taught using Problem-Solving method in Junior Secondary Schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using mean and standard deviation.

Table 9: Performance of students taught Basic Science using Activity-Based and Problem-Solving methods

Method	N	Post-test mean	SD	Mean Diff
Activity-Based	70	55.61	11.43	
				0.99
Problem-Solving	72	54.62	12.46	

Table 10 showed the difference in performance of students taught Basic Science using Activity-Based and those taught using Problem-Solving methods in Junior Secondary Schools in Kaduna State, Nigeria. The mean scores showed that students taught Basic Science using Activity-Based performed slightly better than those taught using Problem-Solving in the post-test administered. For instance, the students taught Basic Science using Activity-Based method had a post-test mean score of 55.61 with corresponding standard deviation of 11.43, while students taught using Problem-Solving recorded post-test 54.62 with standard deviation of 12.46. Thus the answer to research question four is that there is slightly higher mean performance of students taught Basic Science using Activity-Based method than those taught using Problem-Solving method with mean difference of 0.99.

Research Question Four: What is the performance of students taught Basic Science using Activity-Based and Conventional Method in junior secondary schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using mean and standard deviation. Table 8 present the analysis of data collected in the study:

Table 10: Performance of students taught Basic Science using Activity-Based and Conventional Method

Method	N	Pre-test Scores Mean	SD	Mean Diff.	Post-test Scores Mean	SD	Mean Diff.
Activity-Based	70	8.25	5.41		55.61	11.43	
Conventional	76	6.97	4.72	1.28	50.03	16.82	5.54

Table 8 showed the performance of students taught Basic Science using Activity-Based and Conventional method in junior secondary schools in Kaduna State, Nigeria. The mean scores as displayed on the table showed that students taught Basic Science using Activity-Based had better performance mean scores in pre-test and post-test. For instance, the students taught Basic Science using activity-based had a pre-test mean score of 8.25 and post-test mean score of 55.61 with corresponding standard deviation of 5.41 and 11.43, while students taught using conventional method recorded the pre-test mean score of 6.97 and post-test mean score of 50.03 with standard deviation ranging from 4.72 and 16.82. This showed that students' mean difference in Activity-based and Conventional methods were 1.28 and 5.57 for pre-test and post-test respectively. Hence the answer to the research question two was that the students' academic performance of students taught basic science using Activity-based had a better performance than students taught using conventional method with post-test mean of 55.61 and 50.03 respectively. Thus, there was a mean difference of 5.54. This showed that both methods had a positive effect on students' performance, but Activity-based resulted in better performance than the conventional method as observed in the result with a higher mean difference at the post test.

Research Question Five: What is the effect of Problem-Solving and Conventional Method on the academic performance of students in Basic Science in junior secondary schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination (JSCE) was analysed using mean and standard deviation. Table 9 present the analysis of data collected in the study:

Table 11: Effect of Problem-Solving and Conventional Method on the academic *performance of students*

		Pre-test Scores		Mean	Post-test Scores		Mean
Method	**N**	**Mean**	**SD**	**Diff.**	**Mean**	**SD**	**Diff.**
Problem-Solving	72	8.59	4.36		54.62	12.46	
				1.62			4.59
Conventional	76	6.97	4.72		50.03	16.82	

Table 9 showed the effect of problem-solving and conventional method on the academic performance of students in Basic Science in junior secondary schools in Kaduna State, Nigeria. The mean scores as displayed on the table showed that students taught Basic Science using problem-solving had a better performance mean scores in pre-test and post-test. For instance, the students taught Basic Science using problem-solving had a post-test mean score of 54.62 with corresponding standard deviation of 12.46, while students taught using conventional method recorded post-test mean score of 50.03 with standard deviation 16.82. This showed that students' mean difference in post-test was 4.58. Therefore the answer to question three was that the students taught using Problem-solving method had better significant effect compared to those students taught using the conventional method with post-test mean scores of 54.62 and 50.03 respectively. While the mean difference was 4.59. This showed that both methods had positive effects on the performance of students. Although, problem solving method resulted in a better performance than the conventional method.

Research Question Six: What is the difference between the performance of students taught Kinetic Theory of matter using Activity-Based, Problem-Solving Methods and Conventional Method in junior secondary schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using mean and standard deviation. Table 11 present the analysis of data collected in the study:

Table 12: Performance of students taught Kinetic Theory of matter using Activity-Based, Problem-Solving Methods and Conventional Method

Method	N	Mean	SD
Activity-Based	70	9.22	2.57
Problem-Solving	72	7.84	3.09
Conventional method	76	6.84	3.20

The analysis on table 11 showed the differences that existed in the performance of students taught Kinetic Theory of matter using activity-based, problem-solving methods and conventional method in junior secondary schools in Kaduna State, Nigeria. The mean scores as displayed on the table revealed that the students taught Kinetic Theory of matter using activity-based had the mean score of 9.22 with standard deviation of 2.57, students taught using problem-solving had a mean score of 7.84 with standard deviation of 3.09. While the students taught using conventional method had the mean score of 6.84 with standard deviation of 3.20 respectively. This showed the students' mean score difference of 2.38 for activity-based and conventional methods, 1.00 for problem-solving and conventional methods. In essence, those taught using activity based method had the highest mean, followed by those taught with problem solving and lastly by the conventional method

Research Question Seven: What is the difference between the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Methods in junior secondary schools in Kaduna State, Nigeria?

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using mean and standard deviation. Table 12 present the analysis of data collected in the study:

Table 13: Performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Methods

Method	N	Mean	SD
Activity-Based	70	7.02	1.72
Problem-Solving	72	6.26	2.21
Conventional method	76	5.34	2.62

The analysis on table 12 showed the differences that existed in the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Methods in junior secondary schools in Kaduna State, Nigeria. The mean scores as displayed on the table revealed that the students taught Thermal Energy using activity-based had the mean score of 7.02 with standard deviation of 1.72, students taught using problem-solving had a mean score of 6.26 with standard deviation of 2.21, while students taught using conventional method had a mean score of 5.34 with standard deviation of 2.62. This showed the students' mean score difference of 1.68 for activity-based and conventional methods, 0.92 for problem-solving and conventional methods. This indicated that the activity based method was most effective for the teaching of Thermal Energy.

4.4 Hypotheses Testing

This section presents the summary of the hypotheses tested in the study. Seven (7) null-hypotheses were tested using Independent sample t-test and two-way Analysis of Variance (ANOVA). The summary of each of the hypotheses tested were presented as follows:

Hypothesis One: There is no significant difference between the pre-test and post-test performance of students taught Basic Science using activity-based method.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using paired sample t-test. The summary of data collected and analysed in respect of null hypothesis one is presented in Table 14

Table 14: Summary of pre-test and post-test paired sample t-test on the performance of students taught Basic Science using Activity-Based Method

Method	N	Mean	SD	Df	α	t-cal	t-crit	Sig. (2-tailed)	Decision
Pre-test	70	8.25	5.41	138	0.05	4.17	2.05	.002	Rejected
Post-test	70	55.61	11.43						

Table 14 showed the difference in pre-test and post-test performance of students taught Basic Science using Activity-Based methods in Junior Secondary Schools in Kaduna State, Nigeria. The table showed the t-cal of 4.17 and t-crit of 2.05, while the p-value was .002 ($P<0.05$). The null-hypothesis was thus rejected because there was significant difference in pre-test and post-test performance of students taught Basic Science using Activity-Based methods in Junior Secondary Schools in Kaduna State, Nigeria. Hence, it was established that students that were taught Basic Science using Activity-Based method had a higher score in their post-test result.

Hypothesis Two: There is no significant difference between the pre-test and post-test performance of students taught Basic Science using Problem-Solving method.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using paired sample t-test. The summary of data collected and analysed in respect of null hypothesis one is presented in Table 15

Table 15: Summary of pre-test and post-test paired sample t-test on the performance of students taught Basic Science using Problem–Solving Method

Method	N	Mean	SD	df	α	t-cal	t-crit	Sig. (2-tailed)	Decision
Pre-test	72	8.59	4.36	142	0.05	3.17	2.96	.002	Rejected
Post-test	72	54.62	12.46						

Table 15 showed the difference in pre-test and post-test performance of students taught Basic Science using Problem-Solving methods in Junior Secondary Schools in Kaduna State, Nigeria. The table showed the t-cal of 3.17 and t-crit of 2.96, while the p-value was .002 ($P<0.05$). The null-hypothesis was thus rejected because there was significant difference in pre-test and post-test performance of students taught Basic Science using Problem-Solving methods in Junior Secondary Schools in Kaduna State, Nigeria. Hence, it was established that students that were taught Basic Science using problem–solving method had a higher score in their post-test result.

Hypothesis Three: There is no significant difference between the performance of students taught Basic Science using Activity-Based and those taught using Problem-Solving methods in Junior Secondary Schools in Kaduna State, Nigeria.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using independent

sample t-test. The summary of data collected and analysed in respect to null hypothesis four is presented in Table 16.

Table 16: Summary of independent sample t-test on the performance of students taught Basic Science using Activity-Based and those taught using Problem Solving

Method	N	Mean	SD	df	α	t-cal	t-crit	Sig. (2-tailed)	Decision
Activity-Based	70	55.61	11.43						
				140	0.05	.493	1.96	.004	Rejected
Problem-Solving	72	54.62	12.46						

Table 16 showed that the post-test mean performance of students taught using Activity-Based was slightly higher than those taught using Problem-Solving method. The table showed the t-cal of .493 and t-crit of 1.96 while the p-value was .004 ($p<0.05$). The null hypothesis was rejected because there was significant difference between the post-test mean performance of students taught Basic Science using Activity-Based and Problem-Solving methods in Junior Secondary Schools in Kaduna State, Nigeria. The result establish that students taught Basic Science using Activity-Based method had a higher score and performed better than their counterparts taught using Problem-Solving method.

Hypothesis Five: There is no significant difference between the performance of students taught Basic Science using Problem–Solving Method and those taught using Conventional Method in Kaduna State, Nigeria.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination (JSCE) was analysed using independent sample t-test. The summary of data collected and analysed in respect of null hypothesis three is presented in Table 17.

Table 17: Summary of independent sample t-test on the performance of students taught Basic Science using Problem–Solving Method and those taught using Conventional Method

Method	N	Mean	SD	df	α	t-cal	t-crit	Sig. (2-tailed)	Decision
Problem–Solving	72	54.62	12.46						
				146	0.05	2.17	1.96	.002	Rejected
Conventional	76	50.03	16.82						

Table 17 showed that there was difference in the performance of students taught Basic Science using problem–solving method and those taught using conventional method in Kaduna State, Nigeria. The table showed the t-cal of 2.17 and t-crit of 1.96, while the p-value was .002 ($P<0.05$). The null-hypothesis was thus rejected because there was significant difference between the performance of students taught Basic Science using problem–solving method and those taught using conventional method in junior secondary schools in Kaduna State, Nigeria. Hence, it was established that students that were taught Basic Science using problem–solving method had a higher score and significantly performed better than their counterparts that were taught using conventional method.

Hypothesis Four: There is no significant difference between the performance of students taught Basic Science using Activity-Based Method and those taught using Conventional Method in junior secondary schools in Kaduna State, Nigeria.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using independent

sample t-test. The summary of data collected and analysed in respect of null hypothesis two is presented in Table 18.

Table 18: Summary of independent sample t-test on the performance of students taught Basic Science using Activity-Based Method and those taught using Conventional Method

Method	N	Mean	SD	df	α	t-cal	t-crit	Sig. (2-tailed)	Decision
Activity-Based	70	55.61	11.43						
				144	0.05	2.32	1.96	.003	Rejected
Conventional	76	50.03	16.82						

Table 18 showed that there was difference in the performance of students taught Basic Science using Activity-Based method and those taught using conventional method in Kaduna State, Nigeria. The table showed the t-cal of 2.32 and t-crit of 1.96, while the p-value was .003 ($P<0.05$). The null-hypothesis was thus rejected because there was significant difference between the performance of students taught Basic Science using Activity-Based method and those taught using conventional method in junior secondary schools in Kaduna State, Nigeria. Hence, it was established that students that were taught Basic Science using Activity-Based method had a higher score and significantly performed better than their counterparts that were taught using conventional method

Hypothesis Six: There is no significant difference in the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method in junior secondary schools in Kaduna State, Nigeria.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination (JSCE) was analysed using two-

way analysis of variance (ANOVA). The summary of data collected and analysed in respect of null hypothesis five is presented in Table 19.

Table 19: Summary of Analysis of Variance (ANOVA) on the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method

Status	Sum of Squares	df	Mean Square	F-ratio	F-critical	Prob.
Between Groups	208.457	2	104.229	11.759	3.15	.000
Within Groups	1905.768	215	8.864			
Total	2114.225	217				

Table 19 showed the f-ratio value of (11.759) at 217 degrees of freedom and at 0.05 level of significance. The critical value (3.15) is less than f-ratio value (11.759), the probability level of significance P (.000) is less than 0.05. This means that there was significant difference in the performance of students taught kinetic Theory of matter using activity-based, problem-solving and conventional method in junior secondary schools in Kaduna State, Nigeria. The implication of this result was to reject the null hypothesis which states that there was no significant difference in the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method in junior secondary schools in Kaduna State, Nigeria.

Table 20: Summary of Scheffe Multiple Comparison Test on the performance of students taught kinetic Theory of matter using Activity-Based, Problem-Solving and Conventional Method

Methods	Activity-Based	Problem-Solving	Conventional
Activity-Based	1	1.41	0.18
Problem-Solving	1.38	1	1.00
Conventional	2.38	1.00	1

Table 20 is on the performance of students taught kinetic Theory of matter using activity-based, problem-solving and conventional methods in junior secondary schools in Kaduna State, Nigeria. This showed that the performance of students taught kinetic Theory of matter using activity-based was better than those taught using problem-solving and conventional methods. This result indicated that the difference in the performance of students taught kinetic Theory of matter using activity-based was substantial than the other methods.

Hypothesis Seven: There is no significant difference in the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method in junior secondary schools in Kaduna State, Nigeria.

The data collected through the administration of the adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination was analysed using two-way analysis of variance (ANOVA). The summary of data collected and analysed in respect of null hypothesis Seven is presented in Table 21.

Table 21: Summary of Analysis of Variance (ANOVA) on the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method

Status	Sum of Squares	Df	Mean Square	F-ratio	F-critical	Prob.
Between Groups	104.255	2	52.127	10.484	3.15	.001
Within Groups	1069.034	215	4.972			
Total	1173.289	217				

Table 21 showed the f-ratio value of (10.484) at 217 degrees of freedom and at 0.05 level of significance. The F critical (3.15) is less than f-ratio value (10.484), the probability level of significance P (.001) is less than 0.05. This means that there was significant

difference in the performance of students taught Thermal Energy using activity-based, problem-solving and conventional method in junior secondary schools in Kaduna State, Nigeria. The implication of this result was to reject the null hypothesis which states that there is no significant difference in the performance of students taught Thermal Energy using activity-based, problem-solving and conventional method in junior secondary schools in Kaduna State, Nigeria.

Table 22: Summary of Scheffe Multiple Comparison Test on the performance of students taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method

Methods	Activity-Based	Problem-Solving	Conventional
Activity-Based	1	.764	1.68
Problem-Solving	1.764	1	.921
Conventional	1.68	.921	1

Table 22 on the performance of students taught Thermal Energy using activity-based, problem-solving and conventional method in junior secondary schools in Kaduna State, Nigeria showed that the performance of students taught Thermal Energy using activity-based was better than those taught using problem-solving and conventional methods. This result indicated that the difference in the performance of students taught Thermal Energy using activity-based was substantial than the other methods.

4.5 Summary of Findings

In view of the hypotheses tested in the study, the following findings were established that:

1. Students taught basic science using activity-based method had a higher score and performed significantly better in the post-test (P-value 0.002)

2. Students taught basic science using Problem-Solving method had a higher score and performed significantly better in the post-test (P-value 0.002)
3. The post-test mean performance of students taught Basic Science using Activity-Based method is slightly higher than the post-test mean performance of students taught Basic Science using Problem-Solving method (p-value 0.004).
4. Students taught basic science using activity-based method had a higher score and performed significantly better than their counterparts taught using conventional method (P-value 0.003).
5. The performance of students taught basic science using problem-solving method was significantly higher and better than their counterparts taught using conventional method. (P-value 0.002).
6. The performance of students taught kinetics theory of matter using activity based was significantly better than those taught using problem-solving and conventional methods. (P-value 0.000).
7. The performance of students taught thermal energy using activity-based method was significantly better than those taught using problem-solving and conventional methods. (P-value 0.001).

4.6 Discussion of Findings

Findings on research question one and two revealed that there was significant difference in pre-test and post-test performance of students taught Basic Science using Activity-Based and also Problem-Solving methods. The students taught Basic Science using Problem Solving and Activity-Based method achieved higher post-test mean score than the pre-test. The result of the test on hypothesis one and two which stated that there was no significant difference between the pre-test and post-test performance between the students taught using activity-based and those students' taught using problem-solving

was rejected. This finding agreed with the findings of Khan, Muhammed, Ahmed, Saed and Khan (2012), that the activity- based teaching was more appropriate for the development of reflective skills in the students. However, the above findings strongly negate the findings of Gadzama (2012), that there was no significant difference in mean scores between students taught integrated science using activity-based and those taught using problem-solving method. The findings of the study agrees with Omeogun and Akani (2014), who also buttressed that problem-solving approach (PSA) proved to be effective in improving students' attitude (affective) towards science.

Findings on research question three revealed that the mean performance of students taught Basic Science using Activity-Based method was slightly higher and better than those students taught using Problem-Solving method. However, the standard deviation at various levels indicated that students had slightly varied performance in the test administered. The result of the test on hypothesis four which stated that there is no significant difference between the performance of students taught Basic Science using Activity-Based method and those students taught Basic Science using Problem-Solving method was rejected. The above finding disagree with the finding of Gadzama (2012), that there was no significant different in mean scores between students taught Integrated Science (Basic Science) using Activity-Based method and those students taught using Problem-Solving method

Findings on research question four revealed that students taught Basic Science using activity-based method had a higher score and performed better than their counterparts taught using conventional method in Junior secondary schools in Kaduna State, Nigeria. The students taught Basic Science using activity-based recorded higher pre-test and post-test mean scores. However, the standard deviation at various levels indicated that students had a wide varied performance in the test administered. The result of the test on

hypothesis two which stated that there was no significant difference between the performance of students taught Basic Science using activity-based method and those taught using conventional method in junior secondary schools in Kaduna State, Nigeria was rejected. This finding was explained in the context of the fact that activity-based method was more effective to teach Basic Science than conventional method. Interestingly, this finding agrees with Shah and Rahat (2014), which revealed that the activity based teaching was much effective than the lecture method of teaching Science at elementary level. An earlier study by Iwuji (2013), also buttressed this finding that students that were exposed to Activity-based achieved significantly higher than their counterpart taught using lecture method. Similarly, Students exposed to activity- based instructional strategy retained the learnt concepts significantly better than their counterparts exposed to lecture instructional strategy.

Findings on research question five revealed that the performance of students taught Basic Science using problem–solving method was higher and better than their counterparts taught using conventional method in Junior secondary schools in Kaduna State, Nigeria. The students taught Basic Science using problem–solving method achieved higher pre-test and post-test mean scores. However, the standard deviation at various levels indicated that students had varied performance in the test administered. Therefore, the result of the test on hypothesis three which stated that there was no significant difference between the performance of students taught Basic Science using problem–solving method and those taught using conventional method in junior secondary schools in Kaduna State, Nigeria was rejected. This finding was in agreement with the research findings of Perveen (2010), that problem-solving sequence causes the learner to integrate the content conceptually in such a manner that the students can retain more readily than if the concepts were presented in an expository sequence. This finding also

supported the findings of Idris (2014), that students taught using problem-solving strategy achieved significantly better than those that were taught using lecture method; in terms of retention there was significant difference between students taught Basic Science using problem-solving teaching strategy than those taught using the lecture method. This finding also agree with the findings of Adeniran (2013), that the students were exposed to the problem solving approach (PSA) performed significantly better than those exposed to the lecture method (LM).

Findings on research question Six revealed that the performance of students taught kinetic Theory of matter using activity-based was better than those taught using problem-solving and conventional methods in junior secondary schools in Kaduna State, Nigeria. The students taught kinetic Theory of matter using activity-based method achieved higher pre-test and post-test mean scores than those taught using problem-solving and conventional methods. This probably could be as Festus (2013), puts it that Activity-based learning was characterised with high involvement in practical activities and discussions. However, the standard deviation at various levels indicated that students had varied performance in the test administered. The result of the test on hypothesis Six which stated that there was no significant difference in the performance of students taught kinetic Theory of matter using activity-based, problem-solving and conventional methods in junior secondary schools in Kaduna State, Nigeria was rejected. This finding was further buttressed by the result of Scheffe Multiple Comparison Test which indicated that the difference in the performance of students taught kinetic Theory of matter using activity-based was substantial than the other methods. An earlier study by Shafiu (2014), showed that there was significant difference in students' perception of Basic Science concepts before and after exposure to activity-based, problem-solving and conventional methods and there was also a significant difference in the retention ability of students

taught using activity-based than problem-solving and conventional methods. The finding also agreed with the research finding of Iwuji (2012), which revealed that the activity skill-based teaching strategy was superior to the Conventional method of teaching as far as the acquisition of process skills was concerned.

Findings on research question Seven revealed that the performance of students taught Thermal Energy using activity-based was better than those taught using problem-solving and conventional methods in junior secondary schools in Kaduna State, Nigeria. The students taught Thermal Energy using activity-based method achieved higher pre-test and post-test mean scores than those taught using problem-solving and conventional methods. This might be as a result of the treatment plan for Activity-Based which provided opportunity for experiential learning which involved a link between thinking and doing. It is assumed that students who handled the learning activities successfully had learnt the concept in order to perform that particular activity. However, the standard deviation at various levels indicated that students had varied performance in the test administered. The result of the test on hypothesis Seven which stated that there was no significant difference in the performance of students taught Thermal Energy using activity-based, problem-solving and conventional method in junior secondary schools in Kaduna State Nigeria, was rejected. This finding was further buttressed by the result of Scheffe Multiple Comparison Test which indicated that the difference in the performance of students taught Thermal Energy using activity-based was substantial than the other methods. This finding also agreed with the findings of Wong (2012), that students' questions during collaboration facilitated learning by directing their inquiry and expanding their thinking. Wong (2012), also noted that the problem-solving group performed better as well as the Conventional learning group in knowledge acquisition, and the activity-based. The problem-solving helped the high achievers to retain

information better than their peers in the Conventional learning group. Similarly, the findings also yielded significant correlation with the research findings of Nwagbo and Chukelu (2011), which revealed that practical activity method was more effective in fostering students' acquisition of science process skills than the lecture or any other methods. Although, the findings disagreed with the finding of Iliyasu (2011), whose result showed that there was no significant difference in the mean scores performance of students exposed to activity based, problem solving and lecture method.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study assessed the effects of Activity-Based and Problem-Solving methods on students' academic performance in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria. The study was carried out with Seven objectives which were to: determine the Pre-test and Post-test performances of students taught Basic Science using Activity-Based method in Junior Secondary Schools in Kaduna State, Nigeria; determine the Pre-test and Post-test performances of students taught Basic Science using Problem-Solving method in Junior Secondary Schools in Kaduna State, Nigeria; Investigate the effect of Activity-Based and Problem-Solving methods on students' performance in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria. determine the performance of students taught Basic Science using Activity-Based and Conventional method in Junior Secondary Schools in Kaduna State, Nigeria; examine the effect of Problem-Solving and Conventional method on the performance of students in Basic Science in Junior Secondary Schools in Kaduna State, Nigeria; ascertain the performance of students when taught Kinetic Theory of Matter using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria; and determine the difference in the performance of students when taught Thermal Energy using Activity-Based, Problem-Solving and Conventional Method in Junior Secondary Schools in Kaduna State, Nigeria.

Seven corresponding research questions and hypotheses were also formulated for the study.

The study reviewed relevant literatures that has bearing with the variables of the study conceptual framework was looked into, concepts such as concept of basic science

activity-based and problem method, the study adopted theory of progressism, theory of constructivism, the study reviewed 18 empirical researchers research design adopted by different studies, population, sampling techniques, instrument, statistical tools of the reviewed studies as well as the gap created by such studies were filled by the present study.

The study adopted quasi-experimental research design. While the target population was made up of one hundred and nineteen thousand, two hundred and thirty-eight (119,238) Junior Secondary 11students, the sample size for the study consisted of intact classes of two hundred and eighteen (218) junior secondary school students and was arrived at using purposive sampling technique. Also, the instrument used for data collection in the study was an adopted test of multiple choice in Basic Science Junior Secondary Certificate Examination from ever green, 2010-2014. The validated instrument was pilot tested and a reliability index of 0.79 was obtained. Hence, the instrument was therefore considered highly reliable for use because the reliability coefficient fell between 0.5 to positive one (+1).

The statistical tools used for data analysis included descriptive statistics of mean and standard deviation which were used to respond to the research questions raised in the study. Also, inferential statistics of t-test was used to test hypotheses 1, 2, 3, 4 and 5, while two-way Analysis of Variance (ANOVA) was used to test hypotheses 6 and 7. Therefore, the hypotheses were retained or rejected at 0.05 level of significance. The study established that:

1. Students taught basic science using activity-based method had a higher mean score and performed significantly better in the post-test (P-value 0.002)
2. Students taught basic science using Problem-Solving method had a higher mean score and performed significantly better in the post-test (P-value 0.002)
3. The post-test mean performance of students taught Basic Science using Activity-Based method is slightly higher than the post-test mean performance of students taught Basic Science using Problem-Solving method (p-value 0.004).
4. Students taught basic science using activity-based method had a higher mean score and performed significantly better than their counterparts taught using conventional method (P-value 0.003).
5. The performance of students taught basic science using problem-solving method was significantly higher and better than their counterparts taught using conventional method. (P-value 0.002).
6. The performance of students taught kinetics theory of matter using activity based method was significantly better than, those taught using problem-solving and conventional methods. (P-value 0.000).
7. The performance of students taught thermal energy using activity-based method significantly better than those taught using problem-solving and conventional methods. (P-value 0.001).

5.2 Conclusion

Based on the findings of this study, the following conclusions was deduced, it was concluded that There was significant difference in performance of students taught Basic Science using Activity-Based method and those students taught Basic Science using Problem-Solving method. The activity-based method was more effective to teach Basic

Science as the method enabled students to achieve higher score and perform better than their counterparts taught using conventional method. The performance of students taught Basic Science using problem-solving method was also higher and better than their counterparts taught using conventional method and this was as a result of students' involvement in solving the problem that was posed and deliberated upon in the process of finding out answers while learning was taking place, hence, led to better performance. In addition, the students taught Basic Science using activity-based had a higher score and significantly performed better than their counterparts taught using problem-solving method because activity-based learning involved the use of manipulative materials, meaningful learning, and sometimes by simply finding out using scientific processes where the students were very active in carrying out the investigating activities that enhanced learning. However, conclusion was reached that the difference in the performance of students taught kinetic Theory of matter and Thermal Energy using activity-based was substantial than those taught using problem-solving and conventional methods.

5.3 Recommendations

Considering the importance emanated from the study, the following recommendations were made:

1. Teachers and school Managers, should provide and encourage the use of both Activity-based and Problem-solving methods as they have been proven to be effective empirically in enhancing students' academic performance;
2. Basic science teachers should be encouraged to use Activity based method because of its positive effect in enhancing students' academic performance;

3. Teachers should enrich their classroom instructions with activity based and problem-solving activities in order to enhance students' performance in Basic Science;
4. Teachers should be encouraged to make their classrooms active in learning by ensuring that their students are exposed to meaningful Problem-solving activities that will make them active learners not passive listeners or receivers;
5. Curriculum planners, school managers, communities, non-governmental organizations and Ministry of Education at Federal, State, and Local Government levels should incorporate and support the use of activity-based and problem-solving methods in teaching Basic Science at Junior Secondary Schools.
6. The Activity-based and Problem-solving methods should be used alongside with the conventional method. As the saying goes, "no one method has all the answers", variety is the spice of life. Teachers should be encouraged to combine the salient features of traditional method into those of ABM and PSM to make teaching and learning more effective.

5.4 Contributions to Knowledge

The study has established empirically that activity based and problem solving methods significantly enhance the performances of students. Therefore, there is need for transformation from the conventional method to learner-centred Activity-based and Problem-based method. Also, it established the fact that teachers' appropriate use of teaching strategies in their classrooms could enhance students' academic performance and foster co-operation, consequently, improving positive interactions and group learning. Furthermore, the study also contributed to knowledge by revealing the bases for helping Educational planners, Curriculum designers and developers in Nigeria to see the

need of reviewing the basic science curriculum with particular reference to relevant teaching methods for teaching different topics of the curriculum.

In addition, professional bodies like the Science Teachers Association of Nigeria (STAN) were exposed to innovative Science teaching packages which can be used to improve better understanding and consequently improve students' performance. The findings of this study also served as a guide to Government policy formulation and implementation on school infrastructures and materials needed for instruction. The study afford opportunity through which the challenges faced with teaching and learning in Science and other related field can be properly addressed by engaging in thorough supervision and ensuring that teaching materials and infrastructures are properly utilized by both teachers and students.

5.5 Suggestions for Further Studies

The researcher made the following suggestions for further study:

1. Comparative effect of activity-based and problem-solving methods on students' performance in basic science in private and government junior secondary schools in Kaduna State, Nigeria.
2. Assessment of the effect of activity-based and problem-solving methods on students' performance and Interest in basic science in Kaduna State, Nigeria.
3. Relative effects of activity-based instructors' autonomy support and students' autonomous motivation on learning basic science in Kaduna State, Nigeria.

REFERENCES

Abdi, A. (2014).The effect of Inquiry-based learning method on Students' academic Achievement in Science Course, *Universal Journal of Educational Research* 2 (1): 37-41

Abdullahi, J. G. (2013). Comparative Study of Inquiry and Lecture Methods on Student Performance in Chemical Reaction Concept in Secondary Schools of Kankia Educational Zone, Katsina State: Proceedings of Multicultural African Conference 513-522

Abimbola, I.O., (2013). *Philosophy of Science for Degree Students*. Ilorin Bamitex Printing and publishing, Ilorin.

Achor, E. E. & Amadu, S. O. (2015). An Examination of the extent to which School Outdoor Activities could Enhance Senior Secondary Two Students Achievement in Ecology. Journal of Evaluation and e-learning Research 2(3):35-41

Adeniran, S. A. (2013). Effects of Problem Solving Approach on the Performance of Students in Physics. *African Journal of Art, Science, and Education Issues,* 1(1), 63-70.

Adeyemi, T. O. (2008). Predicting Students'Performance in Junior Secondary Certificate Examination, in Ondo State, Nigeria. *Humanity and Social Sciences Journals,* 3(1), 26-36.

Afuwape, M. O. (2012). Integration in science teaching-learning: problems and prospects. *International Journal of Science and Technology. Bahir Dar, Ethiopia.* 1(3): 126-133

Agarwal, Y. P. & Thakur, R. S. (2003). *Concepts and Terms in Educational Planning: A Guidebook. Operations Research and Systems Management Unit.* National Institute of Educational Planning and Administration, New Delhi.

Agboghorhoma, T.E. & Oyovwi, E.O. (2015). *Evaluating Effect of Student's Academic Achievement on Identified Difficult Concepts in Senior Secondary School Biology in Delta State. Journal of Education and Practice* 6(30): 117-125.

Akani, O. (2016). An evaluation of classroom experiences of basic science teachers in secondary schools in Ebonyi State of Nigeria. *British Journal of Education, 4* (1), 64-76.

Akinbobola, A. O., & Afolabi, F. (2009). Constructivist practices through guided discovery approach: the effect on students' cognitive achievements in Nigerian senior secondary school physics. *Bulgarian Journal of Science and Education Policy, 3* (2).

Akinoglu, O. & Tandogan, R. O. (2007). The Effects of Problem-Based Active Learning in Science Education on Student' Academic Achieveent, Attitude and Concept Learning. *Journal of Math, Science and Technology Education,* 3(1), 71-81.

Akkus, Z. (2015). Activity-Based Teaching in Social Studies Education: An Action Research. *Educational Journal Research, 10*(14), 1911-1921.

Akponinovio, S.R., & Odebala. E. (2016). Implementing the Universal Basic Science Education Curriculum for Development in Nigeria Beyond 2020. *Academic Excellence,* 1: 1-12.

Alasoluyi, O. E. (2017). *Effects of Project and Discussion Methods on Students' Performance in Economics in Senior Secondary Schools in Ekiti State, Nigeria.* Unpublished Ph.D Thesis. Ahmadu Bello University. Zaria, Kaduna, Nigeria.

Alozie, N. M., Moje E. B., & Kracik, J. S. (2010). An analysis of the supports and constraints for scientific discussion in high school project-based science. *Science education.* Vol. 94. 395-427

Amalia, E., Surya, E. & Syahputra, E., (2017). The Effectiveness of Using Problem-Based Learning (PBL) in Mathematics Problem Solving Ability for Junior High School Students. *IJARITE* 3(2):3402-3406

Aniaku, O. L. (2012*). Effects of Guided and Unguided Inquiry Teaching Methods on Secondary School Students' Achievement and Interest in Biology in Enugu State*. Unpublished master's dissertation. University of Nigeria, Nsukka, Enugu, Nigeria.

Anyakoha, E. U. (2009). *Developing Research Skills: Concepts and Conceptual Frame Work*. Nsukka. AP Express Publishers Ltd.

Anwer, F. (2019). The Effects of Activity-Based Teaching Techniques on Student Motivation and Academic Achievement. *Journal of Education and Educational Development*. 6(1): 154-170.

Arends, R. I. (2011). *Learning to Teach*. McGraw Hill Publishers, USA.

Atadoga, M. M. (2003). Gender Cognitive Preferences and Achievement in Physics Among Nigeria Certificate in Education (NCE) Students. *Kano Journal of Science Education*,1(1), 125-134.

Awang, H. & Ramly, I. (2008). Creative thinking skills approach through problem-based learning: Pedagogy and practice in the engineering classrooms. *International Journal of Human, Social Sciences, 3* (1), 18 – 23.

Bada, S. O. (2015). Constructivism learning theory: a paradigm for teaching and learning. *Journal of research and method in education*. Vol. (5) pp. 66-70

Baeten, M., Kyndt, E., Struyven, K. & Dochy, F. (2010). Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review*, 5: 243-260.

Bardhoshi. G. & Erford, T (2017) Processes and Procedures for Estimating Score Reliability and Precision. *Measurement and Evaluation in Counseling and Development*, 50:4: 256-263.

Barrette, T. (2010).The problem-based learning process as finding and being in flow. *Innovations in Education and Teaching International*, 47(2), 165-174.

Barron, B. & Darling-Hammond, L.(2008).*Teaching for meaningful learning*: San Francisco: Jossey-Bass.

Barrow, L. H. (2017). A brief history of inquiry-From Dewey to Standards. *Journal of Science Teacher Education*, 17:3, 265-278.

Batdı, V. (2014). The effect of Activity-based Learning Approach on Academic Achievement (A Meta-Analytic and Thematic Study). *E-International Journal of Educational Research*. 1(1): 39-55.

Bawa, M. R. (2011). *Effects of Problem Solving Instructional Strategy on Academic Achievement And Retention In Ecology Among Secondary School Students With Different Cognitive Preferences In Zaria Educational Zone*. Unpublished Ph.D Thesis Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Ben-Yunus, M. (2008).*Issus on curriculum*. Zaria: Sakonre Educational Publisher Company Limited.

Bhounsule, S. A., Samuel, L. J., Walker, Y. S. & Bandudkar, L. V. (2015). Problem Based Learning (PBL) As a Teaching–Learning Strategy to Supplement the Knowledge of Pharmacology Medical School Undergraduates. *Journal of Research and Method in Education*. 5(4), 91 – 94.

Bichi, S. S. (2002). *Effects of Problem-Solving Strategy and Enriched Curriculum on Students' Achievement in Evolution Concepts among Secondary Students*. Unpublished PhD thesis. Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Borich, G. (2011). Effective Teaching Methods. Pearson Education Inc, Boston.

Borůvková, R. Emanovský, P. (2016). Small Group Learning Methods and Their Effect on Learners' Relationships. *Problems of Education in The 21st Century.* 70(1): 45-59.

Çakicil, Y., & Turkmen, N. (2013). An Investigation of the Effect of Project-Based Learning Approach on Children's Achievement and Attitude in Science. *The Online Journal of Science and Technology, 3* (2), 9-17.

Cambridge dictionary (2013). *Theory In dictionary.cambridge.org.* Retrieved from http://dictionary.cambridge.com/definition/english/theory

Casey, D. (2012). *The nature of science.* Retrieved from https://www.vmnh.net/vss1_1_2012 on 5/2/2018.

Çakici, Y. & Turkmen, N. (2013). An Investigation of the Effect of Project-Based Learning Approach on Children's Achievement and Attitude in Science. *The Online Journal of Science and Technology.* 3(2): 9-17.

Çelik, H. C. (2018). The Effects of Activity Based Learning on Sixth Grade Students' Achievement and Attitudes towards Mathematics Activities. *Eurasia Journal of Mathematics, Science and Technology Education.* 14(5): 1963-1977.

Chukwuneka, B. U. (2009). Creativity through S.I.M Education. A gateway to development of entrepreneurial skills among Nigerian Graduates. 68th *STAN Conference Proceedings.* 357-361

Cui, X. (2016). *An empirical study of problem-based learning of English in China.* Unpublished masters dissertation. University of Connecticut, Connecticut, United States of America.

Daluba, N.E. (2013). Effect of Demonstration Method of Teaching on Students' Achievement in Agricultural Science. *World Journal of Education,* 3(6): 1-7.

Danjuma, S. (2017). *Effects of Inquiry-based Instruction on Acquisition of Process-skills, Interest and Performance in Ecology among Secondary School Students, in Lere, Kaduna, Nigeria.* Unpublished PhD Thesis. Department of Science Education, Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Darling-Hammond, L. (2008). *Powerful Learning: What We Know About Teaching for Understanding.* San Francisco: Jossey-Bass

David, E. (2015).*Impact of Enriched Lecture and Demonstration Methods in Secondary School Students' Achievement and Attitude Towards Geography in Zaria, Nigeria.* Unpublished M.Ed Thesis. Department of Science Education, Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Dawaki, J. H. (2014). *Effect of Activity-Based Instructional Strategy on the Academic Performance of Students in Integrated Science in Junior Secondary Schools in Kaduna State, Nigeria.* Unpublished master's dissertation. Ahmadu Bello University, Zaria, Kaduna, Nigeria.

DeWitte, K., & Rogge, N. (2012). Problem-based learning in secondary education: Evaluation by an experiment. *Journal Education Economics.* 24 (1): 58-65

Dignath, C., Buettner, G., & Langfeldt, H.-P. (2008), How can primary school students learn self-regulated learning strategies most effectively? A meta-analysis on self-regulation training programmes, *Educational Research Review*, 3, pp. 101-129.

Dike, B. C. (2008). *The effects of problem-solving strategy and lecture method on socio-cultural beliefs hindering science learning at the junior secondary school in FCT Abuja.* Unpublished Masters Dissertation. Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2014). Effects of problem-based learning: a meta-analysis. *Learn. Instruct.* 13, 533–568.

Dagundura, K. (2016). *Evergreen Solutions on Basic Education Certificate Examination.* Ibadan: Laswell Books Services.

Ediger, M., & Rao, D. B. (2011). *Essays on Teaching Science*. Discovery Publishing House.

Ekeyi, D. N. (2013). Effect of demonstration method of teaching on students' achievement in agricultural science. *World journal of education.* 3(6). 1-7

Emaikwu, S. O. (2012). Assessing the relative effectiveness of the three teaching methods in the measurement of students' achievement in mathematics. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, 3(4). Pp 479-486.

Etherington, M. B. (2011). Investigative Primary Science: A Problem-Based Learning Approach. *Australian Journal of Teacher Education, 36* (9), 52-74.

Ezeaghasi,N.E.(2014). Repositioning Practical BiologyTeaching for Students Accessto Quality Science Process Skills and Attitude in Secondary Schools of Kaduna State.*Prceedings of Multicultural African Conference* Held at Facultyof Education, ABU Zaria 11-16August 2014 ,

Ezekwesili, O. (2007, January 4). Reinventing Education, Vanguard Newspaper, 47.

Federal Republic of Nigeria (2013). *National Policy on Education (6th Edition).* Lagos: Federal Government Press.

Federal Republic of Nigeria (2014). *National Policy on Education.* Lagos: NERDC Printing Press.

Festus, A. B. (2013). Activity-Based Learning Strategies in the Mathematics Classrooms. *Journal of Education and Practice, 4* (13):22-36

Fui, K.S. (2010) *Implementation of Constructivist Approach Among Chemistry Students-Teachers in Teaching Chemistry During Their Teaching Practice.* Unpublished Undergraduate Project. University of Technology, Malaysia.

Funderstanding (2011). *Constructivism*. Retrieved from http://www.funderstanding.com/theory/constructivism on 8/03/2018.

Gadzama, B. I. (2012). *Effects of science process skills approach on academic performance and attitude of integrated science students with varied abilities.* An Unpublished PhD thesis. Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Ganyaupfu, E. M. (2013). Teaching methods and students' performance. *International Journal of Humanities and Social Science Invention,* 2(9), 29-35. Retrieved from www.ijhssi.org on 17/02/2016

Gengle, H. I, Mohammed, A. A., & Badau, K. M. (2017). Effective teaching and learning strategies in science and mathematics to improve students' academic performance in Nigeria. *British Journal of Education, Society and Behavioural Science.* 19(1) pp1-7

Guga A. & Bawa M. R. (2015). *Curriculum and Instruction.* Zaria. Kareem and Guga Publishers

Guido, M. (2017). *All about inquiry-based learning: definition, benefits, and strategies.* Retrieved from https://www.prodigygame.com/blog/inquiry-based-learning-definition-benefits-strategies/

Hamza, F. & Mohammed, U. (2011). Way Forward for the New UBE Basic Science and Technology Curriculum. *Journal of Science Teachers Association of Nigeria,* 4(6), 82-93.

Hang W. K. (2012). *Implementation of problem-based learning in junior secondary science curriculum.* Unpublished PhD Thesis. University of Hong Kong, Hong Kong, China.

Harris, M.J. (2014). *The challenges of implementing project-based learning in middle schools,* Unpublished PhD Thesis. University of Pittsburgh.

Hartman, K.B., Moberg, C.R., & Lambert, J.M. (2013) Effectiveness of problem-based learning in introductory business. *Journal of Instructional Pedagogies* 4(1): 1-13.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analysis relating to achievement.* New York, NY: Routledge.

Hofstein, A. & Naaman, R. M., (2011). High-School Students' Attitudes toward and Interest in Learning Chemistry. *Educacion Quimica.*22 (2):90-102

Holbrook, J. (2011). Enhancing Scientific and Technological Literacy (STL): AMajor Focus for Science Teaching at School. *Journal of the Science Teachers Association of Nigeria, 46* (1): 1-12.

Holm, M. (2018). *Project-based instruction: A Review of the Literature on Effectiveness in Prekindergarten through 12th Grade Classrooms.* Retrieved From https://www.researchgate.net/publication/329000774_PROJECT-BASED_INSTRUCTION_A_Review_of_the_Literature_on_Effectiveness_in_Prekindergarten_through_12th_Grade_Classrooms on 7/1/2019

Hung, W., Jonassen, D.H., & Liu, R. (2008).Problem-based learning. In D.H. Jonassen (Ed.), *Handbook of research on educational communications and technology (3rd edition).*Mahwah, N.J.: Lawrence Erlbaum Associates.

Hussain, S., Anwar, S. & Majoka, M.I. (2011). Effect of Peer Group Activity-Based Learning on Students' Academic achievement in Physics at Secondary Level. *International Journal of Academic Research,* 3(1), 940-944.

Ibe, H. N. (2013). Effects of guided-inquir and expository teaching methods on senior secondary school students' performances in Biology in Imo State. *Journal of Education Research and Behavioral Sciences, 2* (4), 51-57.

Ibrahim, J. (2015). *Effects of Inquiry Method on Performance of Junior Secondary School Students in Islamic Studies in Kaduna State, Nigeria.* An unpublished M.Ed dissertation. Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Idris, Y. (2014*). Impact of Problem-Solving Strategy on Academic Achievement and Retention of Basic Science Concepts Among Varied Ability Students, Kaduna State, Nigeria, Nigeria.* Unpublished M.Ed dissertation, Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Idris, Y. (2016). Effect of Problem-Solving Strategy on Retention and Academic Performance aong Basic Science Students in Anchau Zone, Kaduna State, Nigeria. *Science Education Seminar Series.* Department of Science Education. Ahmadu Bello University, Zaria. 4(1):422–431.

Iliyasu – Shiyanbade, F. O. (2011). *Effects of Problem-Solving Method on Mathematics Performance and Attitude Among Federal Colleges of Education Students in Kano and Zaria.* Unpublished M.Ed dissertation, Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Iwuji, N. P. (2012). *Effect of Activity-Based Teaching Strategy on Academic Achievement and Retention in Basic Science Concepts Among Junior Secondary School Students.* Unpublished MED dissertation. Ahmadu Bello University, Zaria, Kaduna State, Nigeria, Nigeria.

Jackman, H.L. (2011). *Early Education Curriculum: A Child's Connection to the World.* Wadsworth: Cengage Learning.

Jarumai, C. T. (2015). *Effects of simulations using MATLAB with SIMULINK on the achievement and gender of electronic technology education students in Nigerian universities.* Unpublished masters thesis. University of Nigeria, Nsukka, Enugu, Nigeria.

John, E. O. (2009). *Man and the State: Issues in Socio-political Philosophy.* Uyo: Afahaide Publishers.

John, E. O. (2014). A Philosophical Appraisal of Rousseau's child-centred education and it's impact to Nigeria's leadership. *Journal of Education and Practice,* 5(24): 28-40..

Kanno, T. N. (2018*). Guided Discovery Teaching Method. Issues in Curriculum Development and Implementation in Nigeria.* Foremost Educational Services Limited, Lagos, Nigeria.

Kennedy, R. (2017). *Progressive Education: How children learn.* Retrieved from https://www.thoughtco.com on 10/11/2017

Khan, M., Muhammad, N., Ahmed, M., Saeed, F., & Khan, S. A. (2012). Impact of activity-based teaching on students' academic achievements in physics at secondary level. *Academic Research International, 3* (1), 146-156.

Kochhar, S.K. (2012). *Methods and Techniques of Teaching.* New Delhi. Jalandhar, Sterling.

Kohn, A. (2008). *Progressive Education: Why It's Hard To Beat, But Also Hard To Find. Independent School,* 1-9. Retrieved from http:www.alfiekohn.org/article/ progressive-education

Kösterelioğlu, İ., Bayar, A., & Kösterelioğlu, M. A. (2014). Activity based learning process on teacher education: A case study. *International Periodical for the Languages, Literature and History of Turkish or Turkic,* 9(2): 1035-1047.

Kowoser, L. & Berman, G. (2014). *Teaching and Learning Styles in Tertiary Institutions.* Houston Press, Texas, United State.

Kyiracou, S. (2010). *An Introduction to Teaching and Learnin Skills.* Kaduna: Global Link Press.

Labaree, D. F. (2015). Labaree, David. (2004). The Ed School's Romance with Progressivism. *Brookings Papers on Education Policy.* 2004. 89-112.

Maheshwari, V. K. (2017). *The Problem Solving Method.* Retrieved from http//www. V.K.maheshwari.com/wp?p= on 11/11/2017.

Maikudi, J. (2015). *Effect of Guided-discovery and Problem-Solving Strategies on Attitude and Performance Towards Geometry Among Junior Secondary School Students' in Kaduna State, Nigeria, Nigeria.* Unpublished Masters Dissertation in Mathematics Education. Department of Science Education, Ahmadu Bello University Zaria.

Mairin, H. & Fordyce, K. (2017). Cooperative learning on an international masters. *Higher Education Research & Development.* 37. 1-15.

Maurer, H. & Neuhold, C. (2012). *ProblemsEverywhere? Strengths and Challenges of a Problem-Based Learning Approach in European Studies.* Problem Based Learning in European Studies-Maastricht Experience pp 7. Retrieved from http://www.mcegmaastricht.eu/pdf/MCEG.part%20link2%20PBL%20implementation%20challenges.

McGrath, J.R., & MacEwan, G. (2011). Linking pedagogical practices of activity-based teaching. *The International Journal of Interdisciplinary Social Sciences,* 6(3), 261-274.

Meltzer, D. & Thornton, R. (2013). Research-based active-learning instruction in physics. 15005-.

Meziobi, K. A., Fubara, V. R. & Mebiobin, S. A. (2008).*Social Studies in Nigeria teaching methods.* Instructional material and resources. Acadabeak Publishers, Owerri, Nigeria.

Michiko, K. (2009). *The era of adopting quickly.* Retrieved from pagels.blogsome.com/2009/03/19/michiko-e-hatchin-review-925100/-82k

Mogashoa, T. (2014). Applicability of Constructivist Theory in Qualitative Educational Research. *American International Journal of Contemporary Research.* 4 (7). Pp. 51-59

Mokiwa, H.O, & Agbenyeku, E. U. (2019). Impact of Activity-Based TeachingStrategy on Gifted Students: A Case of Selected Junior Secondary Schools inNigeria. *Journal for the Education of Gifted Young Scientists,* 7 (2): 421-434.

Morshead, R. W. (2010). *Patterms of educational practice: theories of curriculum.* Miami. The Pieran Press

National Educational Research Development Council (NERDC), (2013). *Curriculum for Basic Science.* NERDC, Abuja.

National population Commission (2004).*Nigeria Demographic and Health Service Education Data Survey. Education Data for Decision Making.* Federal Ministry of Education, Federal Republic of Nigeria, Abuja Kaduna.

National Research Council. (2000). *Inquiry and the national science education standards.* Washington, DC: National Academy Press.

National Research Council. (2012). *Inquiry and the national science education standards.* Washington, DC: National Academy Press.

National Teachers Institute (NTI), (2000). *Nigeria certificate in education course book on educational cycle.* NTI Institute Kaduna.

Nayak, A. K. (2014). *Teaching of Physics.* New Delhi: ADH Publishing Corporation.

New World Encyclopedia (2017) *Experiential Learning* Retrieved From https://www.newworldencyclopedia.org/entry/Experiential_learning on 10/11/'17

Ngusa, B. M. & Makewa, L. N. (2014). Constructivism experiences in teaching-learning transaction among Adventist secondary schools in South Nyanza Tanzania. *American Journal of Educational Research.* Vol. 2(11) pp. 1-7

Nigeria Certificate in Education Minimum Standard for Sciences, (2012).*National Commission for Colleges of Education* (NCCE).Federal Ministry of Education, Federal Republic of Nigeria, Abuja.

Nsengimana, T., Habimana, S., & Mutarutinya, V. (2017). Mathematics and Science Teachers' Understanding and Practices of learner-Centred Education in Nine Secondary Schools from Three Districts in Rwanda. *Rwanda journal of Education4* (1):55-68

Nsengimana, T., Ozawa, H., & Chikamori, K. (2014). The Implementation of the New Lower Secondary Science Curriculum in Three Schools in Rwanda, *African Journal of Research in Mathematics, Science and Technology Education.* 18:1, 75-86

Nwagbo, C., & Chukelu, U. C. (2011). Effects of Biology Practical Activities on Students' Process Skill Acquisition. *Journal of the Science Teachers Association of Nigeria, 46* (1).

Nwangi, S. N., Barchok, K. & Ogola, F. (2015).Application of Progressivist's Learner-Centred Approaches in Teaching and Learning of Mathematics in Public Primary Schools. *British Journal of Educational Society & Behavioural Science. 12*(3), 1-8.

Obi, N. C. & Kalu, I. (2013). Kitchen resources classroom interaction and academic performance and retention of Senior Secondary School Two (SSS2) chemistry students in thermo chemistry. *Journal of education and practice.* Vol. 4(8). pp. 169-173.

Obi, P., Ukaegbu, M. N. & Iwuji, F. I. (2017). The Need for Inclusion of Constructivist Approach to Learning in Junior Secondary School. Pre-Vocational Studies Curriculum. *Nigerian Journal of Curriculum.* 1(24)

Obioma, G. (2013). *Teacher's guide for the revised nine(9)-year basic education curriculum*. Retrieved from https://www.nerdcnigeria.org on 5/2/2018

Odagboyi, I. A.; Sambo, M.H.; Musa, A.J. &Onche,E. U. (2014). Inovations in Teaching: Between Research and Classroom. *Journal of Education and Practice*. 4(22).35-43

Okoli, M. (2011). *Comparative Study of Using Ptoblem-Solving and Teacher Demonstration Methods on Students' Performance in Financial Accounting in Secondary Schools in Gombe State*. Unpublished PhD Thesis, Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Olorundare, A. S. (2011). Correlates of Poor Academic Performance of Secondary School Students in the Sciences in Nigeria. *Journal Virginia State University, Petersburg, Virginia, USA. Retrieved from http:/scholargoogle.com on 1/03/2017*

Olorundare, A. S. (2018).*Philosophical Underpinning of Curriculum Development. Issues in Curriculum Development and Implementation in Nigeria.* .Foremost Educational Services Ltd, Lagos, Nigeria

Olorundare,A. S. (2014). *Theory into practice: Beyond surface curriculum in science education*. The one hundred and forty-seven Inaugural Lecture presentation at the University of Ilorin, Nigeria. May 2014

Omoegun, O. M., & Akani, O. O. (2014). Effects of Problem Solving and Mastery Learning Strategies on Junior Secondary School Students' Attitudes Towards Mathematics. *Journal of Studies in Education,* 14(1), 263-277.

Omofo, C. N. (2012). Dance of the limits: reversing the trends in science education. A Nigerian Inaugural Lecture, University of Benin, Benin City.

Omorogbe, E. & Ewansiha, J. C. (2013).The challenge of effective science teaching in Nigerian secondary schools. *Academic Journal of Interdisciplinary Studies*, 2(7), 181-189.

Pagander, L., & Read, J. (2014).*Is Problem-Based Learning (PBL) An Effective Teaching Method?; A Study Based on Existing Research*. Retrieved from http://www.diva-portal.org/smash/record/is-problem-based-learning-an-effective-teaching-method? on 6/07/18.

Perveen, K. (2010). Effect of the problem-solving approach on academic achievement of students in mathematics at the secondary school level. *Contemporary Issues in Education Research,* 3(3), 9.

Peter, A. (2009). An investigation in to the effectiveness of the use of advance organizers on students' academic achievement and retention in biology inSS2 in Giwa education zone. A pre-proposal paper presented Science Education section, Ahmadu Bello University, Zaria.

Radu, L. (2011). John Dewey and Progressivism in American Education. Bulletin of the Transilvania, university of Brasov, Series VII: *Social Sciences, Law, 4* (53), 2, 85-90.

Ravi, S. S. (2015). *A comprehensive study of education.* PHI Learning Private Limited, Delhi.

Regoniel, P. A. (2015*). Quantitative Methds:Meaning and Characteristics.* Retrieved from http:/simplyeducate.me on 11/03/2017

Ronis, D. L. (2008). *Problem-based learning for mathematic and science: Integrating inquiry and the Internet*. (2nd Ed). California: Corwin Press.

Roya J.A. & Haier, D. A. (2015). Review of Constructivism and Social Constructivism. *Journal of Social Sciences, litreture and languages* 1(1),9-16.

Rufa'i, R. A. (2018). Curriculum and Community Development. *Nigerian Journal of Curriculum Studies*. 25(1): 4-18.

Sahin, M., & Yorek, N. (2009). A comparison of problem-based learning and traditional lecture students' expectations and course grades in an introductory physics classroom. *Eurasia journal of Mathematics, Science and Technology Education.* 5(4), 321-333

Sambo, S. (2008). Understanding Guidance and Counseling. Zaria: Ahmadu Bello University Press.

Samkange W. & Samkange C., (2012). Philosophies and perspectives in education: examining their roles and relevance in education. *Greener Journal of Educational Research.* 3(10): 454-461.

Sawant, S. P., Rizvi, S. (2015). Study of passive didactic teacher centred approach and an active student centred approach in teaching anatomy. *International Journal of Anatomy and Research*, 3(1): 1192-1197.

Science Teachers Association of Nigeria (STAN 2011).Unpublished lectures delivered at the Basic science panel at the 52ND Annual conference held at Akure, Nigeria. August 2011.

Scott, D. & Friesen, S. (2013). Inquiry-Based Learning: A Review of the Research Literature. *Alberta Education.* 1. 1-29.

Scott, K.S. (2017). An Integrative Framework for Problem-Based Learning and Action Learning: Promoting Evidence-Based Design and Evaluation in Leadership Development. *Human Resource Development Review*, 16(1): 3 –34

Selcuk, G. S. (2010). The effects of problem-based learning on pre-service teachers' achievement, approaches and attitudes towards learning physics. *International Journal of Physical Sciences*, 5(6), 711-723.

Shafi'u, S. M. (2014). *Impact of Science Process Approach Strategy on Students' Perception, Academic Achievement And Retention of Basic Science Concepts in Zaria, Kaduna State, Nigeria, Nigeria.*Unpublished M.Ed Dissertation. Ahmadu Bello University, Zaria, Kaduna Nigeria.

Shah, I., & Rahat, T. (2015). Effects of Activity Based Teaching Method in Science. *International Journal of Humanities and Management Science, 2*(1).

Son, B., & VanSickle, R.L. (2000), Problem-solving instruction and students acquisition, retention, and structuring of economics knowledge, *Journal of Research and Development in Education*, 33(2), pp. 95-105.

Stephan, M. (2014). Teacher-Centered Teaching in Mathematics Education. Retrieved from https://link.springer.com/referenceworkentry/10.1007%2F978-94-007-4978-8_150 on 10/11/2017

Stößlein, M. (2009). Activity-based Learning Experiences in Quantitative Research Methodology for (Time-Constrained) Young Scholars -Course Design and Effectiveness. POMS 20th Annual Conference, Orlando, Florida, U.S.A.

Strobel, J., Barnevald, V. (2009). When is PBL More Effective? A Meta-synthesis of Meta-analyses Comparing PBL to Conventional Classrooms. *Interdisciplinary Journal of Problem-Based Learning,* 3(4): 44-58.

Struyven, K., Dochy, F., & Janssens, S. (2008). Students' likes and dislikes regarding student-activating and lecture-based educational settings: Consequences for students" perceptions of the learning environment, student learning and performance", *European Journal of Psychology of Education*, 23(3), 295-317.

Tebabal, A., & Kahssay, G. (2011).The effects of student-Centred approach in improving students' graphical interpretation skills and conceptual understanding of kinematical motion. *Latin-American Journal of Physics Education.*5 (2), 9.

Tiwari, S. R., Rathor, C.L., & Singh, Y. K. (2014). *Teaching Methos of Physical Education.* APH Publishing Corporation, New Delhi.

Travedi, K. (2013). Opinion of Secondary Teacher about Problem Based Learning. *Voice of Research.* 9(2): 1–7.

Tsoho, L. T. W. (2011). *Effects of Problem-Solving and Student-Centred Teaching Strategy on Students Geometry Performance and Retention in JSS in Kano.* Unpublished PhD Thesis. Ahmadu Bello University, Zaria, Kaduna, Nigeria.

Turco, J. (2010). *ETEC 520: Problem-based learning: the benefits and challenges of implementing problem based learning (PBL) in a grade seven (7) class.* [Class handout]. University of British Colombia, Canada.

Ul-haq, Z. Khurram, A.& Bangash, A.K.(2017).Development of Speaking Skills Through Activity- based Learning at the Elementary Level. *Eurasian journal of Educational Research.69(1): 241-252*

Vansteenkiste, M., Soenens, B., Sierens, E., Luyckx, K., & Lens, W. (2009)."Motivational profiles from a self-determination perspective: The quality of motivation matters", *Journal of Educational Psychology*, 101(3), pp. 671-688.

Weimer, M. (2012). *Five (5) characteristics of learner-centred teaching.* Retrieved from https://facultyfocus.com/articles/effective-teaching-strategies/5-characteristics-student-centred-learning/ on 10th February 2018.

Wong, K. H. (2012). *Implementation of problem-based learning in junior secondary science curriculum.*Unpublished PhD Thesis. University of Hong Kong, Hong Kong, China.

Wright, P. M. (2017). Making Great Theories. *Journal of Management Studies, 54 (3): 1-7*

Yelland, N., Cope, B., & Kalantzis, M. (2008). Learning by design: Creating pedagogical frameworks for knowledge building in the twenty-first century. *Asia Pacific Journal of Teacher Education*, 36(3), 197-213.

Yero, H. J. (2009). The use of model in teaching organic reactions to improve performance among Colleges of Education students in Plateau state. A Proposal paper presented to the science education section. Department of Education, Ahmadu Bello University, Zaria.

Yusuf, H. O. (2012). *Fundamentals of Curriculum and Instruction.* Kaduna: Joyce Graphic Printers & Publishers.

Zakaria, E. Chin, C. L. & David Y. (2010). The effect of cooperative learning on students mathematics achievements and attitude towards mathematics. *Journal of Social Sciences.* 6(2): 272-275.

APPENDIX 1
LETTER OF INTRODUCTION

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM
Faculty of Education
AHMADU BELLO UNIVERSITY, ZARIA

Vice-Chancellor: **Professor Ibrahim Garba,** *B.Sc (Hons) Geology, M.Sc (Mineral Exploration) ABU, Ph.D Geology (London), D.I.C., FNMGS*
Head of Department **Dr. Musa Idris Harbau,** *GRII (TC), NCE, B.A (Ed), M.Ed Admin and Planning (BUK), PhD Admin and Planning (ABU)*

Our Ref: DEFC/S.25 Date: _____

_____
_____
_____
_____

Dear Sir,

LETTER OF INTRODUCTION

The bearer, JUMMAI Habu DAWAKI, with Registration Number PGEDEC/9003 is a student in this department. He /She is carrying out research, being part of requirement for graduation, in CURRICULUM AND INSTRUCTION. He/She needs certain information in your organization. Kindly, allow him/her have access to information in your organization. The information obtained will be used for research purpose only. The topic of his/her research is

ASSESSMENT OF THE EFFECTS OF ACTIVITY-BASED AND PROBLEM-SOLVING METHODS ON STUDENTS' PERFORMANCE IN BASIC SCIENCE IN JUNIOR SECONDARY SCHOOLS IN KADUNA STATE, NIG

Thanks in anticipation of your kind response.

Yours sincerely,

27/03/2019

Dr. M.I. Harbau
Head of Department

Head of Department
Dept. of Educational Foundations & Curriculum
A. B. U. Zaria

APPENDIX 2

TIME-TABLE OF LESSON PRESENTATION

WEEK	LESSON	TOPICS
1	Lesson 1	Measurements of masses, volume, density, and Force
2	Lesson 2	Measurement, masses, volume and density Differences between mass and weight
3	Lesson 3	Concept of Work , Energy, and Power
4	Lesson 4	Calculations on Work and Energy and Power
5	Lesson 5	Simple machines
6	Lesson 6	Efficiency and mechanical advantage of machines and its maintenance
7	Lesson 7	*Tools for work Tools for Medicine*, Agricultural tools, tools for crafts and engineering, Traditional and modern tools
8	Lesson 8	Kinetic theory of matter(solid, liquid, and gas)boiling ,Evaporation and factors affecting evaporation
9	Lesson 9	Thermal Energy Energy Transfer of heat through Conduction, Convection, and Radiation
10	Lesson 10	Revision

APPENDIX 3

TOPICS COVERED ON WEEKLY BASIS

Weeks		Topics
1	Lesson 1&2	Measurements of masses, volume, density, and Force
	Lesson 3	Differences between mass and weight
2	Lesson 4&5	Work, Energy, and Power
	Lesson 6	Concept of Work and Energy and Power
3		
4	Lesson 7	Energy Transfer
	Lesson 8	Continues Assessment
5	Lesson 9&10	Simple Machines , levers
		Mechanical Advantage and Efficiency
6	Lesson 11	Inclined planes, ScrewS and wedges; Machines compared to Body movement
	Lesson 12	Maintenance of Machines
7	Lesson 13	Tools for work, Agricultural tools, tools for crafts and engineering
	Lesson 14	Tools for Medicine, Traditional and modern tools
8	Lesson 15	Kinetic theory of matter(solid, liquid, and gas)boiling, Evaporation and factors affecting evaporation
9	Lesson 16	Thermal Energy Transfer of heat through Conduction, Convection, and Radiation
10	Lesson 17	Revision

APPENDIX 4

LESSON PLAN FOR ACTIVITY-BASED METHOD GROUP 1

Week One Lesson 1 for Experimental Group1 (Activity-Based)

Name of School: Government Junior Secondary School Television
Date: 25th October, 2017
Class: JSS 2
Number in class: 70
Sex: Male and Female
Average age: 12 years
Session: 2016/2017
Term: 3rd Term
Subject: Basic Science
Group: Experimental group 1
Topic: Measurement
Sub-Topic: Measurement of Masses, Volume, density and Force
Duration: 1hour 20min (double period)

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Measuring Cylinder of various sizes, Burette Pipette, Tape rule, Meter rule, ruler

Instructional Method: Activity-Based

Behavioural Objectives: At the end of the lesson the students should be able to:

I. Identify the instrument displayed by the teacher and mention their uses;
II. Identify the instrument used for measuring various volumes of liquid;
III. measure irregular solids by displacement method using the measuring cylinder or graduated jug;
IV. Mention appropriate instrument for measuring length and measure some given length

Previous Knowledge: The Students have learnt, systematic International (S.I) unit and are familiar with the deferent types of measuring instrument such as wall clock, tape rule, at home and school.

The teacher introduce the topic of the lesson: The teacher explain the concept of measurement and give examples of things people measure such as distance, tables, classroom, volume of water, oil both red oil, groundnut oil, petrol

The Students are assigned into groups: The students are grouped in to a small group of Seven consisting (10) students to carry out the activities. The students will appoint their leader, secretary and time keeper among its members

Each group are assigned task: and the teacher gives clear instruction on what to be done by directing the students to i) mention the names of the apparatus and explain what each apparatus is used for ii) fetch water using a cup and measure its volume. iii) take the stones labelled A,B,C,D. and measure their volume iv) the students are ask to pair themselves and measure their heights, measure the length and breadth of their class room, and their table.

Teachers Role: The teacher's responsibility is to monitor the students and guide them as they embark on the activities

Culminating Activities: the teacher shall ask each group to: compile organize, write and provide a key highlight on the activities they conducted and report the same to the rest of the class; the teacher guides students as they return to their seats

Evaluative Activities: The teacher asks the entire class to discuss the various groups report. Each group presents the summary of their findings through the group secretary or chairman to the entire class. The teacher asks the students the following questions:

a what is measurement

b what do you use to measure length list four

c name five instrument used to measure volume of liquid

d what instrument will you use to give exact volume of 12.5cm

Assignment: How many litres will fill a gallon? ; Measure the school football field

Conclusion: the teacher goes round to mark the students work and write down summary notes to students to copy.

Week Two Lesson 2 for Experimental Group 1 (Activity-Based)

Name of School: Government Junior Secondary School Television
Date: 1st November, 2017
Class: JSS 11
Subject: Basic Science
Group: Experimental Group 1
Topic: Measurement
Sub-Topic: Weight, Mass and Density,
Duration: 1:20 minutes
Average Age of Students: 12 years
No. of Students: 70
References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional materials: Students themselves, spring balance, beam balanced bathroom scale hydrometer, various stones A, B,C,D

Instructional Method: Activity-Based

Previous Knowledge: The Students have learned measurement of liquid, length and solid materials such as stone

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

Measure the weight of each member of the class and calculate the average weight of the class;

students should use beam balanced or chemical balanced to measure the various masses of stones A,B,C,D or any given solid materials;

Use measuring cylinder to find volume of A, B, C, D.

Discover what density of a substance means

The teacher introduces the topic of the lesson: The teacher introduce the lesson asking the students to recap the procedure they use to measure in the previous lesson. And the concept of Mass, Weight and Density

The Students are assigned into groups: The 70 students are paired into groups of Seven (10) students and after which each group appointed their leaders; chairman, secretary and time keeper among its members:

Each group are assigned task: The students are asked to measure the weight of each member of the group using the bath room scale and record after which they compile all their weight and find the average; The students are directed to measure the mass of the four stones and record them The students recall the volumes of the 4 stones measured earlier; The teacher ask the students to find out the ratio of the stones example using mass of stone A over volume of stone A, Mass of volume B to Volume B,

Teachers Role: The teacher serves as a guide, monitoring from one group to the other to ensure students involvement in the activities.

Culminating Activities: the teacher shall ask each group to compile their findings and present the key highlights of the Activities to the rest of the students.

Evaluative Activities: This is the time the Teacher calls for the meeting of the whole class and each group present the summary of their findings to the whole class through the Secretary or Chairman. The Teacher assign a secretary to take the readings of the weight of the groups writing it on the chalk board and ask the class to: i) find the average weight of the class. ii) observe the values of M/V. From the above activity, the ratio M/V is mass per unit volume and is constant for the five stones of the same materials used. This ratio is known as density. The teacher leads the students in to determining the unit of density from its definition as the ratio of mass/volume; where the unit of mass is kg and that of volume is m^3 thus unit of density is kg/m^3. The symbol of density is rho.

Evaluation: The students are given the following work to do

i. what is mass; what is weight
ii. define density;
iii. State the S.I Unit of Weight, Mass, and Density.
iv. What instrument do you use to measure density?

Conclusion: the teacher goes round to mark the students work and write down summary notes for students to copy.

Week Three Lesson 3 for Experimental Group 1 (Activity-Based)

Name of school: Government Junior Secondary School Television
Date: 8th November, 2017
Class: JSS 2
No of Students: **70**
Average age of Students: 12 years
Sex: You and Energy
Period: Double
Duration: 1:20 minutes
Subject: Basic Science
Topic: Concept of Work, Energy and Power
Sub-Topic Concept of Work and Energy

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Intcgdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Metal balls of different sizes, slopy edge, stop watch, objects of different masses, bicycle, meter rule.

Reference: STAN Nigerian Basic Science New Edition 2008 Text Book Two, HEBN Publishers Plc

Behavioural Objectives: By the end of the lesson the students should be able to;
i explain the concept work and its systematic unit
ii explain the concept of energy and it systematic unit
iii define potential energy and Kinetic energy; solve Problems on Work and Energy

Previous knowledge: The students have learnt that the food they eat give them energy to do work.

The Teacher introduces the topic of the lesson: The teacher explain the key Concepts Work and Energy showing how they work with relevant examples

Students are assigned into Groups: The entire class of 70 students are paired up into Small groups of ten (10) students to carry out the activities. Each group will appoint a Leader, secretary and time keeper among its members.

Each group are assigned task: The teacher instructs the students, to carry out simple activities to show that i) energy is needed to do work. And discover the definition of Work Follow the Activities in the Work book Activity 16.1: Release a ball A so that it Rolls down a slope and hits another ball B at the bottom of the slope (ball A, give energy

to ball B to make it move.); Repeat this with four other balls of different sizes placed at the same point on the top of edge and roll down to hit ball B. Record your observation;

Activity 2: The students are asked to push their desk and say what happens, pull your desk towards you what happens? (Objects move through a distance when force is applied).

Thus Work= Force × distance moved in the direction of the force.

Discover the S.I unit of work.

ii) The students tried to find out about concept of Energy through the following activities; i) allow a ball A to stand at a height on the sloppy edge from the ground and label it as h. What kind of energy does ball A posses? ; ii) release the ball to vertically roll down to the ground. What kind of Energy does it have now?;iii) assuming the mass of a ball A is 0.02kg and the height h is 8m. Find the amount of energy in ball A iv) calculate the new Energy in ball A after it has rolled down the slope with a velocity of

$2ms^{-1}$ iii) (This activity is to be carried outside the class room.) take a walk from the goal post

of the football field to the next goal post. And note the time taken. ii)

Carry a load of five kg and walk from the goalpost of the football field to the next and record the time taken. iii) use a bicycle to repeat the activity in i) and iv) also use bicycle to repeat activity ii) . v) Tabulate your records vi) calculate the rate for each work done.

Culminating Activities: The teacher shall ask each group to compile and organise the results of their finding.

Evaluative Activities: This is a time when the teacher calls the entire class to take the various reports. Each group present the summary of their findings through the group Secretary or chairman to the entire class. Each group will present the summary of the findings on the three major concepts Work, Energy and Power through their chairman or Secretary. The teacher guides the students to answer the following questions:

Evaluation: What is work; What is the SI Unit of Work? calculate Work done when a force of 10N moves through a distance of 1m in the direction of the force. When Force of 20N Moves through 0.5M; Define Work Energy and Power and give their S.I Units;

What is energy? Give four forms of energy; explain Potential energy and Kinetic energy;

Assignment: Work out the exercise on page 85 of Nigerian Basic Science Project

Week Four Lesson 4 for Experimental Group 1 (Activity-Based)

Name of School: Government Junior Secondary School Television

Date: 15th November, 2017

Class: JSS2

No of Students: 70

Average age of Students: 12

Sex: Mixed

Period: Single

Duration: 1:20 minutes

Unit: You and Energy

Subject: Basic Science

Topic: Power and Energy Transfer when Work is done

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

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

Define Power and solve any given problem on it

State energy transfer that occurs when work is done

State the law of conservation of energy.

Demonstrate an experiment on how energy is transferred when work is done

Instructional Material: Hammer, nails, students, wood, cork, test tube, holder Bunsen burner etc.

Instructional Method: Activity-Based

Previous knowledge: The students have learnt the concept of Work and Energy and different forms of Energy.

The Teacher introduces the topic of the lesson: The Teacher using the students prior knowledge discuss Energy, various forms of energy, examples of a body that has energy and is able to do work, (Moving car has energy, man moving from one place to another uses energy, and Falling mango)

Students are assigned into groups: The entire 70 students are grouped into smaller groups of ten (10) to carry out their activities and then each group will appoint a chairman as their leader and Secretary to write and record their findings.

Each group are assigned task: The teacher ask the students to do the following Activities in their various groups. i) Rub your palms, what energy changes occur? ii) drive a nail into a wood using a hammer and state your observation. Also state the various energy changes iii) The students are instructed to run to the field and describe what happened stating the energy changes that occurs.

Teacher's Role: The teacher will move from one group to another to monitor and guide the students as they embark on the activities.

Culminating Activities: The teacher will ask the students to compile, organize, write and present their findings.

Evaluative Activities: This is a time when the teacher calls for the meeting of the entire class to give and deliberate on the various reports. Each group presents the summary of their discussion through the group's secretary or chairman to the entire class.

Evaluation: The teacher ask each students to write answers to the following: What is energy ii) State the law of conservation of energy, iii) Explain how energy is transferred when a student runs iv) State the energy generated when a student rub his palms.

Assignment: Read about Non-Human means of doing work such as moving water, hurricane, and tornado. Write their importance.

Week Five Lessons 5 for Experimental Group 1 (Activity-Based)

Name of School: Government Junior Secondary School Television
Date: 22nd November, 2017
Class: JSS2
No of Students: 70
Average age of Students: 12
Sex: Mixed
Period: Double
Duration: 1:20 minutes
Subject: Basic Science
Unit: You and Energy
Topic: Simple Machines
Sub-topic Machines and levers, Wheel and Axle
Behavioural Objectives: By the end of the lesson the students should be able to

i. Define machine; explain the meaning of simple machine
ii. Identify what constitutes a simple machine
iii. Identify the essential parts of lever and use the arrangement of their parts to classify levers
iv. Describe uses of wheel and axle
v. Name one example of wheel and axle and how it works

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: brooms, opener, scissors, knives, wheel barrow, pliers, students, and jack, hammer, spanner, nut cracker, sugar tongs, inclined plane.

Previous Knowledge: The students have been using machines knowingly or unknowingly to enable them do work easily such as using broom to sweep and Opener to open bottle drinks.

The Teacher introduces the topic of the lesson: The teacher introduces the lesson Simple Machine as any arrangement that enable us to do work easily. For example brooms for sweeping the class and also opener for opening a bottle of Malt.

Each group are assigned task: The class of 70 students are paired up into a small group of ten (10) each to carry out the activities. Each group will choose a leader as the chairman and the secretary and time keeper among their member.

Each group is assigned task: The students are instructed to use the Nigerian Basic Science Project 2 page 87 to carry out the Activities which lead to defining what a simple

machine is. The students are instructed to classify the various classes of lever from figure 17.2: The students are to write out the three essential parts of lever. Discover how a wheel and axle works.

Teacher's Role: The teacher will move from one group to another to monitor and guide the students as they embark on the activities

Culminating Activities: The teacher will ask the students to compile, organize, write and present their findings to the entire class.

Evaluative Activities: This is a time when the teacher calls for the meeting of the entire class to give and deliberate on the various reports. Each group presents the summary of their findings through the group's secretary or chairman to the entire class.

Evaluation: The teacher ask each students to write answers to the following i) define a simple machine; ii) what is a lever? Iii) Describe the three classes of lever. iv) what is a wheel and axle? v) Name one example of wheel and axle and describe how it works.

Summary/Conclusion: The teacher marks the students work and write out the correct answers on the board for the students to copy as their summary notes.

Assignment: (individual assignment) a) after your class lesson take a trip to a motor car or motor cycle mechanic's workshop b) Ask the mechanics to show you a gear c) identify the parts of the gear (the driving wheel and the driven wheel).d)Ask the mechanic to show you how the gear works .e) Write your note on gears

Week Six Lesson 6 for Experimental Group 1 (Activity-Based)

Name of School: Government Day Junior Secondary School Television
Date: 22nd November, 2017
Class: JSS2
No of Students: 70
Average age of Students: 12
Sex: Mixed
Period: Single
Duration: 1:20 minutes
Subject: Basic Science
Unit: You and Energy
Topic: Simple Machines
Sub-topic: Srew thread, Gears, Efficiency and Maintenance

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

Identify the parts of a screw thread;

Identify how the screw thread works; describe how the screw thread works; state the uses of screw thread name some examples of a screw thread.

Describe Gears; and state application of Gears

Explain what efficiency and explain why no machine is 100% efficient and gives ways for Maintenance.

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course for Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Carpenters workshop, screw, bolts and nuts and car jack

Instructional Method: Activity-based

Previous Knowledge: The students have learnt what machine is and types of levers.

The Teacher introduces the topic of the lesson: The teacher introduces the topic of the lesson Screw thread as a Simple Machine that is drive into a piece of wood.

Students are assigned into groups: The class of 70 students are paired up into a small group of Ten (10) each to carry out the activities. Each group will choose a leader as the chairman and the secretary and time keeper among their members.

Each group is assigned task: each group is instructed to lift the teacher's car up using a jack to change tire. The teacher ask the students to do the activities given in their Basic Science book page 90 Activity17.7 on how to make a paper screw thread and also present to each group a Screw and ask them to discover how the screw work. Draw and describe

the parts of the screw. The groups are asked to use the procedure given in the work book to find out the uses of screw. i) Look at the diagram of a gear system on figure 22.1 page 104 ii) identify the features of the gear and write them down ii) (from the individual assignment given yesterday on your trip to mechanic workshop answer Activity two) i) identify the parts of the gear (the driving wheel and the driven wheel).ii) How do gears work?.iii) state two application of gears. Look at the diagram of a gear system on figure 22.1 page 104 ii) identify the features of the gear and write them down ii) (from the individual assignment given yesterday on your trip to mechanic workshop answer Activity two) i) identify the parts of the gear (the driving wheel and the driven wheel).ii) How do gears work?.iii) state two application of gears. The Activities page 88 Activity 17.4 and 17.5 to be carried out to discover efficiency and how machines will be maintained. The teacher provides user manual of blender, handset, and refrigerator and the students are to study the manual and discuss the steps to maintain each named machines.

Teacher's Role: The teacher will move from one group to another to monitor and guide the students as they embark on the activities

Culminating Activities: The teacher will ask the students to compile, organize, write and present their findings.

Evaluative Activities: This is a time when the teacher calls for the meeting of the entire class to give and deliberate on the various reports. Each group presents the summary of their findings through the group's secretary or chairman to the entire class by describing a screw thread; and explaining how the screw thread works; giving examples of screw; describing a Gear and how it works and its application; discuss Efficiency of a Machine and how Machines can be maintained.

Evaluation: The teacher ask them to answer some questions to stamp in their learning.

i) A gear transfers energy from the engine to the _____a driving wheel b toothed wheel c driven wheel d gear box

ii) Describe the parts of a gear. iii) State two applications of gears

iii) the efficiency of a machines is the ratio of energy output and energy input and it is always express as a _____ ii) state why no machine is 100% efficient iii) state two ways of taking care of machine.

Week Seven Lesson 7 for Experimental Group 1 (Activity-Based)

Name of School: Government Junior Secondary School Television
Date: 29th November, 2017
Class: JSS2
No of Students: 70
Average age of Students: 12years
Sex: Mixed
Period: Double
Duration: 1:20 minutes
Subject: Basic Science
Unit: You and Energy
Topic: Tools for Work
Behavioural Objectives: By the end of the lesson the students should be able to: describe or state names of tools for Agriculture, Engineering, Medicine and Fishing.

i. Compare Traditional and Modern Tools
ii. Visit a Carpenter's shop and fine out which tools are used there. Draw them and describe them. (the Basic introductory Tools can be used.)

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course for Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Axe saw, hoe, Spanner, Screws, Screwdriver, forcep, syringes and needle, charts on Modern and Traditional Tools

Instructional Method: Activity-Based

Teacher introduces the lesson: The teacher introduces the lesson by displaying many tools that are handy used for agriculture, Auto mechanic, Capentry, fishing and so on.

Students are assigned into groups: The entire 70 students in the class are classified into a small group of Ten (10) students.

Each group is assigned task: the teacher asks the students to:

1. List all the tools that are used for
   a. Agriculture
   b. Auto mechanic
   c. Carpentry
   d. Fishing
2. Discuss among themselves the advantages of modern tools over traditional tools
3. Students are asked to draw the tools that are used in the carpentry workshop

Evaluative Activities: This is a time when the teacher calls for the meeting of the entire class to give and deliberate on the various reports. Each group presents the summary of their findings through the group's secretary or chairman to the entire class.

Evaluation: the teacher evaluates the lesson by asking the students the following question:

i. Write and draw five equipment's used by doctors during operation
ii. List the advantages of modern tools over traditional tools
iii. Draw all the equipment's used by a carpenter when making a chair

Week Eight Lesson 8 for Experimental Group 1 (Activity-Based)

Name of School:	Government Junior Secondary School Television
Date:	13th December, 2017
Class:	JSS2
No of Students:	70
Average age of Students:	12 years
Sex:	Mixed
Period:	Double
Duration:	1:20 minutes
Subject:	Basic Science
Topic:	Kinetic Theory

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course for Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Solid ice cubes, beakers, Bunsen burner or stuff, tripod stand, gauze.

Instructional Method: Activity-Based

Behavioural Objectives: by the end of the lesson the students should be able to:

i. state the principles of kinetic theory of matter using change of state.
ii. explain the structures of solid, liquid and gas particles using the kinetic theory;
iii. list properties of matter
iv. distinguish between boiling and evaporation using kinetic theory;
v. state the factors that affect evaporation.

Previous knowledge: The students have already learnt that matter exist in three state namely Solid, Liquid and Gas

The Teacher introduces the topic of the lesson: The teacher introduces the topic Kinetic Theory of matter.

Students are assigned into groups: The class of 45 students are paired up into a small group of five (5) each to carry out the activities. Each group will choose a leader as the chairman and the secretary and time keeper among their members.

Each group is assigned task: All the groups are given the same activities to be carried out. The teacher asks the students to observe what happens with the ice block as they carry out the following activities: i) put an ice block in a beaker and keep it for five minutes. Record what you see .ii) Heat the ice block and record what you see.iii) Heat it

further until it boils. iv) The students are to describe the structures of the various states of matter. Solid, Liquid and Gas

The students are asked to perform the following experiment to explain, boiling and evaporation. i) Put water in a beaker and heat; ii) use a thermometer to measure the degree of hotness every two minutes. Record your observation; Place ether (mentholated spirit) at the back of your hands what do you feel? And what happen to the ether? From the activities carried out state the factors that affect evaporation.

Evaluative Activities: This is a time when the teacher calls for the meeting of the entire class to give and deliberate on the various reports. Each group presents the summary of their findings through the group's secretary or chairman to the entire class.

Evaluation: the teacher evaluates the lesson by asking the students the following questions; using kinetic theory; i) explain why a solid has definite shape and a liquid has no definite shape; ii) state the differences between boiling and evaporation; iii) state two factors that affect evaporation.

Assignment: Mix a spoonful of sugar into a small cub of water stir and record your observation. Separate the sugar from the water and write your observation.

Week Nine Lesson 9 for Experimental Group 1 (Activity-Based)

Name of School:	Government Day Junior Secondary School Television
Date:	20th December, 2017
Class:	JSS2
No of Students:	70
Average age of Students:	12
Sex:	Mixed
Period:	Double
Duration:	1:20 minutes
Subject:	Basic Science
Topic:	Thermal Energy
Sub-Topic:	Transfer of heat energy

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga Aderinola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson publishers limited

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

i. Illustrate that when two bodies are in contact, heat flows from the hot one to the cold one;
ii. Name the methods of heat transfer;
iii. describe heat conduction and its applications

Previous knowledge: The students are conversant with Energy and how energy constitute a very important aspect of our daily activities. And have learned that the sun is the main source of energy.

Instructional Materials: spoon silver cup pot heat Thermometer, beaker

Instructional Method: Activity-Based

The Teacher introduces the topic of the lesson: The teacher introduces the topic as Thermal Energy which means Heat. And the sub-topic is how heat is transferred. Various Activities will be carried out to discover ways in which heat is transferred.

Each group is assigned task: All the groups are given the same activities to be carried out. The teacher asks the students to observe what happens during the activities: i) Hold a thick piece of copper wire in a Bunsen flame, can you continue to hold it for long? Pour boiled water into a tea cup and stir it with silver spoon what do you feel? What can you deduce from your observation? Find out good and bad conductors of heat from the given objects copper, glass, zinc plastic, iron,

ii) The students are instructed to use a piece of glass tubing to drop a crystal of potassium tetraoxomanganate (vii) on one side of a beaker full of water. Heat the beaker under the crystal and state what you observe. Put your finger to feel the water, state how the heat is transferred from the bottom of the beaker to the top.

iii) Heat water to boil placing thermometer into the beaker T_1 and bring another thermometer near the beaker T_2 . Does T_2 show a rise in temperature? By what method of heat transfer does it reach T_2?

Teacher's Role- The teacher serves as a guide so he moves from one group to the other at every stage.

Evaluative Activities: This is the time when the whole class meet to report about their findings each group secretary or chairman will report their findings. After the teacher will ask some basic questions to ensure the students learning of the concept .i) state three ways by which heat can be transferred from one point to another. Give an example of each. ii) Group these substances into good and bad conductors: copper, water, sand, wood, iron, glass and carbon.

Week One Lesson Plan 1 for Experimental Group 2 (Problem-Solving Method)

Name of School: Junior Secondary School, Angwan Rimi, Kaduna

Date: 26th November, 2017

Class: JSS 2

Number of Students: 72

Sex: Male and Female

Average age: 12 years

Session: 2016/2017 Academic Session

Term 3rd Term

Subject: Basic Science

Period: Double

Duration: 1:20min

Topic: Measurement

Sub topic: Measurement of masses and volumes

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga, Aderinola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson Publishers limited

Instructional Materials: Measuring Cylinder, Burette, Pipette, Tape rule, Meter rule, Ruler

Behavioural Objectives: At the end of the lesson the students should be able to:

i. Identify the instrument displayed for the lesson as well as mention their uses;
ii. Identify the instrument used for measuring various volumes of liquid;
iii. Mention appropriate instrument for measuring length and measure some given length

Previous Knowledge: The students' have learnt, systematic International (S.I) unit and are familiar with the deferent types of measuring instrument such as wall clock, tape rule, jugs and bottles at home and school.

Procedures:

i. Students were assigned into groups; the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who were saddled with leading the group and recording their findings respectively.

ii. Students defined the problems from the given topic (Measurement). How would you find the volume of a liquid, how would you:
    a. find the volume of a regular sized object?
    b. find the volume of an irregular sized object like a stone?
    c. what is the size of your bench?
    d. What is the area of the classroom?
iii. Brainstorming: the students' brainstormed on how to measure volumes of some liquids as well as found out if different masses in the same container have the same volume.
    a. what instrument to use to measure the length and breadth of the classroom?
    b. the length and breadth of the classroom
    c. do the instruments for measuring volume have the same calibration?
iv. Objectives:
    a. determines various volumes of instruments such as pipette, burette, measuring cylinder, etc.
    b. find out the area of the class using metre rule, or a 30-centimetre ruler.
    c. Is there a difference between mass and volume?
v. The students searched for information through various activities such as reading, observing, experimenting, measuring, and recorded the information.
vi. Synthesis: the groups shared their findings to arrive at the same goal.
vii. Feedback: this was the time the whole class meet to discuss their findings. Each group's secretary reports their findings. The various reports were considered collectively by the entire class and a final report was drawn by the class.
viii. Evaluation: answer the following questions:
    a. what is measurement?
    b. define mass and volume. How are they different from each other?
    c. how would you find the volume of an irregular object like a stone?

Week Two Lesson Plan 2 for Experimental Group 2 (Problem- Solving Method)

Name of School: Junior Secondary School, Angwan Rimi, Kaduna

Date: 2nd November, 2017

Class: JSS 2

Number of Students: 72

Sex: Male and Female

Average age: 12 years

Session: 2016/2017 Academic Session

Term 3rd Term

Subject: Basic Science

Period: Double

Duration: 1:20min

Topic: Measurement

Sub topic: Measurement of density and weight

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga, Aderinola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson Publishers limited

Instructional Materials: Spring balance, beam balanced, bathroom scale, hydrometer, and the various stones labelled A, B, C, D

Previous Knowledge: The Students have been taught measurement of liquid, length, and volume of irregular stones.

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

i. Measure the weight of each member of the class and calculate the average weight of the class;
ii. students should use beam balance or chemical balance to measure the various masses of stones A,B,C,D or any given solid material;
iii. Use measuring cylinder to find volume of A, B, C, D.
iv. Discover what density of a substance means

Procedures:

i. Students were assigned into groups; the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a

chairperson and a secretary who was saddled with leading the group and they recorded their findings.

ii. Students defined the problems from the given topic (Measurement) as well as found out the density of a stone and average weight of the class

iii. Brainstorming: the students' brainstormed on their set objectives.

   a. what instrument to use to measure mass of stones?
   b. define density
   c. each student should be weighed and the average weight of the group should be recorded.

iv. Objectives: the students set their objectives which were as follows

   a. Set to find mass of some stones
   b. Find the volume of the stones using displacement method
   c. Weigh each student in the group and find the average weight.

v. Searching for information through reading, recap of previous lessons, and weighing objects using balances were carried out by the students.

vi. Synthesis: the groups shared their findings to arrive at the same goal.

vii. Feedback: this was the time the whole class met to discuss their findings. Each group's secretary reported their findings. The various reports were considered collectively by the entire class and a final report was drawn by the class.

viii. Evaluation: the following questions were answered:

   a. Explain how the density of a given irregular solid is arrived at.
   b. Explain how the whole class arrived at its average weight.

Assignment: Read and attempt all activities and solve problems on Work, Energy, and

Week Three Lesson 3 for Experimental Group Two (2) (Problem-Solving Method)

Name of School: *Junior Secondary School, Angwan Rimi, Kaduna*

Date: 9th November, 2017

Class: JSS 2

Number of Students: 72

Sex: Male and Female

Average age: 12 years

Session: 2016/2017 Academic Session

Term 3rd Term

Subject: Basic Science

Period: Double

Duration: 1:20min

Topic: Work, Energy and Power

Sub topic: Concept of Work, and Energy

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga, Aderinola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson Publishers limited

Instructional Materials: Metal balls of different sizes, slopy edge, objects of different masses, text books, table and desk.

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

i. explain the concept work and its systematic unit
ii. explain the concept of energy and state it systematic unit
iii. define Potential and Kinetic energy
iv. solve problems on work and energy

Procedures:

i. Students assigned into groups; the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who was saddled with leading the group and recording their findings respectively.
ii. Students define the following problems:
    a. When is work said to be done?
    b. When you push a wall, is that work?
    c. When you push your desk and it moves through a distance, is that work?

d. Does work require energy?
e. What is energy?
f. Energy contributes in doing work but not all energy successfully does work\
g. What do you think of when you hear the term, 'energy'?

Problem: Pushing a wall all day may feel like work but unless you get that wall moving, you are not doing any work, therefore, what is work?

iii. Brainstorming: the students' used their previous knowledge of force and mass to come up with ideas about work, energy, and power

iv. Objectives: the students set out the goals on how to arrive at the proper understanding of the concept of work, energy, and power:
   a. Define work, energy, and power.
   b. Give examples and forms of energy.
   c. Does work require energy?
   d. When you are pushing a standing wall, is that work?
   e. When you push a chair away from its present position, is that work?
   f. Calculate the given problems on work and energy (kinetic and potential energy).

v. Searching for information: this includes activities that were carried to find solution such as experimenting, observation, etc. by the students

vi. Synthesis: During this step, the members of the group shared the results of their individual findings and solved problems given on work and energy.

vii. Feedback: Here, each group presented its findings and outstanding presentations were applauded. The various concepts were considered by the whole class and general secretary took notes which served as reference points to all the members of the class.

viii. Evaluation: answer the following questions:
   a. What is work? Calculate the work done by an engine when it moves a car with a force of 500N through a distance of 1 km; What work is done when a mass of 5kg is raised through a vertical height of 2.5m given acceleration due to gravity is $10ms^2$
   b. What is energy? If amass of a ball is 20kg and height 8meter .Calculate potential energy and Kinetic energy.Acceleration due to gravity $10ms^{-2}$

Assignment: Read and attempt all questions on Power and Energy transfer.

Week Four Lesson 4 for Experimental Group 2 (Problem-Solving Method)

Name of School: Junior Secondary School, Angwan Rimi, Kaduna

Date: 16th November, 2017

Class: JSS 2

Number of Students: 72

Sex: Male and Female

Average age: 12 years

Session: 2016/2017 Academic Session

Term 3rd Term

Subject: Basic Science

Period: Double

Duration: 1:20min

Topic: Work, Energy and Power

Sub topic: Power and Energy Transfer

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga, Aderínola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson Publishers limited

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

i define power and solve any given problem on it

i. State energy transfer that occurs when work is done

ii. State the law of conservation of energy.

iii. Demonstrate an experiment how energy is transferred when work is done

Previous knowledge: The students have learnt the concept of work, energy and different forms of energy.

Procedures:

i. **Students assigned into groups;** the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who will be saddled with leading the group and recording their findings respectively.

ii. **Defining the problem given from the topic,** Power, how would you measure how fast work is done? what energy changes occur when the students rub their hands?, when mango fruits drop to the ground from the tree.

iii. **Brainstorming:** students used their previous knowledge to explain the problem. Here, each student was encouraged to speak their mind as all ideas were valued and noted.

iv. *Objectives: the students set their objectives in which they:*

a. Define Power, attempt all the calculations on the problems on power from the text.

b. What energy changes when a ball is release from an upstairs building to reach the ground level?

c. State law of conservation of energy.

v. Searching for information: from the objectives set by the students in their group, each of them searched for information with the objectives in mind.

vi. Synthesis: the students shared their results and also the solution they worked on. They also explained energy transfer.

vii. Feedback: Here, each group presented their findings and outstanding presentations were applauded.

viii. Evaluation: the following questions were answered:

a. What is power?; find the power used by a student whose mass is 60kg runs up a height of 7.2m in 10.4 seconds, given acceleration due to gravity as $10ms^{-2}$

b. What is conservation of energy?

c What energy conversion occurs when a nail is driven through a plank wood with the aid of a hammer?

Assignment: Read the topic on simple machines

Week Five Lesson 5 for Experimental Group 2 (Problem-Solving Method)

Name of School: Junior Secondary School Ungwan Rimi
Date: 23rd November, 2017
Class: JSS2
Number in class: 72
Average age of Students: 12
Sex: Male and female
Session: 2016/2017 Academic Session
Period: Double
Duration: 1:20
Subject: Basic Science
Unit: You and Energy
Topic: Simple Machines
Sub-Topic: Machines and levers Wheel and Axle.

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

i. Define machine; explain the meaning of simple machine
ii. Identify what constitutes a simple machine
iii. Identify the essential parts of lever and use the arrangement of their parts to classify levers
iv. Describe uses of wheel and axle
v. Name one example of wheel and axle and how it works

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: brooms, opener, scissors, knives, wheel barrow, pliers, students, and jack, hammer, spanner, nut cracker, sugar tongs, inclined plane.

Previous Knowledge: The students used machines knowingly and unknowingly to enable them do work easily such as using broom to sweep.

Procedures:

i. **Students assigned into groups;** the entire class of 72 were divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who were saddled with leading the group and recording their findings respectively.
ii. **Students defined the problem:** The students defined the problem on the given topic machines, by looking around the environment at home, kitchen and school. Things that enabled the students work easier were listed out: Can broom be said to

be a machine? What do you do to fix a car that is punctured? Find out what levers and their classes are; what wheel and Axle are used for and their examples.

iii. **Brainstorming:** students used their previous knowledge to explain the problem. Here, the students interacted with each other as they freely voiced out their opinion and ideas as they found solution to the problems through understanding the questions and students were encouraged to speak their mind and all ideas were valued and noted.

iv. **Objectives:** the students set their objectives: observe and list all materials used in the environment that makes work easier; mention various machines and their uses. Find out what lever is and different arrangement of levers.

v. **Searching for information:** The students gathered information by reading, observing and experimenting from the objectives set by the students in their group, each of them searched for information with the objectives in mind.

vi. **Synthesis:** the students shared their results and findings thereby achieving their goals.

vii. **Feedback:** Here, each group presented their findings and outstanding presentations were applauded.

viii. **Evaluation:** answer the following questions: i) define a simple machine; ii) what is a lever? Iii) Describe the three classes of lever. iv) what is a wheel and axle? v) Name one example of wheel and axle and describe how it works.

Week Six Lesson 6 for Experimental Group 2 (Problem-Solving Method)

Name of School: Junior secondary school Ungwan Rimi

Date:	30th November, 2017
Class:	JSS2
No of Students:	72
Average age of Students:	12 years
Session:	2016/2017
Term:	Third term
Sex:	Male and female
Period:	Double
Duration:	1:20
Subject:	Basic Science
Unit:	You and Energy
Topic:	Simple Machines
Sub-topic:	Screw thread, Gears, Efficiency and maintenance

Behavioural Objectives: By the end of the lesson the students should be able to identify the parts of a screw thread; identify how the screw thread works; describe how the screw thread works; state the uses of screw thread name some examples of a screw thread; describe Gears; State application of gears; explain the meaning of Efficiancy; explain why no machine is 100% efficient; State ways of maintaining machines

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Carpenters workshop, screw, bolts and nuts and car jack, gears (driven and driving gears). Bicycle gears, Crushing machine.

Procedures:

i. **Students assigned into groups;** the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who were saddled with leading the group and recording their findings respectively

ii. **Students defined the problem:** This lesson took place at the mechanics work shop and the students identified the specific ideas they want to ask the mechanics about. What do mechanics use to drive nails easily into a piece of wood? Which is

easier is it to drive nail into a wood or screw it through a wood? Ask the mechanics to show you a gear identify the parts of the gear (the driving wheel and the driven wheel).d)Ask the mechanic to show you how the gear works .e) Write your note on gears

iii. **Brainstorming:** The students interacted with each other by freely voicing out their opinion and ideas as they found solutions to the problems through interaction with the mechanics and also practicalising the usage of some screws.

iv. **Objectives:** The objectives were stated by the students on how to make a Paper Screw thread? Find the uses and examples of Screw? Draw and describe the parts of the screw; Gears

v. **Searching for information:** The students learnt the various uses of machines in the mechanic workshops and handled most of the equipment and observed how they work.

vi. **Synthesis:** Here, all the students in the group shared and discussed the lessons they learnt at the workshop.

vii. **Feedback:** This is where all the groups discussed about their findings and solved all the problems stated. They also made sure that the stated objectives were achieved.

viii. **Evaluation:** The students answered the following questions; what are screws use for? Give 3 examples of screws; describe gears, what are the uses of gears. Give 3 examples of gears

Week Seven Lesson 7 for Experimental Group 2 (Problem-Solving Method)

Name of School:	Junior Secondary School Ungwan Rimi
Date:	7th December, 2017
Class:	JSS2
Number in class:	72
Average age of Students:	12years
Sex:	Male and female
Session:	2016/2017
Term:	3rd term
Period:	double
Duration:	1:20
Subject:	Basic Science
Unit:	You and Energy
Topic:	Tools for work
Time:	1:20 minutes

Behavioural Objectives: By the end of the lesson the students should be able to describe or state names of tools for Agriculture, Engineering, Medicine, Fishing.

State the reasons for the use of tools, and ways for maintenance.

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Procedure:

i. **Students assigned into groups:** the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who were saddled with leading the group and recording their findings respectively

ii. **Students defined the problem:** What kinds of tool do you use at home? Are they different from those used by our forefathers? What agricultural tools do you use in your environment? Discover tools for craft at blacksmith's shed and carpenter's shop and Engineering both auto-mechanic and auto-electrician. Can you mention some tools in medicine?

iii. **Brainstorming:** The students in their various groups brainstormed and discussed which sheds they wanted to visit in their environment. Using their prior

knowledge of a mechanic's visit, it helped list auto-mechanic and auto electrician tool.

iv. **Searching for information:** The students visited a blacksmith and carpenter shed to identify tools and how they are used.

v. Synthesis: The students in each group shared their findings and compiled their various findings.

vi. Feedback: Here the various groups gave their reports and any outstanding presentation was applauded and praised.

vii. Evaluation: write names of field these tools are used cutlass, saw, hoe, hammer, fishing hooks, screw driver, net spanners, jack, stretcher, syringes.

Week Eight Lesson 8 for Experimental Group 2 (Problem-Solving)

Name of School:	Junior Secondary School Ungwan Rimi
Date:	14th December, 2017
Class:	JSS2
Number in class:	72
Average age of Students:	12years
Sex:	Male and female
Session:	2016/2017
Term:	3rd term
Period:	Double
Duration:	1.20 minutes
Subject:	Basic Science
Unit:	You and Energy
Topic:	Kinetic Theory of Matter

Behavioural Objectives: by the end of the lesson the students should be able to:

i. State the principles of kinetic theory of matter using change of state.
ii. Explain the structures of solid, liquid and gas particles using the kinetic theory;
iii. List properties of matter
iv. Distinguish between boiling and evaporation using kinetic theory;
v. State the factors that affect evaporation.

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Procedure:

i. **Students assigned into groups:** the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who were saddled with leading the group and recording their findings respectively
ii. **Students defined the problem**: Kinetic theory of matter states that all matter is made of small particles that are in random motion and that have space between them .How can this be verified?
iii. **Brainstorming:** the students observed what happened with Ice block when heated describe the structures of the various states of matter. (Solid, Liquid and

Gas). what will you do to arrive at boiling and evaporation. The students interacted with each other freely by voicing out their opinions and ideas as they tried to find solutions to the problems through understanding the questions and experimenting. Here the students thought of the experiment to be carried out to melt, boil and evaporate the ice block. Discuss the characteristics

iv. **Feedback:** This is a time when the entire class gave and deliberated on the various reports. Each group presented the summary of their findings through the group's secretary or chairman to the entire class.

v. **Evaluation:** the teacher evaluated the lesson by asking the students the following questions; using kinetic theory; i) explain why a solid has definite shape and a liquid has no definite shape; ii) state the differences between boiling and evaporation; iii) state two factors that affect evaporation.

Week Nine Lesson 9 for Experimental Group 2 (Problem-Solving Method)

Name of School:	Junior Secondary School Ungwan Rimi
Date:	21st December, 2017
Class:	JSS2
Number in class:	72
Average age of Students:	12
Sex:	Male and female
Period:	double
Duration:	1:20minutes
Subject:	Basic Science
Topic:	Thermal Energy
Sub-Topic:	Transfer of heat energy (Conduction, Convection, and Radiation)

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga Aderinola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson publishers limited

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

i. illustrate that when two bodies are in contact, heat flows from the hot one to the cold one;
ii. Name the methods of heat transfer;
iii. describe heat conduction and its applications

Previous knowledge: *The students were conversant with Energy and how energy constitutes a very important aspect of our daily activities. And have learned that the sun is* the main source of energy.

Instructional Materials: spoons, silver cups, pots, heat, Thermometer, beaker

Procedure;

i. **Students assigned into groups:** the entire class of 72 was divided into nine (9) groups of eight (8) students for easy participation. Each group selected a chairperson and a secretary who were saddled with leading the group and recording their findings respectively
ii. ***Students defined the problem***: *the students thought of how could heat be* transferred through material such as metals, liquid such as water or in what ways does the sunlight reaches us?

iii. **Brainstorming:** The students interacted with each other freely as they voiced out their opinions and ideas while finding solutions to the problems through understanding the questions and what is required by reading, discussing, observing and experimenting.

iv. **Synthesis:** All the processes of Science were used here to ensure proper understanding of the Asking questions, observation, formulating hypothesis, experimenting recording i, Hold a thick piece of copper wire in a Bunsen flame, can you continue to hold it for long? Pour boiled water into a tea cup and stir it with silver spoon what do you feel? What can you deduce from your observation? Find out good and bad conductors of heat from the given objects copper, glass, zinc plastic, iron,

v. The students were instructed to use a piece of glass tubing to drop a crystal of potassium tetraoxomanganate (iii) on one side of a beaker full of water. Heat the beaker under the crystal and state what you observe. Put your finger to feel the water, state how the heat is transferred from the bottom of the beaker to the top.

vi. Heat water to boil placing thermometer into the beaker T_1 and bring another thermometer near the beaker T_2. . Does T_2 show a rise in temperature? By what method of heat transfer does T_2 temperature rises?

vii. **Feedback:** This was the time when the whole class meet to report about their findings each **Evaluation:** group secretary or chairman reported their findings.

viii. After the students were asked some basic questions to ensure the students learning of the concept i) state three ways by which heat can be transferred from one point to another. Give an example of each. ii) Group these substances into good and bad conductors: copper, water, sand, wood, iron, glass and carbon.

Week One Lesson 1 for Control Group1 (Conventional Method)

Name of School: Government Junior Secondary School Rigachikun
Date: 30th October, 2017
Class: JSS 2
Number in class: 76
Sex: Male and Female
Average age: 12 years
Session: 2016/2017
Term: 3rd Term
Subject: Basic Science
Group: Conventional group 1
Topic: Measurement
Sub-Topic: *Measurement of Masses, Volume, density and Force*
Duration: 1hour 20min (double period)

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Measuring Cylinder of various sizes, Burette Pipette, Tape rule, Meter rule, ruler

Instructional Method: Conventional

Behavioural Objectives: At the end of the lesson the students should be able to:

I. Identify the instrument displayed by the teacher and mention their uses;
II. Identify the instrument used for measuring various volumes of liquid;
III. measure irregular solids by displacement method using the measuring cylinder or graduated jug;
IV. Mention appropriate instrument for measuring length and measure some given length

Previous Knowledge: The Students have learnt, systematic International (S.I) unit and are familiar with the deferent types of measuring instrument such as wall clock, tape rule, at home and school.

The teacher introduce the topic of the lesson: The teacher explain the concept of measurement and gives examples of things people measure such as distance, tables, classroom, volume of water, oil both red oil, groundnut oil, petrol. The teacher defines measurement as the act or process of finding the size, quantity or degree of matter.

Presentation of lesson: The lesson is presented to the students using the following steps:
Step i) The teacher displayed all the instruments, said their names and the uses of each of them.
Step ii) The teacher picked out the instruments used for measuring length and explained their uses. The teacher use Tape, metre rule, Chalk board ruler to measure students desk and classroom size.
Step iii) The teacher picked out the instrument for measuring volume and explained how it can be used. The teacher measure quantities of liquid using various equipment such as Measuring Cylinder, Burette, Pipette, etc
Step iv) The teacher explained ways to measure masses of irregular objects using graduated cylinder.
Evaluation: The teacher evaluates the topic by asking the following questions:
what is measurement?; list four instruments used to measure length; name five instruments used to measure volume of liquid; what instrument will you use to give exact volume of $12.5cm^3$
Conclusion: Notes is given on the board and the students copy it into their note books.
Assignment: The teacher gives the students the following assignment: How many litres will fill a gallon? ii Measure the school football field.

Week Two Lesson 2 Control Group 1 (Conventional Method)

Name of School: Government Junior Secondary School Regachikun

Date: 6th November, 2017

Class: JSS 11

Subject: Basic Science

Group: Control Group 1

Topic: Measurement

Sub-Topic: Weight, Mass and Density,

Duration: 1:20 minutes

Average Age of Students: 12 years

No. of Students: 76

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional materials: Students themselves, spring balance, beam balanced bathroom scale hydrometer, various stones A, B,C,D

Instructional Method: Conventional Method (Talk and Chalk)

Previous Knowledge: The Students have learned measurement of liquid, length and solid materials such as stone

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

i. Measure the weight of each member of the class and calculate the average weight of the class;
ii. students should use beam balanced or chemical balanced to measure the various masses of stones A,B,C,D or any given solid materials;
iii. Use measuring cylinder to find volume of A, B, C, D.
iv. Discover what density of a substance means

The teacher introduces the topic of the lesson: The teacher introduce the lesson asking the students to recap the procedure they use to measure in the previous lesson through questioning: what is measurement? ; what is the name of equipment used in measuring Length and liquids? ; how do you measure the volumes of irregular solids?

Presentation: The teacher presents the lesson through the following steps:

Step i):The teacher defines mass and weight. Mass is the quantity of matter contained in a substance However, weight of an object is the force acting on it due to gravitational attraction. The S.I. unit of mass is (kg) and S.I unit for weight is the Newton (N) .

Step ii): The Teacher explains the modern instrument for measuring accurate masses to include the equal arm balance, platform balance, compression chemical balance, spring balance, top loading balance.

Step iii) The Teacher reminded them the instrument used for measuring volume of liquid include a) measuring cylinder which is one of the commonest instruments for measuring volumes of liquid it is most often used in school laboratories for approximate volume measurement. b) burette is another device for measuring accurate volume measurement than the measuring cylinder.c) pipette is an instrument designed for specific volume of liquids, the common volumes are 10.0cm^3 20cm^3 and 25.0cm^3 d) Irregular solids like small stones can be found using displacement of water by the object. An overflow is used for this measurement.

Step iv) The Teacher defines density to the students as the ratio of mass per unit volume and its unit is obtained from the units of mass and volume. Since the unit of mass is the kg and that of volume is m^3 so the unit of density is kg/m-^{3}

The symbol of density is 'rho'.

Evaluation: The students are given the following work to do

i. what is mass; what is weight
ii. define density;
iii. State the S.I Unit of Weight, Mass, and Density.
iv. What instrument do you use to measure density?
v Give three Differences between mass and weight

Summary/Conclusion: The teacher concludes the lesson by summarizing what has been taught and goes round to mark their books. And also the students copy their notes

Assignment: What instrument do you use to measure density of liquid directly? Draw and label it.

Week Three Lesson 3 for Control Group (Conventional Method)

Name of school: Government Junior Secondary School Television
Date: 13th November, 2017
Class: JSS 2
No of Students: 76
Average age of Students: 12 years
Sex: You and Energy
Period: Double
Duration: 1:20 minutes
Subject: Basic Science
Topic: Concept of Work, Energy and Power
Sub-Topic Concept of Work and Energy

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Metal balls of different sizes, slopy edge, stop watch, objects of different masses, bicycle, meter rule.

Reference: STAN Nigerian Basic Science New Edition 2008 Text Book Two, HEBN Publishers Plc

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

i. explain the concept of work; and how its S.I Unit is derived
ii. explain the concept of energy; and state its S.I Unit
iii. mention the various forms of energy;
iv. define Potential energy and Kinetic energy;
v. Show simple calculations to solve problems on both work and energy.

Previous knowledge: The students have learnt that the food they eat give them energy to do work.

The Teacher introduces the topic of the lesson: The teacher explain the key Concepts work energy and showing how they work with relevant examples

Introduction: The teacher introduces the lesson using the previous knowledge to ask the following questions From the Students previous knowledge the Teacher ask the following questions: i What is the source of energy for animals? ii What do you need to perform the following: (a) running (b) dancing,(c) sitting in the class to listen and do your assignment ?

Presentation: The teacher presents the lesson through the following steps.

Step i) The teacher explains the concept of work as, work is said to be done whenever a force moves an object through a distance. The amount of work done is determined by both the force exerted and the distance the object is moved in the direction of the force. Thus Work= Force × distance moved in the direction of the force. The unit of force is Newton; the unit of distance is metre (M) Therefore unit of work W=N ×m or Nm. Joule is the S.I unit of work.

Step ii) The teacher explain the concept of energy and tells the students that doing work requires energy. Energy is defined as the ability to do work by exerting a force to move an object through a distance, and the S I unit of energy is also joule. The teacher further enumerate the various forms of Energy as Mechanical energy, chemical, electrical, heat, light, sound, and atomic energy.

Step iii) The teacher writes on the board the different forms of energy.

Step iv) The teacher discusses the two types of Mechanical energy; Potential energy (PE) and kinetic energy (KE). Solving many problems and giving various examples of PE and KE.

Potential Energy- Is the energy of a body due to its position. For example, a ripe mango fruit hang on a tree possess Potential Energy, a catapult that is drawn before being release possess Potential Energy. The Potential energy of waterfalls is applied for the generation of electricity at hydroelectric power stations for example the Kainji power station in Nigeria. The Potential energy of a mass m, at a height h above the earth's surface is given by; P.E= mgh where g is acceleration due to gravity.

Step iv) The teacher solve the following mathematical deductions on work and energy.

Worked examples 1 A 50kg mass is raised to a height of 10m from the ground. What is its potential energy?(g=10m/s2)

Solution; P.E=mass × acceleration due to gravity × height

P.E = mgh that is 50× 10× 10 =5000j or 5kj

2 A body is said to possess a potential energy of 6000j when raised to a height of 30m.What is the mass of the body if acceleration due to gravity (g) is 10m/s2

Solution ; P.E= mgh; Therefore m=P.E/gh=6000/10 × 30=20kg

Kinetic Energy ; This is the energy a body has due to its motion. The kinetic energy of a body depends on its mass as well as speed. When the mass of a body increases its kinetic energy increases. Kinetic energy can be calculated by using the expression K.E=1/2 MV^2 where m is the mass of the object, and v is its speed.

Worked Examples;

1 What is the kinetic energy of a bicycle of mass 40kg moving with a velocity of 8m/s?

Solution; K.E= $1/2mv^2$ =1/2×40kg×8×8=1280j

2 A boy of mass 35kg is running with a speed of 5m/s. What is his kinetic energy?

Solution; K.E=1/2 mv^2 = 1/2×35×5×5=437.5joules

Evaluation: The Teacher evaluate the students learning by asking the following questions:

i. Define Work and give its S.I Unit;
ii. What is energy?, list 6 forms of energy;
iii. explain Potential energy and Kinetic energy;
iv. Calculate workdone when

A , a force of 10N moves through distance of 2m

B, 20N moves through 0.5m,

C, Calculate Potential Energy gives mass 50g and weight 5,(g=10m/s2)

D, Calculate K.E. of a bicycle of mass 40kg moving with a velocity of 8m/s

Week Four Lesson 4 for Control Group (Conventional Method)

Name of School: Government Junior Secondary School Television

Date: 20th November, 2017

Class: JSS2

No of Students: 76

Average age of Students: 12

Sex: Mixed

Period: Single

Duration: 1:20 minutes

Unit: You and Energy

Subject: Basic Science

Topic: Power and Energy Transfer when Work is done

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science An Integdated Science Course For Junior Secondary Schools 2 Longman, Nigeria

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

i. Define Power and solve any given problem on it
ii. State energy transfer that occurs when work is done
iii. State the law of conservation of energy.
iv. Demonstrate an experiment on how energy is transferred when work is done

Instructional Material: Metal balls of different sizes, slopy edge, stop watch, objects of different masses, bicycle, meter rule. Hammer, nails, students, wood, cork, test tube, holder Bunsen burner etc.

Instructional Method: Conventional Method

Previous knowledge: The students have learnt the concept of Work and Energy and different forms of Energy.

Introduction: The Teacher using the students prior knowledge discuss Energy, various forms of energy, examples of a body that has energy and is able to do work, (Moving car has energy, man moving from one place to another uses energy, and Falling mango)

Presentation: The teacher presents the lesson through the following steps:

Step i The teacher defines power as the rate of doing work. He /She further gives some illustrations to buttress what power is. The rate at which work is done is very important to

farmers, Factory owners and various aspects of human activities. The teacher explains how the S.I unit of power is arrived from the definition Thus:

Power= Work done/Time taken or Energy expended/Time taken =

work done= Force × distance which is in joule over or per Time taken that is in seconds.

Therefore S.I. Unit of power =joule/second=Watt

The teacher solves the following problems using the above taught formular;

I. What is the work done in pushing a lorry with a force of 120N over a distance of 50m? b) if this exercise takes place in 2 minutes, what is the power consumed?

Solution: Given that Force =120N ; distance =50m

From the formula W= F ×S =120×50=6000j

B time=2min=120s

Power=Work done/Time=6000/120=50W

Answer= 50watt

2 A boy of mass 40kg climbs a flight of stairs of height 12m in 15 seconds.

a. How much work does he perform?
b. What is his power output during the climb? (g=10m/s2)

Solution; The work performed by the boy is used to increase his Potential energy=mgh =40×10×12(here F=mg and s=h) 4800joules

B Power output=Work down/Time taken = 4800/15=320 Watt.

Answer 320Watt

A water pump lifts 400g of water through a height of 3.2m in 8 seconds, what is the power of the pump? (g=10m/s2)

Solution; Power= work done/time taken=Force× distance/time taken= mgh/t (since F==mg and s=h) Therefore power of pump=400×10×3.2/8 = 1600W or 1.6kw

Step ii The teacher explains Energy transfer giving examples: Energy Transfer means when energy is converted from one form to another. For example when a carpenter uses hammer to drive a nail into a wood. He transfer the energy gotten from the food they have eaten (chemical energy) into kinetic energy. When hands are moved, the kinetic energy is also transferred into sound that is the sound heard when the hammer strikes the nail; heat, as the nail becomes hot, and kinetic energy as it drives the nail into the wood, that work on the nail.

Step iii The teacher states and discusses the law of Conservation of energy.

Energy cannot be destroyed, but only transferred into another form when work is being done. This is called law of conservation of energy which states that energy can neither be created nor destroyed but can only be transferred from one form to another.

Step iv: The teacher gives illustrations on Energy Transfer

Most mechanical and human activities represent interchange of energies from kinetic energy, potential energy and work done. A simple example is the pushing of a car by three students. The students potential energy (stored energy) with their kinetic energy ($1/2mv^2$) will bring about the movement of the car from its original position. The work done is the force that causes the movement.

Step iv: The teacher using the recent floods in some part of the country explains how such non-human does a lot of work. For example Wind can be used on a smaller scale in windmills which are used to pump water up from a well. Moving water is another means of getting energy. Moving water can be made to turn a waterwheel or turbine, and this in turn will work a dynamo and generate electricity.

Evaluation: The teacher evaluates the lesson by asking the students the following questions,

i) Define Power. ii) what is the S.I. unit of Power? iii) Calculate the power developed by a man weighing 100kg from running to the top of a hill of height 40 metres in 15minutes. Assume $g=10m/s^2$

ii) What is energy transfer? State the law of conservation of energy and explain how energy is transferred when a student runs and kick a ball.

iii) State non-human means of doing work.

CONCLUSION: The teacher marks the students' work and also write the summery of the lesson on the black board for the students to copy.

ASSIGNMENT: Read about non human means of doing work such as moving water, hurricane, tornado. Find ways in which they help in doing work.

Week Five Lessons 5 for Control Group (Conventional Method)

Name of School: Government Junior Secondary School Television
Date: 22nd November, 2017
Class: JSS2
No of Students: 76
Average age of Students: 12
Sex: Mixed
Period: Double
Duration: 1:20 minutes
Subject: Basic Science
Unit: *You and Energy*
Topic: Simple Machines
Sub-topic Machines and levers, Wheel and Axle
Behavioural Objectives: By the end of the lesson the students should be able to

i. Define machine; explain the meaning of simple machine
ii. Identify what constitutes a simple machine
iii. Identify the essential parts of lever and use the arrangement of their parts to classify levers
iv. Describe uses of wheel and axle
v. Name one example of wheel and axle and how it works

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: brooms, opener, scissors, knives, wheel barrow, pliers, *students, and jack, hammer, spanner, nut cracker, sugar tongs, inclined plane.*

Previous Knowledge: The students have been using machines knowingly or unknowingly to enable them do work easily such as using broom to sweep and Opener to open bottle drinks.

Introduction: The teacher introduces the lesson Simple Machine as any arrangement that enable us to do work easily. For example brooms for sweeping the class and also opener for opening a bottle of Malt.

Presentation: *The Teacher presents the lesson through the following steps:*

Step i The teacher explain clearly what Simple Machines is, as any device that makes it easier and more convenient for us to do work.

Step ii: The teacher gives two types of Machines: Simple and Complex machines. Examples of simple machines are hoes, brooms, axes, knives lever, inclined plane,

wedge, screw, wheel and axle, and pulley while those of complex machines include a sewing machine, a pump, car and so on All machines are made from two or more basic machines called the lever and the inclined planes.

Step iii: The teacher discusses lever and the three classes of lever: A lever is a simple machine that is used to move objects. All levers have three parts, the load, pivot or fulcrum, and the effort. Levers are commonly divided into three classes according to the position of the fulcrum with respect to the effort and load.

First class levers: in first class levers, the load, and the effort, act on opposite sides of the fulcrum. Examples of simple machines that work on this principle are: seasaw pliers spade, scissors, equal arm balance and claw hammer

Second class levers: in this type of machines, the load (L) and the effort (E) are on the same side of the fulcrum (F) but act in opposite direction. The load is nearer the fulcrum than the effort. Examples of simple machines that work on this principle include Nut crackers, Wheel barrow Bottle opener

Third class lever: In this levers both Load and Effort are on the same sidewith the fulcrum and also act in opposite directions, but hear the effort is nearer the fulcrum than the load. Examples of simple machines that work on third class levers principle are : a long handle shovel, a fishing rod a pair of tongs, A table knife

Step iv: The teacher explains the component of wheel and axle as having two wheels of different diameters rigidly fixed on the same axle. Wheel and axle can be used for lifting heavy materials from any place below the wheel and axle position. For example it is used for drawing water from the well.

Step v: The teacher describes how a wheel and axle works: The working part of a wheel and axle can be illustrated with a windlass. The principle by which the wheel and axle operates is: when effort is applied to the rope attached to the rim of the larger wheel, the load is raised by the rope wound round the axle or smaller wheel.

Evaluation: The teacher ask each students to write answers to the following i) define a simple machine; ii) what is a lever? Iii) Describe the three classes of lever. iv) what is a wheel and axle? v) Name one example of wheel and axle and describe how it works.

Summary/Conclusion: The teacher marks the students work and write out the correct answers on the board for the students to copy as their summary notes.

Week Six Lesson 6 for Control Group (Conventional Method)

Name of School:	Government Day Junior Secondary School Television
Date:	27th November, 2017
Class:	JSS2
No of Students:	76
Average age of Students:	12
Sex:	*Mixed*
Period:	double
Duration:	1:20 minutes
Subject:	Basic Science
Unit:	You and Energy
Topic:	Simple Machines
Sub-topic:	Srew thread, Gears, Efficiency and Maintenance

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

i. Identify the parts of a screw thread; describe how the screw thread works; state the uses of screw thread and give three examples of a screw thread.
ii. Describe Gears; and state application of Gears
iii. Explain what efficiency and explain why no machine is 100% efficient and gives ways for Maintenance.

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course for Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: *Carpenters workshop, screw, bolts and nuts and car jack,* Bicycle gears, grinding machine gears, etc.

Instructional Method: Conventional Talk and Chalk

Previous Knowledge: The students have learnt what machine is and types of levers.

Introduction: The teacher introduces the lesson by asking the students from their previous knowledge: What is simple machine? Give examples of simple machines. What is the uses of Wheel and Axle.

Presentation: The teacher presents the lesson via the following steps:

Step i): The teacher draws and labels a screw thread and leads the students to identify the parts of the screw thread. Screw thread is a Simple Machine that is drive into a piece of wood. The teacher explains how screw thread works. The teacher lists examples of screw thread and states their various uses.

Step ii The teacher defines gears, and describes how Gears work,the teacher together with the students discusses the application of gears.

Step iii The teacher defines Efficiency of a Machine as the ratio of the work output of a Machine to work input. It is usually expressed as a percentage:

Efficiency = Work output/work input x100% .The teacher further explain why no Machine is 100% efficient

Evaluation: The teacher asks the students to answer the following questions:

1. Draw and label a screw driver, Describe how a screw driver works and state three examples of screw driver.
2 Define a gear. What is a driving wheel? Describe the parts of a gear and State two applications of gears.

3 what is Efficiency of a Machine? Why is machine not 100% efficient?

Summary/Conclusion: The teacher marks the students' work and writes the correct

Week Seven Lesson 7 for Control Group (Conventional Talk and Chalk)

Name of School:	Government Junior Secondary School Television
Date:	3rd November, 2017
Class:	JSS2
No of Students:	76
Average age of Students:	12years
Sex:	Mixed
Period:	Double
Duration:	1:20 minutes
Subject:	Basic Science
Unit:	You and Energy
Topic:	Tools for Work

iii. **Behavioural Objectives:** By the end of the lesson the students should be able to: describe or state names of tools for Agriculture, Engineering, Medicine and Fishing.

iv. *Compare Traditional and Modern Tools*

v. Visit a Carpenter's shop and fine out which tools are used there. Draw them and describe them. (the Basic introductory Tools can be used.)

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Axe saw, hoe, Spanner, Screws, Screwdriver, forcep, syringes and needle, charts on Modern and Traditional Tools

Instructional Method: Conventional Method

Introduction: the teacher introduces the lesson by asking the students what kind of Tools do you use at home? Are they very different from the one used by fore fathers?

The teacher present the Topics through the following steps:

Step i The teacher displays (cutlass, Saw, Hoe, Hammer Fishing hooks, Screw driver, Net, Spanner, Jack Syringes) many tools that are handy used for agriculture, Auto mechanic, hospital, Capentry, fishing and so on. Then the teacher classify them according to the Occupation in which each is most commonly used.

Step ii The Teacher together with the students list and discuss traditional and Modern Tools used in above profession stating the advantages of Modern tools over the traditional Tools.

Week Eight Lesson 8 for Control Group (Conventional Talk and Chalk)

Name of School: Government Junior Secondary School Television
Date: 10th December, 2017
Class: JSS2
No of Students: 76
Average age of Students: 12 years
Sex: Mixed
Period: Double
Duration: 1:20 minutes
Subject: Basic Science
Topic: Kinetic Theory

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Ndu, F.O.C.; & Somoye, E.O. (2009) Basic Science an Integrated Science Course For Junior Secondary Schools 2 Longman, Nigeria

Instructional Materials: Solid ice cubes, beakers, Bunsen burner or stuff, tripod stand, gauze.

Instructional Method: Conventional Method

Behavioural Objectives: by the end of the lesson the students should be able to:

i. state the principles of kinetic theory of matter using change of state.
ii. explain the structures of solid, liquid and gas particles using the kinetic theory;
iii. list properties of matter
iv. distinguish between boiling and evaporation using kinetic theory;
v. state the factors that affect evaporation.

Previous knowledge: The students have already learnt that matter exist in three state namely Solid, Liquid and Gas

Instructional Materials: Solid ice cubes, beakers, Bunsen burner, stuff, tripod stand, gauge.

Introduction: The teacher introduces the lesson by asking the students questions from their previous knowledge: What is matter? What are the three states of matter?.

Presentation: The teacher presents the lesson through the following steps:

Step i): The teacher states the kinetic theory of matter and explains it.

Step ii): The teacher gives the characteristics of each of the states of matter.

Step iii): The teacher explains between boiling and evaporation as an application of the kinetic theory of matter.

Step iv): The teacher together with the students discuss factors that affect evaporation.

Evaluation: The teacher evaluates the lesson by asking the students to write the answers the following questions. State the particulate theory of matter.

1. Give three characteristics of solid.
2. Give three characteristics of liquid.
3. Give three characteristics of gas.
4. List two factors that affect evaporation.

Summary/Conclusion: The teacher goes round to mark the students' workbooks and then together answer the questions and the students copy the summary given by the teacher

Week Nine Lesson 9 for Control Group (Conventional Talk and Chalk)

Name of School:	Government Day Junior Secondary School Television
Date:	17th December, 2017
Class:	JSS2
No of Students:	76
Average age of Students:	12
Sex:	Mixed
Period:	Double
Duration:	1:20 minutes
Subject:	Basic Science
Topic:	Thermal Energy
Sub-Topic:	Transfer of heat energy

References: Science Teachers Association of Nigeria STAN (2008) Nigerian Basic Science Project Text Book Two HEBN Publishers Plc

Adenuga Aderinola, Akuwudike, Onyirioha, and Tejumola (2010) Functional Basic Science for Junior Secondary Schools 2 Nelson publishers limited

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

i. Illustrate that when two bodies are in contact, heat flows from the hot one to the cold one;
ii. Name the methods of heat transfer;
iii. describe heat conduction and its applications

Previous knowledge: The students are conversant with Energy and how energy constitute a very important aspects of our daily activities. And have learned that the sun is the main source of energy.

Instructional Materials: spoon silver cup pot heat Thermometer, beaker

Instructional Method: Conventional Method

Introduction: The teacher introduces the topic as Thermal Energy which means Heat. And the sub-topic is how heat is transferred. Various Activities will be carried out to discover ways in which heat is transferred.

Presentation: The teacher presents the lesson through the following steps:

Step i): The teacher asks the students to rub their two hands together and say what they feel - heat.

Step ii): The teacher presents three forms in which heat can be transferred: conduction, convection and radiation.

Step iii): The teacher describes to the students some application of heat transfer as seen in cooking food, ironing cloths, boiling water, sun heat to use as light panels.

Evaluation: The teacher asks the students to answer the following questions:

1. What is thermal energy?
2. What are the methods of heat transfer?
3. Explain with example how a cloth is ironed.

Summary/Conclusion: The teacher answer the questions on the board as the students copy the summary given by the teacher.

APPENDIX 5

BASIC SCIENCE MULTIPLE CHOICE QUESTIONS

1. A body of mass 30g is suspended at a height of 12m from the ground. What is the potential energy of the body at this height? (g = 0.03) (A) 0.36 J (B) 3.6 J (C) 36 J (D) 360 J (E) 3600 J
2. The weight of an object is measured in: (A) Joules (B) Kilogram (C) Kilowatt (D) Newton (E) Metre
3. Chika's car had a punctured tyre and he is to repair and put back the punctured tyre, which of these tools will he not used? (A) chisel (B) jack (C) pump (D) spanner (E) wrench
4. A way of reducing friction in the moving parts of a machine is by applying (A) Bitumen (B) Diesel (C) Grease (D) Kerosene (E) Petrol
5. The amount of work done when a weight of 0.5g is raised to a height of 5m is (A) 2.5 J (B) 4.5 J (C) 5.5 J (D) 25 J (E) 250 J
6. Friction is defined as:
   (A) A force due to motion
   (B) A force which balances the force of a moving object
   (C) An opposing force which disappears when a body is moving
   (D) An opposing force between two surfaces in contact
   (E) Force that keeps a body moving towards the centre
7. The ability to do work is known as: (A) Density (B) Energy (C) Force (D) Mass (E) Power
8. The energy contained in food is known as _____ energy (A) Chemical (B) Food (C) Heat (D) Light (E) Sound
9. The process of energy transfer by which heat from the sun reaches the earth is called
   (A) Conduction (B) Convection (C) Evaporation (D) Radiation (E) Transportation
10. The density of a substance can be expressed as
    (A) $\frac{mass}{weight}$ (B) $\frac{mass}{area}$ (C) $\frac{mass}{pressure}$ (D) $\frac{mass}{volume}$ (E) $\frac{length}{mass}$
11. When you stir a cup of hot tea, heat is transferred to your fingers by what method?
    A) Convection (B) conduction (C) evaporation (D) radiation (E) boiling

12. The energy produced when a person rubs his palms against each other is _____ energy

(A) Chemical (B) Heat (C) Kinetic (D) magnetic (E) Potential

13. Repairing, cleaning and oiling of machine is termed (A) Cleanup (B) Lubrication (C) Repairs (D) Magnetic (E) Potential

14. A machine lifts a load of 50N. Calculate the Mechanical advantage of the machine (A) 0.1 (B) 0.01 (C) 25.0 (D) 45.0 (E) 55.0

15. Which of the following is a good conductor of heat? (A) plastic (B) glass (C) iron (D) cork (E) wood

16. A mounted hydrometer in a liquid is used to measure the _____ of a liquid (A) Depth (B) Density (C) Heat Capacity (D) Rate of flow (E) Volume

17. According to kinetic theory of matter, the force of attraction or repulsion between the particles of a gas are (A) Elastic (B) Large (C) Small (D) Strong (E) Weak

18. A tool that allows a force applied at one point to overcome a resisting force at another point is called a/an (A) Carrier (B) Gadget (C) Machine (D) Organ (E) Uploader

19. Which of the following instruments is mostly used by a carpenter? (A) Spanner (B) Syringes (C) Saw (D) Hook (E) Hoe

20. Which of these simple machines is an example of wheel and axle? (A) Bottle top opener (B) Pencil sharpener (C) Razor blade (D) Pair of scissors (E) Spoon

21. The sphygmomanometer is an instrument being used for; (A) cutting electrical wires B driving nails into joints C measuring blood pressure D lifting cars to effect tyre replacement E none of the above

22. Modern implements for preparing land for cultivation include (A) hoe and cutlass (B) tractor and pail-loader (C) tractor and bulldozers (D) hoes and diggers (E) harvesters and earth moving machines

23. The molecule in a gas are (A) Close together and revolving at random (B) Close together and stationary (C) Close together and vibrating (D) Far apart and moving at random

(E) Far apart and stationary

24. Which of the following is an effect of friction on a machine? (A) Aids movement on a machine (B) Generates heat (C) Improves performance (D) Prevent wear and tear (E) Reduces surfaces in contact

25. A student of mass 60kg runs up a height of 7.2m in 10 seconds. What is the power expended in KJ by the student? (g= 10 m/s^2) (A) 3.0 (B) 4.3 (C) 7.2 (D) 30.0 (E) 40.

26. The energy possessed by a stone placed on a table is _____ energy. (A) Chemical (B) Heat (C) Kinetic (D) Light (E) Potential

27. A man pushes a drum of oil 9kg up an inclined plane 5m high. Calculate the potential energy. (g = 10m/s^2) (A) 45 J (B) 50 J (C) 90 J (D) 140 J (E) 450 J

28. Boiling point is a temperature at which _____. (A) the solid state changes to liquid (B) the solid state changes to gas (C) the liquid state changes to gas (D) the liquid state changes to solid (E) the gas state changes to solid

29. When a torch is used to light up a dark room, what energy conversions are likely to take place? A)Electrical to light B) Electrical to heat C) Electrical to chemical D)Chemical to potential E) Chemical to light

30. Heat can be transferred from one point to another by these three method
(A) conduction, radiation and evaporation (B) convection, construction and radiation (C) conduction, convection and retaliation (D) conduction, convection and radiation (E) conduction, osmosis and absorption

31. A school boy riding a bicycle is converting A) Mechanical to kinetic energies B)Electrical to mechanical to kinetic energies C) Chemical to mechanical to kinetic energies (D) Potential to mechanical to kinetic energies
(E) None of the above

32. The kinetic theory of matter was propounded by (A) Isaac Newton (B) John Dalton (C) Robert Brown (D) Robert Dalton (E) Robert Green

33. The point where a lever rocks back and forth is the (A) fulcrum (B) load (C) force (D) effort (E)work

34. If a crate of 1000N is dragged horizontally by an engine along a floor of distance 6m n 5s, what is the power of the engine in watts? (A) 500 (B) 700 (C) 900 (D) 1,000 (E) 1,200

35. The following tools are used by doctors during surgical operations except? (A) Forceps (B) Needles (C) Scissors (D) Syringes (E) Voltmeter

36. A tool used by a carpenter to tighten a joint is (A) Gear (B) Hammer (C) Plane (D) Pulley (E) Screw

37. An electrical pressing iron converts electrical energy to (A) Chemical (B) Heat (C) Kinetic (D) Mechanical (E) Potential

38. Efficiency of a machine is expressed as (A) $\frac{work\ input}{work\ output} \times 100$ (B) $\frac{work\ output}{work\ input} \times 100$ (C) $\frac{work\ output}{100} \times work\ input$ (D) $\frac{100}{work\ input} \times work\ output$ (E) $\frac{work\ input}{100} \times work\ output$

39. The heat transfer by the movement of liquid molecules is (A) Conduction (B) Contraction (C) Convection (D) Conversion (E) Radiation

40. A simple machine used to draw water from a well is an example of (A) Fulcrum (B) Inclined plane (C) Lever (D) Saw (E) Wedges

41. Mechanical advantage can be represented as (A) E/L (B) F/mg (C) L/E (D) MA/VR (E) VR/MA

42. A machine has a velocity ratio of 8 and efficiency of 85%. Calculate the mechanical advantage of machine (A) 1.1 (B) 3.4 (C) 6.8 (D) 7.7 (E) 9.3

43. Which of the following is true about solid molecule structure? The

    I. molecules are fixed in definite positions

    II. Molecules vibrate about fixed position

    III. Intermolecular force of attraction is weak

    (A) I only (B) II only (C) I and II only (D) III only (E) II and III only

44. The movement of solute particles through a medium from a region of higher Concentration to region of lower concentration is: (A) evaporation (B) diffusion (C) absorption D) boiling (E) melting

45. A girl of mass 25kg climbs up 8 steps each of height 0.25m in 20s. Calculate the power of the girl ($g = 10\ ms^{-2}$) (A) 0.25 W (B) 2.50 W (C) 12.50 W (D) 25.00 W (E) 100.00 W

46. Which of the following conditions is work done? (A) Bag of rice standing on a platform (B) Girl holding a pot of water (C) Man climbing a staircase (D) Man pushing against a stationary kerosene tank (E) Woman supporting a heavy load above her head with her hand

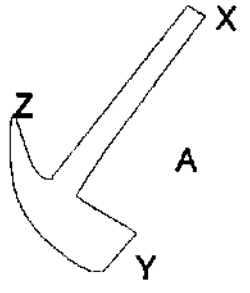
47. To measure 12.50cm3 of distilled water accurately a student needs a (A) Measuring cylinder, (B) pipette (C) burette (D) chemical balance (E) thermometer

48. The following statements are true about mass of an object EXCEPT (A) a beam balance is used to measure mass of an object (B) a formula is used to measure

mass of an object (C) mass is the quantity of matter in a body (D) mass is equal to force /acceleration due to gravity (E) the mass of an object is a constant value

49. The substance will change directly from solid to gaseous state on heating (A) ice (B) wax (C) iodine (D) chalk (E) sand

50. XYZ as indicated in the diagram of a claw hammer shown below respectively stand for



(A) Effort, Fulcrum and load

(B) Effort, load and fulcrum

(C) Fulcrum, load and effort

(D) Fulcrum, effort and load

(E) Load, effort and fulcrum

APPENDIX 6

PERFORMANCE OF JUNIOR SECONDARY SCHOOL STUDENTS IN KADUNA STATE, NIGERIAS AT CREDIT LEVEL

YEAR	TOTAL STUDENTS	PASS AT CREDIT LEVEL UPWARD	PERCENTAGE %
2010	73,106	20,737	29%
2011	87,657	36,928	42%
2012	77,517	26,409	34%
2013	82,283	37,689	46%
2014	83,946	30,829	37%

APPENDIX 7

Training Manual for Research Assistant

The research assistants were trained for 2 days, the following were involved in the cause of the training:

1. General orientations of the research assistants concerning the objectives of the field work.
2. The researcher will meet the Basic Science teachers of the selected schools for the study.
3. The researcher will then select the research assistants and give them introduction of members then a subsequent short interview will follow the aim of the interview is to select social studies teaches based on competence as research assistance.
4. After the selection, the researcher will provide an overview of the research work at the beginning of the session, detailing what is expected of them from the research, the time frame, regular meetings with the students.
5. The scripts will be collected marked scores and recorded to make companions between the groups will the help of the research assistants.
6. How to be polite and simple with the respondent and not to be harsh
7. How to answer questions that would possibly arise from the respondents.
8. To dress well and not look shabbily
9. To be careful with the collected scores so as not to get missing
10. To learn to refer questions that may arise from the test items to the researcher.
11. How to speak simple and correct English given the level of the students.
12. Do not show sign of contempt or disagreement with students

APPENDIX 8
PROOF OF EDITING

From: Pst. Daniel La'aki
No. 121 College Road,
Ungwan Gimbiya, Sabon Tasha,
Kaduna, Kaduna State.

To: Dean/Head of Department
Department of Foundations and Curriculum,
Faculty of Education,
Ahmadu Bello University,
Zaria, Nigeria.

Date: 29th July, 2019

Dear Sir,

Subject: Re: Edited Work on the Thesis done by Mrs. Jummai Habu Dawaki; on the *Activity "ASSESSMENT OF THE EFFECTS OF ACTIVITY BASED AND PROBLEM SOLVING METHODS ON BASIC SCIENCE JUNIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN KADUNA STATE, NIGERIA"*, in Pursuance for the award of Doctoral Degree in the Ahmadu Bello University, Zaria.

I write to affirm that I carefully edited the works on the thesis of **Mrs. Jummai Habu Dawaki** for the Topic stated above, in the pursuance for the award of Doctoral Degree in your esteemed and highly recognized institution.

It is therefore my hope and believe that she would be considered worthy to be awarded with the certificate by your institution.

Please accept the assurances of my highest regards.

Yours faithfully,

Daniel La'aki

APPENDIX 9
VALIDATION FORM

DEPARTMENT OF EDUCATION FOUNDATIONS & CURRICULUM
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA

Instrument Validation Form

Dear Sir/Ma,

The candidate is a postgraduate student of *Education Foundation* and Curriculum Department, Ahmadu Bello University, Zaria. He/she is hereby humbly requesting your assistance in validating this research instrument. Please, grant the candidate all the necessary assistance. Thank you.

.....

Head of Department (signature, Date & Stamp)

Student's Surname: Dawaki Other names: Lumma Habu

Registration Number: Pg/PhD/16/85 Programme: Ph.D Curriculum Instruction.

Title of the Instrument: LESSON PLAN: BASIC SCIENCE MULTIPLE CHOICE QUESTION.

Please Comment on the following:

1. Appropriateness of the instrument for the research: Instrument is appropriate for the research.
2. Clarity and simplicity of the language used: Items on the instrument are clearly stated in simple language.
3. Suitability of the instrument for the level of respondents: Items are very suitable for the level of respondents.
4. The extent to which items cover the topic it meant to cover: The items have good coverage in line with the research topic.
5. Is the instrument properly structured in line with objectives and research questions? Items on the instrument are structured in line with the objectives.
6. Others (Grammatical errors, spelling errors and others): Very minimal errors in terms of spelling.
7. General comment on the instrument: Instrument is adequate

1

and suitable for the research.

Suggestion(s) for improving the quality of the instrument

1. All typographical and spelling errors should be corrected.
2.
3.
4.

ATTESTATION SECTION

I hereby testify that the above named students brought his/her instrument for validation

Name of Attester: Prof

Designation: Professor

Name and Address of Institution: Ahmadu Bello University, Zaria

Phone No.: 080

Signature and Date

Thank You

DEPARTMENT OF EDUCATION FOUNDATIONS & CURRICULUM
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA

Instrument Validation Form

Dear Sir/Ma,

The candidate is a postgraduate student of Education Foundation and Curriculum Department, Ahmadu Bello University, Zaria. He/she is hereby humbly requesting your assistance in validating this research instrument. Please, grant the candidate all the necessary assistance. Thank you.

26/5/2015

Head of Department (signature, Date & Stamp)

Student's Surname: ... Other names: ...

Registration Number: ... Programme: ...

Title of the Instrument: ...

Please Comment on the following:

1. Appropriateness of the instrument for the research: ...
2. Clarity and simplicity of the language used: ...
3. Suitability of the instrument for the level of respondents: ...
4. The extent in which it will cover the topic it is meant to cover: ...
5. Is the instrument properly structured in line with objectives and research questions? ...
6. Others (Grammatical errors, spelling errors and others) ...
7. General comment on the instrument ...

1

Suggestion(s) for improving the quality of the instrument

1. Lack specification of concept to be discussed during the treatment. Therefore the Concept should be specify
2. Area of ~~skel~~ human skeleton system, reproduction and many other and is of course. You need to factorize
3. .....
4. .....

ATTESTATION SECTION

I hereby testify that the above named students brought his/her instrument for validation

Name of Attester: Dr. M.A. [illegible]

Designation: Associate Professor

Name and Address of Institution: A.B.U. Zaria, Dept. Sc. Educ.

Phone No.: 08[illegible]519 **E-mail:** [illegible]

Signature and Date: [illegible] **Thank You**