EFFECTS OF ACTIVE REVIEW AND PRACTICE-INVENTION STRATEGIES ON STUDENTS' ATTITUDE TO, ACHIEVEMENT AND PROCESS SKILLS IN BASIC SCIENCE IN OYO STATE

BY

Adebare Idowu ADEG0KE

TC (IBADAN); NCE (OYO); B.Sc (Ed)(ADO-EKITI); M.Ed.(IBADAN)

MATRIC NO; 130105

A THESIS IN THE DEPARTMENT OF TEACHER EDUCATION,

FACULTY OF EDUCATION, UNIVERSITY OF IBADAN, IBADAN, NIGERIA.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PH.D) IN SCIENCE EDUCATION OF THE UNIVERSITY OF IBADAN, NIGERIA.

2015

ABSTRACT

Junior secondary school students' achievement in Basic Science in Oyo State seems not to be encouraging, a trend attributed partly to persistent usage of teacher-centered instructional methods. This necessitates the adoption of students-centered instructional strategies such as the active review and practice-invention strategies. The effectiveness of these two instructional strategies in the teaching of Basic Science has however not been properly documented. This study, therefore, investigated the effects of Active Review (ARIS) and Practice-invention (PiIS) Instructional strategies on students' attitude to, and achievement and process skills in Basic Science in Oyo State. The moderator effects of Parent Educational Background (PEB) and gender were also examined.

The study adopted a pretest-posttest, control group, quasi experimental design with a 3x3x2 factorial matrix. Oyo North senatorial district was purposively selected due to the observed low performance of students in Basic Science in the area. Nine Junior Secondary Schools (JSS) were randomly selected from the district, while nine intact classes of JSS II student participants were randomly assigned as follows: ARIS (131), PiIS (125) and control (131) groups. The six instruments used were Basic Science Achievement Test (r =Interrater) r = 0.80), Basic Science Attitude Scale (r = 0.86), Basic Science Process Skills Rating Scale (r = 0.76), and instructional guides for ARIS (Scott's π = 0.74, PiIS (π =0.76) and conventional (π =0.78) strategies. Seven null hypotheses were tested at 0.05 level of significance. Data were analysed using Analysis of Covariance and Scheffe post-hoc test.

Treatment had a significant main effecton achievement ($F_{(2, 369)} = 35.25; \eta^2 = 0.16$), attitude ($F_{(2, 369)} = 13.30; \eta^2 = 0.07$) and science process skills ($F_{(2,369)} = 29.40; \eta^2 = 0.14$). Students in the PiIS group ($\bar{x}$=14.69) performed better than those in ARIS($\bar{x}$=14.62) and control ($\bar{x}$=13.08) groups. Also, they had better attitude ($\bar{x}$=53.64) than those in ARIS ($\bar{x}$=51.11) and control ($\bar{x}$= 45.28). However, participants in ARIS performed better in process skills ($\bar{x}$=12.43) than those in PiIS($\bar{x}$=11.29) and control ($\bar{x}$=6.24).Gender had a significant main effect on achievement ($F_{(1, 369)} = 5.67; \eta^2 = 0.02$), with the female performing better ($\bar{x}$=14.48) than their male counterparts ($\bar{x}$=13.75). The main effect of PEB was not significant, but two-way interaction effect of gender and PEB on achievement in Basic Science was significant ($F_{(2, 369)} = 5.560; \eta^2 = .03$). The female students from low PEB ($\bar{x}$=14.87) did better than their male counterparts ($\bar{x}$=13.22). The two-way interaction effect of treatment and gender, as well as treatment and PEB were not significant. Also, the three-way interaction effect of treatment, gender and PEB was not significant.

Active review and practice-invention strategies enhanced student's achievement in process skill and attitude to Basic Science in Oyo State. Therefore, these strategies should be adopted in teaching Basic Science to junior secondary schools students.

Keywords: Active review instructional strategy, practice-invention instructional strategy, Students' achievement, Basic Science, Junior secondary school.

Word count: 486

CERTIFICATION

I certify that this work was carried out by Adebare Idowu **ADEGOKE** Matric. No 130105 in the Department of Teacher Education, Faculty of Education, University of Ibadan, Ibadan, Nigeria.

……………………………………

Supervisor

Professor Alice M. Olagunju

B.Sc. Ed(Ife), M.Ed.,(Ibadan)
Ph.D. (Science Education) (Ibadan),
Department of Teacher Education,
Faculty of Education,
University of Ibadan,
Ibadan, Nigeria.

DEDICATION

This work is dedicated to Almighty God and to my beloved parents, Late Pa. Ayoade Alamu Adegoke and Late Mrs. Alice Ogunjoke Adegoke.

ACKNOWLEDGEMENTS

O for a thousand tongues to sing,
My great Redeemer's praise,
The glories of my God and King,
The triumphs of His grace!

Charles Wesley (1707 – 1788)

To God be the glory, great things he has done; truly, with God all things are possible. I acknowledge with highest regard and total humility, the favour of the Almighty God and His infinite love, protection, provision, grace and mercies over my life throughout the programme.

My sincere and reserved appreciation goes to my caring, loving, open-minded, indefatigable, dedicated, an erudite scholar, a mother and a unique mentor, Prof. Alice M. Olagunju, for her courage, challenge, corrections and priceless contributions to the successful completion of this programme. I have immensely benefited from her brilliant ideas, invaluable suggestions and unreserved release of all the necessary materials that supported the progress of the work. The Almighty God will continue to bless and lead you to greater heights in Jesus name (Amen).

I am very grateful to the Dean of the Faculty of Education, Prof. M.K. Akinsola, and the Head of Department of Teacher Education, Prof. J.O. Ajiboye, for their fatherly advice and love during the period of this research work.

I am short of words to appreciate the effort of Prof. C.O.O. Kolawole, Prof. Oluremi Bamisaye, Prof. F. A. Adesoji, Prof. Alade Abimbola, Prof. I. O. Osokoya, Prof. O. Akinbote and Prof. Esther Oduolowu, God indeed used them to assist me during my trying period concerning the timely completion of the programme. I pray that your progress will not be cut short in Jesus name (Amen).

I am also grateful to Prof. T. A. Akanji, my Internal/External examiner for giving me his time, suggestions and full support. God willexault your entrie family.

I appreciate the constructive criticisms and positive contributions of all the lecturers in the Department of Teacher Education: Dr. S. A. Babatunde, Dr. T. A. Ige, Dr. Ayotola Aremu, Dr. D. O. Fakeye, Dr. B. O. Lawal, Dr. S. O. Ajitoni, Dr. P. A. Amusan, Dr. A. A. Adeyinka, Dr. Gloria Adedoja, Dr. M. Araromi, Dr. Edidiong Uchor, Dr. A. Tella, Dr. I. A.

Salami, Mr. Israel, and my able Sub–Dean (Postgraduate), Dr. K.O. Kester. The Lord's blessing will continue to be upon you all (Amen).

I could not have achieved this without the full cooperation and support of my beloved wife, Mrs. Abigael I. Adegoke. I appreciate your love, care, understandingand prayers. God will give you peace of mind, good health and long life to reap the fruits of your labour (Amen). My beloved children; Tosin, Tope, Toba and Tofunmi took part in the struggle towards the success of this programme. Indeed, you are wonderful children. God will bless you all and grant you fulfilled lives, in Jesus name (Amen).

I am very grateful to the following people for their moral, financial and spiritual support: Late Mr. and Mrs. Nofiu Raji, Rev. and Mrs. G.O. Kehinde, Rev. &Mrs. G.A Bamikole, Adegoke's family, Dr. &Mrs. A.O. Ogundiwin, Mr. and Prof. (Mrs) K.O. Oyedepo, Mr. & Mrs. Ipadeola S.A, Mr. & Mrs. A.O. Babatope, Dr. & Mrs. A.D. Bamidele, Mr. & Mrs. C. Odoje, Dr. & Mrs. S.M. Raimi, Mr. & Mrs. Akin Oyediran, Dr. C.B. Idowu, Mrs. Ahamed A.A. Miss.Yemisi Ogunmola and Calvary Love Society of First Baptist Church, Isokun, Oyo. I also acknowledge the contribution of my Dean,School of Science, Mr. A.J. Oladipupo, my H.O.D., Mr. P.A. Afolabi and the contribution of my colleagues at work: Mr. A.O. Aremu (H.O.D, Biology) Dr. S .A. Olaoluwa (H.O.D, Mathematics) Mr. Ige, A.O, Mr. Bankole S.O, Mrs. Taliat F.A, Mr. Fadara O.O, Mr. Adubi, A.O, Mr. Aasa, M.A, Mr. Aborisade, J.A, Mr. Adegbola, I.A; Mrs. Gbolagade S.O, Mrs. Ogunnaiya R.T., Pastor S. K. Olugbenro,Mr. Oyeniyi M.O. Mr. Kofoworade A.D Mr. Binuomote, M. O. and Mr. AdegokeAdeolu, I appreciate you all.

To my course mates, Mrs. O. O. Oloyede, Mrs. D. A. Ogunjimi, Mrs. V. O. Animasahun, Mr. M. A. Awolere,Mrs. S. Nodim, Mrs. AhamedA.A., Mr. D.O. Ajani, Mr. A. E. Adesina, Mr. O. A. Bolaji, Mr. O. E. Ogunseemi, and others I cannot remember when I was writing this acknowledgement, I say thank you.

Finally, this programme would not have been possible without the approval and support of the Provost, Dr. R.A. Adefabi and the Head of Campus, Dr. J.O. Adeagbo, and the Management Team of Emmanuel Alayande College of Education, Oyo and LanlateCampus respectively. God will continue to lead and direct all your activities, in Jesus name (Amen).

TABLE OF CONTENTS

CHAPTER THREE: METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ANCOPSS - All Nigeria Conference of Principals of Secondary Schools

ANCOVA – Analysis of Covariance

ARS – Active Review Strategy

BESD – Binominal Effect Size Displao

CDC- Curriculum Development Centre

CTS – Conventional / Traditional Strategy

EMM – Estimated Marginal Means

ESATPS – Evaluation Sheets for Assessing Teachers Performance on the Strategy

ESAT – Evaluation Sheets for Assessing Teachers

FME- Federal Ministry of Education

ICT – Information and Communication Technology

IGACSBS – Instructional Guide on Conventional Strategy in Basic Science

IGARSBS – Instructional Guide on Active Review Session in Basic Science

IGPISBS - Instructional Guide on Practices Invention Strategy in Basic Science

JCC – Joint Consultative Committee on Education

JSS – Junior Secondary School

JSSCE – Junior Secondary Certificateof Examination

NCE – Nigeria Certificate in Education

NERDC – Nigerian Educational Research and Development Council

NPE – National Policy on Education

PiS – Practice- invention Strategy

PEB – Parental Educational Background

SBSAS –	Students' Basic Science Attitude Scale
SBSAT –	Students' Basic Science Achievement Test
SBSARS –	Students' Basic Science Active Review Strategy
SBSPSRS –	Students' Basic Science Process Skills Rating Scale
STAN –	Science Teachers Association of Nigeria
SUBEB –	Oyo State Universal Basic Education Board
TIGASS –	Teachers' Instructional Guide on Active Review Session Strategy
TIGPiS –	Teachers' Instructional Guide on Practice – Invention Strategy
TIGCS-	Teachers' Instructional Guide on Conventional Strategy
UBEC –	Universal Basic Education Commission
YCCD-	Yuba Community College District

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The Federal Government of Nigeria, in its quest for scientific development, formulated goals in the National Policy on Education (FGN, 2004) which reflected, among others, the acquisition of appropriate skills and the development of mental, physical and social abilities as well as competencies, required for the individual to live in and contribute to the development of the society. Educational activities, therefore, are expected to be centered on the learner for maximum self-development and self-fulfillment. In view of these, the Junior Secondary School is made of both pre-vocational and academic. The Nigerian government realized the importance of science education as the basic requirement for economic and social development, hence, science education forms the major part of the country's education at all levels (NERDC, 2012). Indeed, science is one of the core subjects offered at all levels of the Nigerian education system. It is an important subject that has positive impact on human lives and the nation's economy.

The knowledge of science is used in the production of materials that reduce peoples stress, suffering, and hunger, as well as make life enjoyable and secure. It is also a necessary factor for the economic development of a nation (Yuba Community College District, 2005). It therefore, implies that for any meaningful national growth and development to be achieved, Science and Technology must be essential parts of the nation's culture (Aina, 2013). Science is also one of the ways humans search for the truth and achieve understanding of their environment and the universe.

The relevance of Basic Science to technological development in Nigeria is a fact and the knowledge of the concepts in the subject is pivotal to the scientific academic careers of students. This notwithstanding, only negligible sample of students eventually offer science courses at higher levels due to their recurrent mass failure in the Junior School Certificate Examination (JSSCE) Ige and Arowolo, (2011). On the same issue, ANCOPSS Oyo State (2010) deliberated on the poor performance of students in various examinations and how to improve students' performance in future examinations. The body then concluded with the following as some of the reasons students perform poorly in various examinations:

- Mass promotion of students from one class to another
- Lackadaisical attitude of students to both internal and external examinations.
- Inability of senior secondary students to read or write well.
- Shortage of qualified teachers in schools due to poor remunerations.
- Parents not being responsible for examination fee of their students.

The association then observed that to improve students' performance in future examinations the following hard line decisions, among others, should be taken:

- There should be a stop to mass promotion of students both in primary and secondary schools.
- The cost of external examinations should be borne by the parents to ensure their full commitment.
- Mock examinations that have been re-introduced in some states should be used to prepare students intending to write both Junior and Senior Secondary Examination, as it was done in the past.

Also, Oni (2014) remarked that acquisition of knowledge in the subjects is one of the means by which the nation hopes to attain the Millennium Development Goals (MDGs) by 2015 and the important targets of the National Economic Empowerment and Development Strategies (NEEDS) (NERDC, 2012). Basically, Basic Science and Technology is said to contribute to the achievement of the national education goals by providing the required technical knowledge and vocational skills.

Hence, Ajisegiri (2010) observed that:

> *If the quality of education at the primary level is poor it will be foolish to expect that the standard at the secondary level will be high because it is the primary school that feeds the secondary. In the same vein, if the standard at the secondary level is poor, we should also expect that the quality at tertiary level will be poor. So, in ensuring that we have a high quality of education in the country, it is incumbent on government to see that the standard is high at all levels.* (Pg. 25)

Therefore, in order for science and technology to take its firm shape in our society, the poor state of Basic Science education must be addressed. One of many ways for achieving this noble goal is through effective instructional strategies.

Integrated Science as a discipline is an integration of concepts from such other disciplines as Biology, Chemistry, Physics, and with extracts from Health Science, Mathematics, Geography, Agriculture and Technology. This implies that the subject is a combination of concepts from these disciplines with energy and environment, forming the contents of the curriculum of the traditional science. Chemical knowledge was demonstrated in the native production of wine, spirits and manufacturing of black soap and dyes. The rudiments of Physics were in terms of mass-volume relationship in the making of bows and arrows, principles of refrigeration by using clay pots as a cooler and canoe building, In Biology, the ancient scientists established that water is needed for the germination and growth of seeds, while sunlight is needed for manufacturing the food in plants and others.

However, the subject (Integrated Science) is offered at all levels of education, for example at the primary, secondary and tertiary level not excluding Colleges of Education. Integrated Science has been defined as the course which is presented in a way that pupils gain the concepts of the fundamental unity of science as well as the common approach to problems of scientific nature, and the understanding of roles and functions of science in everyday life. As stated in NERDC (2012: pp vi), the objectives of Basic Science and Technology curriculum expect the learner to:

(i) develop interest in science and technology;
(ii) acquire basic knowledge and skills in science and technology;
(iii) apply scientific and technological knowledge and skills to meet contemporary societal needs;
(iv) take the advantage of the numerous career opportunities provided by science and technology;
(v) become prepared for further studies in science and technology;
(vi) avoid drug abuse and related vices; and
(vii) be safety and security conscious;

The Primary Reference Committee of the Joint Consultative Committee (JCC) set up a panel to produce a "core-curriculum" for science education. The panel, with Science

Teachers' Association of Nigeria (STAN), came up with the Nigerian Integrated Science Project which was published around 1982. In recent years, due to educational reform efforts, Nigeria had a metamorphosis of the science curriculum as the Universal Basic Education Commission (UBEC) changed Integrated Science into Basic Science (NERDC, 2007). This implies that the Integrated Science offered in primary and post-primary schools have metamorphosed into Basic Science, specifically in September 2008 (Oyediran, Agoro and Fabiyi, 2009; Oludipe, 2011). The development of any nation is a measure of its development in the area of Science and Technology. Technological growth of a nation leads to its social and economic development. Globally today, science and technology has become a dominant power development indicator. America, Russia, Japan and China have typical examples of development in the area of Science and Technology.

The number of students offering Basic Science is more than the number of teachers employed to teach the subject in various schools, and the class size is large. This increases teachers' workload, resulting in teachers' ineffectiveness. In addition, Basic Science has the perennial problems of lack of class activities and instructional resources to teach the subject. Lemon (2011) emphasized the importance of class activities. Class activities make the learning process successful. Teachers should allow students' creative ideas during instructional process by providing meaningful class activities. Basic Science at the Junior Secondary Schools (JSS) level is all about doing. An attempt to make science class all of teachers' activities but none of students' activities is making science passive to learners. Students will only be familiar with the scientific concepts but will not be able to live in the real world of science.

The importance of studying Basic Science in schools is not only for obtaining certificate but also for producing future scientists in all spheres of life that will bring about national developments in all its ramifications. The future scientists begin their scientific experience from the studying of Basic Science in Junior Secondary Schools (JSS), which should be activity-based, and they continue with this experience at higher educational levels, including Senior Secondary Schools (SSS). Basic Science enables students to develop knowledge and understanding of the application of scientific knowledge to everyday life activities. It also helps in the acquisition of life-long learning skills for solving everyday problems. It helps students to develop positive attitudes towards science and places high values on scientific activities. It further helps students to develop and appreciate the role of science in fostering a safe and healthy lifestyle; it enables individuals to function effectively within increasingly technological and scientific global environment, as well as the appreciation of the need to contribute to sustainable development.

Science has become such an indispensable tool that no nation, (developed or developing) wishing to progress in the socio-economic sphere will afford to relegate its learning in schools. The role of science in this modern era of technology is wide and profound. In line with this reasoning, Ogunleye and Fasakin (2011) emphasized the importance of scientific knowledge in boosting national prestige, military might, national income and international rating of the country. According to them, science leads to the production of micro-computers and their innovative applications, which earned the developed countries, such as: the United States of America and Japan, unparalleled national wealth, military potential and enviable national prestige.

In Nigeria, in spite of the enormous role that science plays in national development and the efforts of government and other stakeholders in improving science education, learning of science has not been encouraging. Many factors have been attributed to this as unwholesome situation. These factors include: students' negative attitude towards science subjects, student' lack of interest in science subject, gender inequality and student study habits (Akanbi, 2014; Asikhia, 2010; Macmillian, 2012).

The content is drawn from NERDC (2007) and Basic Science Curriculum was divided into four themes namely: You and Environment, Living and Non-living Things, Science and Development and You and Energy. The Basic Science and Technology Curriculum (Revised, 2012) is a product of the restructuring and integration of four Primary and Junior Secondary Schools' (JSS) science curricula namely Basic Science, Basic Technology, Physical and Health Education, and Computer Studies/ Information Communication Technology (ICT). The integration of these science curricula became necessary for the following reasons according to NERDC (2012)

1. Recommendations of the Presidential summit on education (2010) to reduce the number of subjects offered in primary and junior secondary schools.
2. Feedback from the implementation of the curricula in schools that identified repetition and duplication of concepts as the major cause of curriculum load
3. Need to encourage innovative teaching and learning approaches and techniques that promote creativity and critical thinking in learners.

4. Need to promote the holistic view of science at the basic education level for better understanding of contemporary and changing world.
5. Need to infuse emergent issues that are of national and global concern such as gender sensitivity globalization and entrepreneurship, (NERDC, 2012)

The thematic approach to content organization was adopted to achieve a holistic presentation of scientific and technological concepts and skills to learners. The basic science sub-themes that were used for this study are: Learning about the environment (Living and non-living things, chemicals, You and Energy, work, energy and power, and types of energy), and Science and Development (Crude oil and Petrochemicals).

Instead of experiencing good outcomes in Basic Science both in achievement and attitude, the result from different scientific researches on science have not been encouraging. Afuwape and Olatoye (2003) recommended simulation game-assisted instruction as an effective treatment of students' attitude towards Integrated Science. The positive attitude of students towards Integrated Science would in turn improve their achievement. Similarly, they also advocated enriched mastery and methodology in order to improve students' outcome in Integrated Science.

Attitude are acquired through learning and can be changed through persuasion using variety of techniques. Attitudes, once established, help to shape the experiences the individual has with object, subject or person. Although attitude changes gradually, people constantly form new attitudes and modify old ones when they are exposed to new information and new experiences (Jinsto and Dibiasso, 2006). Juch (2003) defined attitude as an internal state that influences the personal actions of an individual; he sees attitude as a major factor in subject choice. He considered attitudes as a mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's responses to all objects and situations with which it is related. Attitudes associated with Science appear to affect students' participation in science as a subject (Jegede, 2007).

Literature has also indicated that teachers' attitude have exerted some influence on the academic achievement of students. For instance, Yara (2009) reported that teachers' attitude towards science has strong relationship with students' achievement in science as well as their attitude towards science, while Amjad and Mohammed (2012) asserted that one of the important factors in science teaching is the attitude which determines behaviour while

Olatoye and Aderogba (2012) are of the opinion that a person with good scientific attitude is free from superstitions, unverified assumptions and many times from popular opinions that have no empirical basis. This position is corroborated by Olasehinde and Olatoye (2014) who said that a person with scientific attitude is not necessarily a scientist but he or she consciously or unconsciously thinks, acts and demonstrates traits that are common to scientists.

Adodo (2005), Yara (2009) and Gbore and Daramola (2013) all asserted that teachers' and students' attitudes toward teaching and learning, respectively combine to determine record achievement in science, while Ogunwuyi (2000) observed a significant relationship between teachers' attitude and students achievement in Integrated Science. Edomwonyout and Avaa (2011) concluded that practical work in science motivate the students' attitude towards science and influence positive achievement in science.

Effort needs to be concentrated on fostering desirable attitudes toward science and the teaching of science (Lucas & Dooley, 2006). An attempt to foster positive attitude in the learner calls for the teacher to ask himself/herself the following salient questions: what do I teach? And how do I teach? Where can I get relevant information on what to teach? When a Basic Science teacher is sufficiently prepared in terms of his attitude, quality, materials and methods, there is tendency for learners to develop positive attitude towards his or her subject (science). This is because attitude toward science is closely related to achievement in science (George, 2000). Attitude toward science predicts achievement in science (Kan & Akbas, 2006). Positive attitude or favourable attitude may lead to significant or higher achievement in science. The attitudes of the teachers, to a large extent, affect achievement and attitudes of students in science (Adetunji, 2000).

In recent years, students' achievement in Basic Science has been a gradually declined failure rate in the subject. This is evident in the JSSCE result of 2008 to 2013.

Table1.1 shows students' performance in Oyo State's Junior School Certificate Examination in Basic Science. Though students seem to pass Basic Science in Junior School Examination with the result on Table 1.1, but the result is not too good for a country like Nigeria that is aspiring for technological breakthrough. There were noticeable improvements in 2008 and 2010, but with much effort on the part of the teachers, parents, government and students themselves, greater percentage of success could be archived in Basic Science and this will increase the number of students offering science subjects in senior secondary schools.

Abimbola, Olorundare, Omosewo, Ahmed, Johnson and Yahaya (2011), while working on the importance of science and technology in national development, emphasized that teaching science in secondary schools is very important. They lamented that despite the numerous usefulness of science, its greatest problem is poor performance among students. Other researchers also attributed reasons for poor achievement in science to:

i. shortage of qualified teachers (Ajayi, 2005);
ii. failure of teachers to put into use research findings and recommendations (Osuafor, 2008);
iii. instructional method used which have no bearing on students' practical life (Adodo and Gbore, 2012);
iv. inadequate materials in schools (Adedayo, 2011);
v. teachers' inability to satisfy students' aspirations or goals (Fasasi, 2014); and
vi. lack of regard for the cultural beliefs of learners (Hiwatig, 2008).

Effort has been made by government, individuals, educational researchers and other stakeholders at improving students' achievement in science. In Nigeria and abroad, increasing overall students' achievement, especially lifting the performance of low achievers, is a central goal of education reform. One of the reasons government embarks on this perhaps is to encourage students' achievement in the sciences. Both federal and state governments run scholarship scheme to encourage science and technology studies. However, this effort, especially in Nigeria, has not been yielding the desired results.

For effective teaching and learning and improved learning outcomes to be achieved in Basic Science, a single strategy is inadequate (Agoro, 2012); however, recent studies revealed diverse strategies for Basic Science: Instructional Strategies (Bolorunduro, 2005); Jigsaw II Instructional strategy (Olaniyi, 2009) Multiple Intelligence Teaching Strategies

(Duru and Okeke, 2010) and Agoro (2012) suggested the use of other methods that could promote effective Basic Science delivery which is crossword-picture and Bolorunduro (2005) recommended puzzle-based teaching strategies. However, the rate of failure keeps increasing as shown in figure 1.1 below.

Table 1.1 Summary of Junior School Certificate Basic Science Examination Result for Oyo State

Year	Total Candidates	(A – C) Higher quality passes	% of Higher quality passes	(P) poor quality passes	% of poor quality passes	(F)outright failure	% of outright failure	(P – F) cumulative	% of poor and outright failure
2008	80,070	59,683	74,54	14,138	17,66	6,249	7.80	20,387	25.46
2009	85,034	47,087	55.37	29,935	35,20	8,012	9.43	37,947	44.63
2010	80,355	61,508	76.55	18,081	22,50	766	0.95	18,847	23.45
2011	75,437	44,479	59.26	15,640	20.73	9,603	12.73	25,243	40.74
2012	89,047	52,899	58.41	25,466	28.60	10,682	12.00	36,148	41.59
2013	78,733	49,132	59.86	20,723	26.32	10,878	13.82	31,601	40.14

Source: Oyo State Ministry of Education, Evaluation Department, 2014.

The Table 1.1 is shown Graphically as in figure 1.1

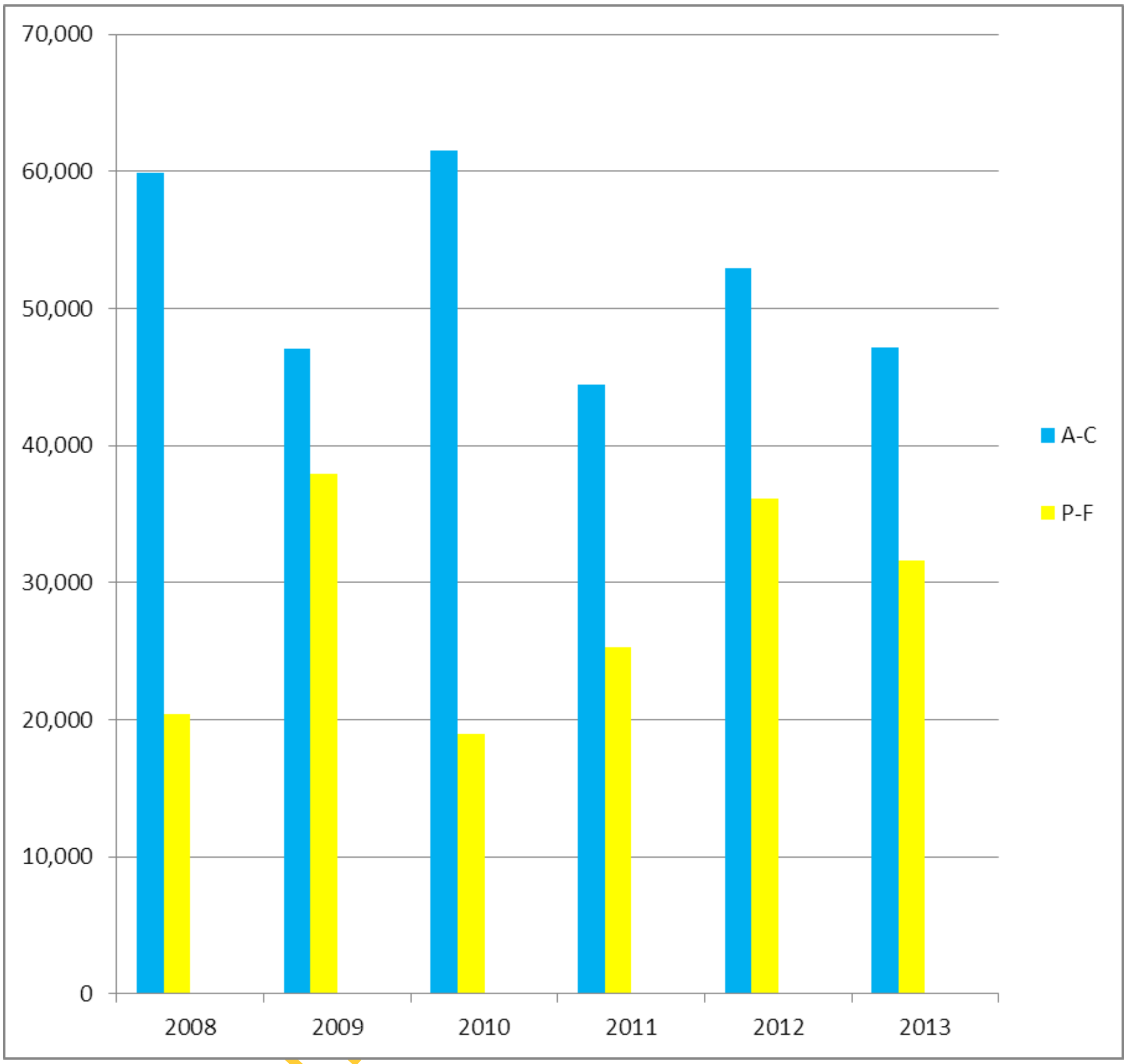


Fig.1. 1: Junior Secondary School Certificate Examination Basic Science Result Analysis for Oyo State from 2008 to 2013

The increase in the percentage of students that fail Basic Science has attracted educators' comments and concerns over the years (Adeyemi, 2006; Oshodi, 2006, Gbodi, 2007). Educators perceived that students' attitude towards a particular discipline may affect their motivation to excel (Osborne *et. al*. 2003). In order to facilitate learning, it is therefore important that teachers understand students' attitude as well as a factor that may influence their learning attitude. Attitude could be learned or formed and acquired from member of the family, teacher and peer group. The learner acquires from the teacher's disposition (attitude) towards teaching which could positively affect his performance. Teachers are role models to the students because as they act, so do the students demonstrate and perfect such act or behaviour. It is very unfortunate that many teachers fail to realize that the manner they handle the teaching of Basic Science as a subject and behave and interact with the students as Basic Science teachers could produce major effect on students' achievement (Gbore, 2013).

Teachers have the opportunity of structuring lessons cooperatively, competitively or individualistically and the decisions teachers make in structuring lessons can influence students' interactions with knowledge, attitudes and science process skills. Another variable influencing gradual failure rate in Basic Science is lack of students' science process skills, an aspect that must be given considerable attention. These skills include observing, measuring, classifying, communicating, predicting, inferring, deferring, questioning, controlling variables, hypothesizing, defining operationally, formulating models, designing experiments and interpreting data. This is necessary because, integrating the science process and skills into teaching requires the processes of science to be more explicit in lessons, investigations and activities already in use in the science curriculum (Wetzel, 2008).

In 2009, the Oyo State Universal Basic Education Board (SUBEB) undertook monitoring and assessment of all the teachers in the primary school in the State and reported that the primary school teachers were performing poorly in all school subjects and even worse in the sciences (OYO SUBEB News, 2009). The report showed that the primary school teachers were not doing well academically both in pedagogy and in science processes and skill of the subject matter the learners are to demonstrate as they carry out practical investigations in the process of solving a defined problem. Fifteen of these skills have been identified by American Association for the Advancement of Science (AAAS). These are observing, measuring, inferring, and classifying, communicating, predicting, using number, using space/time relationship, questioning, controlling variables, hypothesizing, defining operationally, formulating models, designing experiment and interpreting data. Due to the level of the students in JSS classes, only five of the process skills are investigated in this study. They are observation, recording, drawing, labeling and manipulating apparatus.

To correct this imbalance, there should be a reformation of teaching strategy at all levels of educational system. Indeed, the Basic Science teaching strategies in Junior Secondary Schools should be properly addressed. Students should exposed to various teachings strategies that could arouse and sustain as well as improve science process skills in students. Those skills will be regarded as very important for various reasons such as: motivation, concept learning, manipulative abilities, enquiry skills and the development of appropriate scientific attitudes. Gazi, Oloruntegbe and Orimogunje (2010) and Edomwonyi & Avaa (2011) reported that practical work improve students' attitude towards science knowledge which could influence positive achievement in science. Lack of process skill in Basic Science has resulted in poor communication and observation skills and the absence of these skills would give rise to failure rate in expected performance in Basic Science both in qualitative and quantitative analysis.

Another factor responsible for this poor performance in Basic Science is instructional strategy adopted by teachers. There seems to be consensus of opinions among science educators concerning the important role played by instructional strategy adopted as a classroom variable in affecting students' achievement and attitude towards Biology (Ige, 2001), including practices (Olagunju, 2002). In fact, these scholars are of the opinion that ineffective teaching strategies contribute to the poor performance in Biology and other related sciences.

Traditional teacher-centered methods are focused on rote learning and memorization of facts. Students need acquisition and understanding of scientific knowledge, and teachers are the instruments by which this knowledge is communicated and these standards of behaviour are enforced. In a conventional lecture setting, students would need to sit quietly in their places and listen to one student after another recite the lesson, until everyone has been called upon. The teacher's primary activity is assigning and listening to these recitations; students study and memorize the assignment at home. A test or oral examinations might be given at the end of the instructional process. This is called uncontrolled emphasis on verbal answers, reliance on rote memorization (memorization with no effect at understanding the meaning) and disconnected, unrelated assignment, and it is also an extremely inefficient use of students' and teachers' time.

Traditional education is associated with much stronger element of coercion than seems acceptable now in most cultures. It has sometimes included the use of corporal punishment in maintaining classrooms discipline or punishes errors; inculcating the dominant religion and languages; separating students according to gender, race, and social class, as well as teaching different subjects to girls and boys. In terms of curriculum, there was and still a high level of attention paid to time-honored academic knowledge. Students are less attentive, more likely to skip class and less engaged (Christopher 2013). More of the disadvantages of conventional lecture method can still be highlighted. Conventional lecture method:

1) Places students in passive rather than active roles, which hinder learning.
2) Encourages one–way communication; therefore, the teacher must make a conscious effort to become aware of students' problems and students understanding of content without verbal feedback.
3) Requires a considerable amount of unguided student time outside of the classroom to enable understanding and long-term retention of content.
4) Does not allow for different learning abilities or speed.
5) Is often perceived as "boring" by learners.

Active review strategy is the magic balm that can alleviate examination woes and stress. It offers students opportunity to gain through understanding of the materials. Very low research on the use of active review strategies in developing countries, particularly Nigeria, except in South Africa where it has been tested (Ndukka, 2005). Hence, Ndukka (2005) and Donkor (2006) have suggested its use in other African countries in teaching and learning of science. Active review sessions are intended to help students learn and prepare for upcoming examinations. Most sessions are passive 'question and answer sessions' that look backward at content deficits rather than advancing students learning. Jenson and Moore (2009) noted that students who attended one or more review classes earned higher grades than those that did not. This result was not surprising, but the authors were able to determine those in higher grades that need less attention.

Basic Science teachers and students' parents have expressed concern over students' poor achievement and lack of interest in learning of Basic Science. The deterioration in achievement and lack of interest may be partly due to defective teaching strategies in the teaching and learning of Basic Science and the fear of the course by many students (Cook, 2006). Effective teachers will select varied instructional strategies that could accomplish varied learning outcomes that are both behavioural and cognitive. Recent studies like Igwe, 2002; Raimi, 2002; Afuwape 2002; Ajila, 2003; and Oshodi, 2006 revealed diversified strategies for science. Hence, there is need to implement active review and practice-invention strategies complement students activity based recommended in Basic science curriculum for effective learning of Basic science.

In addition, Research evidence suggests that students need opportunities for ‘practice-invention’ to discover scientific ideas and invent scientific procedures, they have a stronger conceptual understanding of connections between scientific ideas (Boarler; 1998). If teachers want adaptness in problem solving, students must be given opportunities to practice process skills; if strong deductive reasoning is a goal, students’ work must include tasks that require such reasoning and if it is competence in procedures the curriculum must include attention to such procedures. Therefore, a balance must be maintained between the time students spend practicing routine procedures and the time they devote to inventing and discovering new ideas. To increase opportunities for invention, teachers should frequently use non-routine problems; periodically introduce a lesson involving a new skill by posing it as a problem to be solved (Backhouse *et. al*, 1999).

Practice and invention involves structuring instruction around carefully chosen problems, whereby learners develop their method and solutions to the problems. The findings from Okurumeh (2009) showed that, when students discover ideas and invent procedures, they have a stronger conceptual understanding of connections between the ideas.

Okurumeh (2009) used Practice and Invention Strategy with other retention enhancing strategies to teach the concepts of the sets statistics and probability to 346 SS2 students from Delta State, Nigeria. He reported that the treatment had a significant effect on students’ achievement in Mathematics. The result analysis showed that students in the Practice invention strategy group obtained the highest post-test mean score than student who used other strategies. Based on his analysis, he concluded that Practice-invention strategy is most effective in improving students’ achievement in Mathematics than the traditional instructional strategy.

The finding of Okurumeh (2009) study made the investigation of the effect of this strategy on ecology imperative in the sense that the strategy may also improve the performance of students in statistical concept in ecology, such as population studies, distribution of organisms etc. Abimbola (2013) has shown that when students have opportunities to develop their own solution methods, they are better able to apply mathematical knowledge in biological science.

Using Practice and Invention, Ogundiwin and Ahmed (2015) opined that students work must include tasks that require such reasoning, and the competence in procedures that is stated in the objective and the curriculum. It must also include attention to such procedure in which the Science teacher grasp the interest of science students when problem solving skills are developed by the students. The finding of Ogundiwin and Ahmed (2015) on Practice and Invention Strategy indicated that the strategy enhanced students' problem solving skills in ecology. The increase in the problem solving skills might be attributed to the fact that the instructional strategies encouraged student to-student interaction thus enhancing learning through group cooperation. In addition, the students' interest in the subject was enhanced, which led to a positive effect on their problem solving skills.

Teachers that want positive result must allow students to practice on their own. Many teachers today want to move from passive learning to active learning. Active learning is finding ways of engaging students actively in the learning process; and the learning activities can take place in and out of a classroom (Fink, 2007). This includes everything from listening practices, which help the students to absorb what they hear, to short note-writing exercises in which students react to lecture materials, to complex group exercises in which students apply course material to "real life" situation as well as to new problems. These activities will embrace three (3) main components thus: getting information's/ideas; making students get experiences through doing and/or observing others; reflective dialogue with self and/or others.

Parent educational background is a factor affecting the learning outcomes of students in Basic Science. Studies conducted by Mok and Flynn (2008) showed that parents' level of education made a significant contribution to the achievement of their students. This is corroborated by Adodo (2007) that parental educational background affects learners learning outcomes positively in terms of achievement in Basic Sciences, while Yaya (2010) reported that children from broken homes and unstable marriage relations perform poorly in schools.

Education breaks the barriers to intergenerational mobility so that students from economically deprived facilities can escape from poverty through greater educational achievement and attain a greater success in the labour market than attained by their parents, Steve, Guiseppe and Jim (2008) reported that, learners with high parental educational-background status exhibit higher levels of achievement than those with low parental educational background. Also, Jabor, Machtimes, Kungu, Buntat and Nordin (2011) and Akinfe, Olofinniyi, and Fashinku (2012) reported its significant effects on the academic performance of Senior Secondary School students, Gale (2013) also revealed that students whose parents have higher levels of education may have an enhanced regard for learning, more positive ability beliefs, a stronger work orientation and they may use more effective learning strategies than children of parents with lower levels of education. Therefore, Chen (2009) concluded that parental education is found as a key determinant to students' achievement.

However, the effect of gender on learning outcomes in science-related subjects is still a major issue of controversy among educators. This may be as a result of conflicting result obtained from such gender-related studies. For example, some researchers have shown that boys perform than their female counterparts in science subjects (Raimi, 2003). In his research, Olajengbesi (2006) reported a higher achievement of girls compared to boys in Physics and Chemistry respectively.

Literature also showed the assumption of female intellectual inferiority Dijkstra (2006), but Osokoya, (2006), produced scientific evidence that within the limits of experimental accuracy, gender did not significantly influence the level of science achievement. There is a significant shift in the gender gap and the reason for this however is clear. Girls' performance in science classes was consistently poor, while (Osokoya, 2006) found that in the Nigerian Primary and Secondary schools, girls were given less time for tasks than boys, which, no doubt, hindered the performances of the female or girl-child. Chamber (2009) concluded in his research that gender based education can affect standardized test score for both positive and negative outcomes. For Ayanda (2006), within the limits of experimental accuracy, gender did not significantly influence the level of science achievement, Aremu and John (2005), concluded that the search for the strategies that can bridge the gap in the achievement of males and females in science is an ongoing one.

This inconsistency led to the need to investigate the effect of an active review strategy and practice-invention strategies on students' attitude to, achievement in and process skills in Basic Science. The study also investigated the moderating effects of gender and Parent educational background on the three dependent measures.

1.2 Statement of the Problem

Basic Science is a compulsory subject offered at Junior Secondary Schools curriculum which has the potential of laying the foundation for subjects like Physics, Chemistry and Biology at the senior secondary school education. In spite of the importance of the subject, results from schools and public examination bodies reveal that student' record low achievement as a result of lack of skills in the subject. This has been attributed to the use of convectional lecture method which concentrates on talking about problems rather than solving problems. Scholars have thus, recommended a shift in focus from teacher centered teaching strategy to learner-centre teaching strategy such as Active Review and Practice-invention Strategies that could help students learn collaboratively, engage in thought–provoking activities and acquire problem solving skills. These two strategies have been proved in literature to be effective in teaching Mathematics, Geography and Fine-Art but not in Basic Science especially in Oyo State, even in South Africa were it has been used, the two strategies were not combined. Therefore, this study determined the effects of Active Review and Practice-invention Strategies on students' attitude to, Achievement and Process skills in Basic Science. The moderating effects of parent educational background and gender of students were also examined.

1.3 Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

HO_1: There is no significant main effect of treatment on students (a) Attitude to (b) Achievement in (c) Process Skills in Basic Science.

HO_2: There is no significant main effect of Parent's Educational Background on students' (a) Attitude to (b) Achievement in (c) Process Skills in Basic Science.

HO_3: There is no significant main effect of gender on students (a) Achievement in (b) Attitude to (c) Process Skills in Basic Science.

$H0_4$: There is no significant interaction effect of treatment and Parents' Educational Background on students' (a) Attitude to (b) Achievement in (c) Process Skills in Basic Science.

HO_5: There is no significant interaction effect of treatment and gender on secondary school students' (a) Attitude to (b) Achievement in (c) Process Skills in Basic Science.

HO_6: There is no significant interaction effect of Parents' Educational Background and gender on students'; (a) Attitude to (b) Achievement in (c) Process Skills in Basic Science.

HO_7: There is no significant interaction effect of treatment, Parent Educational Background and gender on students' (a) Attitude to (b) Achievement in (c) Process Skills in Basic Science.

1.4 Scope of the Study

The study covered nine Junior Secondary Schools in Oyo North Senatorial District (Iseyin, Itesiwaju and Kajola Local Governments) of Oyo State. An intact class was used in each school. The teachers of the selected classes (3 teachers per Local Government) were involved in the study. The study lasted for twelve weeks and three hundred and eighty seven (387) JSS2 students involved. The study focused on the effects of Active Review and Practice-invention Strategies on students' attitude to, Achievement and Process skills in Basic Science. The study was delimited to the effect of parent educational background and gender on JSS2 students' attitude to, achievement and process skills in Basic Science. The content for the study was from Basic Science topics. These topics are:

i. Living and Non-living things

ii. Work, Energy and Power

iii. Types of energy

iv. Crude Oil and Petro chemicals.

1.5 Significance of the Study

The findings of this study would supply the practical empirical basis of assessing the effects of Active Review and Practice-invention Strategies on students' attitude to, Achievement and Process skills in Basic Science at Junior Secondary School level in Nigeria. The result of this study would help students:

(a) Improve their psychomotor skills in the area of science which are needed to answer some higher ordered thinking questions in science examination.

(b) To be self-reliant after leaving school instead of roaming about the street.

(c) In enhancing their learning and in providing them with new sets of skills.

In addition, the findings of this study would provide Basic Science teachers with relevant information on appropriate skills needed as teacher to make Basic Science practical lessons more interesting and productive.

To the school administrator and counselor who are responsible for students' placement in school, this study would offer insight on why students' perquisite knowledge in Basic Science and their attitudes are factors affecting students' learning outcomes in Basic Science.

Furthermore, government at various levels especially those concerned with the business of science and technology education would find this work useful as it would provide information on the ways of giving its citizen quality Science Education.

1.6 Operational Definitions of Terms

Active Review Strategy: This is an instructional strategy in which the instructor poses questions, students work in groups and provide their solutions to the whole group for discussion. Disparity of ideas are then resolved among the group member with the help of the teacher.

Attitude: This refers to students' predisposition to Basic Science, which may be positive or negative and this would be measured using Student Basic Science Attitude Scale (SBSAS).

Basic Science Achievement: This refers to scores obtained in the Students' Basic Science Achievement Test (SBSAT) based on the selected aspects of the Junior Basic Science Curriculum.

Conventional Strategy: This is the common traditional method of teaching Basic Science to junior secondary school students where the teacher does all the talking and demonstration.

Practice-Invention Strategy: This is a strategy whereby learners learn independently to develop their own method and find practical solutions to problems arising among other groups.

Parental Educational Background (PEB): This is the level of literacy of learners' parents based on high (degree holder and above), medium, (HND, NCE and Diploma) and low (Illiterates Secondary schools and Primary schools)

Students' Basic Science Process Skill: This refers to scores obtained in the students' Basic Science process skills Rating Scale (SBSPS).

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The review of relevant Literature covers the following themes: theoretical framework, conceptual review and empirical review.

2.1 Theoretical Frame work

2.1.1 Constructivist Theory of Learning:

2.1.1.1 Constructivism

2.1.1.2 Cognitive Constructivism in Relation to the Practice-Invention Strategy

2.1.1.3 Social Constructivism Theory of Learning

2.1.2 Stimulus Model of Active Review Strategy

2.1.3 Skills Model of Practice-Invention Strategy

2.2 Conceptual Framework

2.2.1 The Nature of Integrated Science/Basic Science

2.2.2 Basic Science Curriculum

2.3 Empirical Review

2.3.1 Instructional Strategies and Students' Learning Outcomes

2.3.2 Active Review Strategies and Student Attitude

2.3.3 Active Review Strategy and Students' Achievement

2.3.4 Active Review Strategy and Science Process Skills

2.3.5 Practice-invention Strategy and Students' Attitude to Basic Science

2.3.6 Practice-invention Strategy and Students' Achievement in Basic Science

2.3.7 Practice-invention Strategy and Students' Science Process Skills in Basic Science

2.3.8 Convention Lecture Strategy and Students' Attitude to Basic Science

2.3.9 Convention Lecture Method and Students' achievement in Basic Science

2.3.10 Convention Lecture Strategy and Students' Science Process Skills in Basic Science

2.3.11 Parental Educational Background and Students' Leaning Outcomes

2.3.12 Gender and Students Learning Outcomes in Basic Science

2.4 Appraisal of Reviewed Literature

2.1 Theoretical Framework

The theoretical framework of this study is built on constructivism and cognitive theories of teaching and learning.

2.1.1 Constructivist Theory of Learning

2.1.1.1 Constructivism

The root of Constructivism as a Learning theory, can be found in the works of Piaget (1954), and Glasersfeld (1989) traced to many decades back, while the actual application of the theory is relatively new (Richardson, 2003). Active review learning strategies obtain their roots from Constructivism. Research shows that good pedagogical practices are more likely to result when including a constructivist approach is included, compared to a mere inclusion of one traditional approach to education (Azzarito & Ennis, 2003; DiEnno, Hilton & Fall, 2005; Muller, Sharma & Reimann, 2006). Three dimensions of constructivism have been identified from the works of several educationists of constructivist persuasion. The most revolutionary of the three are:

i. Radical constructivism which holds that while knowledge is constructed from experience, that which is constructed is not, in any way, an accurate representation of the external world of realities (Glasserfeld, 1989), and other two main schools of thought. Constructivist Learning Theory is social constructivism.

ii. Psychological (cognitive) constructivism (Richardson, 2003). Cognitive constructivists believe that learners construct knowledge individually; that learning is acquired when a learner evaluates new information based on prior experience and that knowledge is the result of "accurate internalization and reconstruction of external reality" (Wang, 2008).

iii. Social constructivists, on the other hand, believe that knowledge is the outcome of collaborative construction in a socio-economic context mediated by discourse; and that learning is fostered through interactive processes of information sharing, negotiation, and discussion (Richardson, 2003; Wang, 2008).

Constructivism is basically a theory - based on observation and scientific study about how people learn. Their idea is that people construct their own understanding and knowledge of the world by experiencing things and reflecting on those experiences. When humans encounter something new, they have to reconcile it with their previous ideas and experience, may be changing what humans believe, or may be discarding the new information as irrelevant. In any case, we are active creators of knowledge. To do this, they must ask questions, explore, and assess what we know in the classroom because the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure he or she understands students' (pre-existing conceptions), and guides the activity to address them and then build on them.

The theory is based on two assumptions:

(1) that learning is by nature, an active endeavour and

(2) that different people learn in different ways (Meyers and Jones 1993).

Constructivist-teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners." This gives them ever-broadening tools to keep learning. With a well-planned classroom environment, the students learn HOW-TO-LEARN. Constructivism transforms the students from passive recipients of information to active participants in the learning process. Students construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook because the teacher is only a guide.

Constructivism is also often misconstrued as a learning theory that compels students to "reinvent the wheel." In fact, constructivism taps into and triggers the students' innate curiosity about the world and how things work. Students do not reinvent the wheel, rather, they attempt to understand how it and turns how it functions. They become engaged by applying their existing knowledge and real-world experience; this involves learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings.

2.1.1.2 Cognitive Constructivism in Relation to the Practice-invention Strategy

Cognitive Constructivism is applicable to the Practice-invention strategy. Cognitive Constructivism is the concept that learners actively construct their own knowledge and meaning from their experiences. Knowledge is deemed fluid and in a constant state of change, therefore, students' ability to construct viable knowledge and to adapt and be flexible is highly paramount. The implication of cognitive constructivism, according to Kato and Kammi (2001), is that the child becomes very autonomous and docile, refusing to be governed by reward and punishment. The Practice-Invention Strategy has its roots from this theory because teachers periodically introduce a lesson involving a new skill by posing it as a problem to be solved. They also maintain the time students spend practicing routine and time devoted to inventing and discovering new ideas.

Confucius' pedagogical methods also supported this view in which teacher poses questions, cites passages from the classics or uses apt analogies, and waits for his students to come to their own understanding. The origins of Practice-invention Strategy can be traced to the early philosophies of Plato and Aristotle. Plato believed that people learn about the world in two different ways. They get useful information through their senses, like sight and touch, but we reach the truth by using a higher thinking ability, which he called reason. Plato said that people's senses give them imperfect knowledge, because they tell people about specific objects, but reason gives truth, or perfect knowledge, because it is people about ideas. Both Plato and Aristotle believed that as humans develop, there are qualitative changes in their ability to think logically about experiences. At the heart of constructivist philosophy is the belief that knowledge is not given but gained through real experiences that have purpose and meaning to the learner, and the exchange of perspectives about the experience with others.

By engaging students in Practice-invention Strategy and variety of questioning that relates to the idea or content being studied, students develop and apply critical thinking skills. It has also been discovered that children's sense of reality is based on their interactions with the environment and material in it (Piaget, 1954). That is the usefulness of Practice-invention Strategy in which materials and objects from the children's environment enable them to recognize, verify and store experiences tour-discover new concepts, and manipulate apparatus through appropriate heuristic approach, based on necessary environment and teaching materials provided by the teachers.

Piaget stressed the importance of acquisition and recall of basic Cognitive Constructivism: (Jean Piaget was a Swiss Psychologist, who began to study human development in the 1920's, he is most famous in cognitive constructivism). He proposed a development theory that has widely been discussed in both psychology and education fields. Learning, to Piaget, should be holistic in approach. A child constructs understanding through many channels such as reading, listening, exploring (as in the case of practice-invention where students re-discover new concepts), and manipulating apparatus through appropriate heuristic approach by providing necessary environment and teaching materials by teachers and experiencing his environment.

Practice-invention Strategy is based on constructivism perspective that sees learning as a construction. Piaget was the first to evolve a constructivist theory of cognitive functioning development from around 1920. The main argument of his theory arose from the weaknesses in the traditional answers put into stages: The first stage being that, human knowledge is innate, and the second, human knowledge is directly shaped by experience (Gestalt, 1993). According to Piaget, "human beings are capable of extending biological programming to construct cognitive systems that, interpret experiences with objects and other persons".

Thus, the choice of constructivist theory in this study is based on the assumption that students learn independently with practice-invention to rediscover new ideas within themselves, while a research assistant serves as a guardian.

2.1.1.2 Social Constructivism Theory of Learning

Social constructivists, on the other hand, believe that knowledge is the outcome of collaborative construction in a socio-economic context mediated by discourse; and that learning is fostered through interactive processes of information sharing, negotiation, and discussion (Richardson, 2003; Wang, 2008).

Active review strategy is based on social constructivism in that the teacher groups and presents the lesson in different forms on the same topic by explaining and illustrating the concepts being taught to arouse feedback from the students. The same time is being allocated for each review while students experiment the new concepts or skills on their own in the classroom. In Vygotsky's (1978) view, "learning leads to development through the gradual internalization of intellectual process that, are activated through social interaction". Vygostky's (1978) theory views human developments as Socio-genetic process by which children gain mastery over cultural tools and signs in the course of interacting with others in their environments. Even though Vygotsky (1978) stressed the individuals' active role in development, his research shows that the child can always do more in collaboration than he can do independently. However, for this study researcher adopted two model for Active review strategy and practice invention strategy:

1. Stimulus of Active review strategy
2. Skills Model of Practice-invention Strategy

2.1.1.3.1 Stimulus Model of Active Review Strategy

The stimulus model of Active Review strategy is relevant in that it provides learners with lot of questions to arouse student's interest under the guidance and instruction of teacher or child peer.

Seven steps could be used to connect this theory with the work:

STEP 1. Introduction (asking students' questions)

STEP 2. Response (by students)

STEP 3. Grouping (group of ten each)

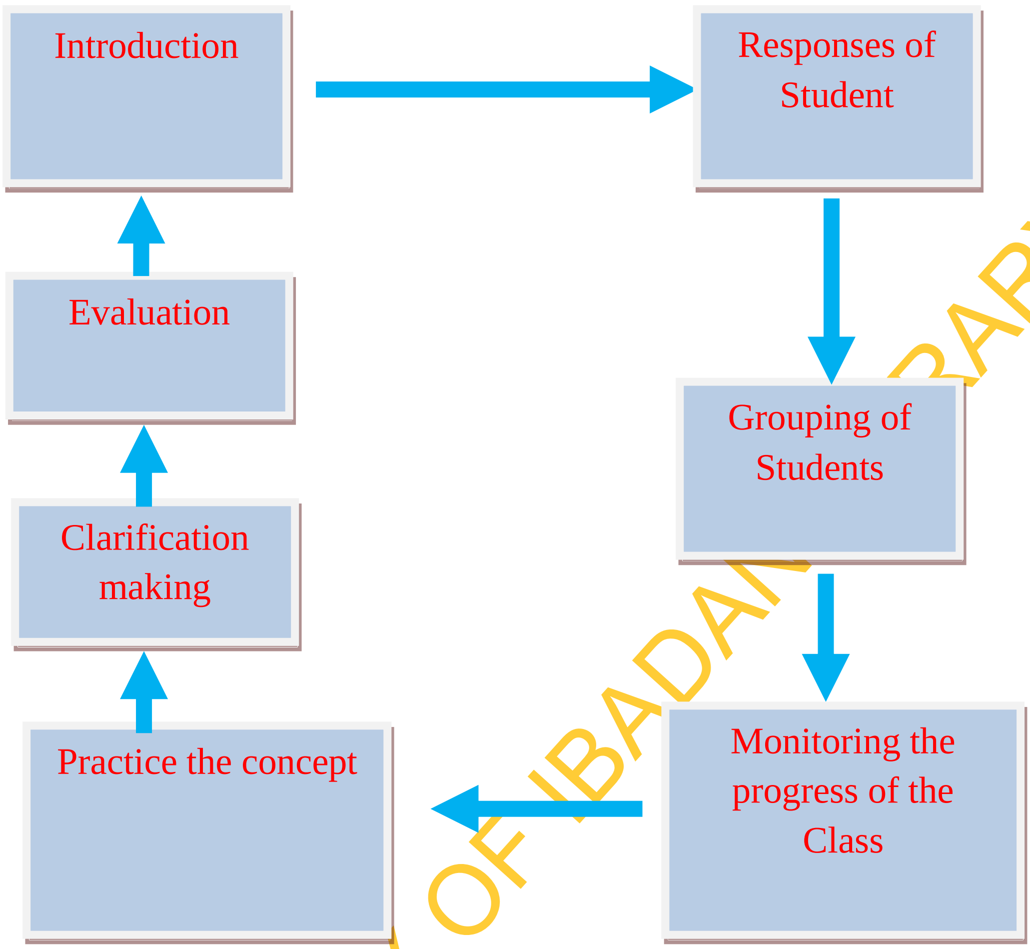
STEP 4. Monitoring (research assistant monitor the progress and provide support).

STEP 5. Practice (practicing new content pointed out by the students).

STEP 6. Clarification (to each group by research assistant).

STEP 7. Evaluation (feedback)

Figure 2.1: Stimulus Model of Active Review Strategy



Source: Adegoke 2015.

2.1.1.3.2 Skills Model of Practice-Invention Strategy

The skills model of practice-invention strategy is also relevant in that it provided learners with a lot of opportunities to explore for themselves under the guidance and instruction of teacher using different methods of instruction. Seven steps could be used to connect this model with work:

STEP 1. Task (students embarked on task).

STEP 2. Practice (opportunity to practice)

STEP 3. Introduction (the lesson)

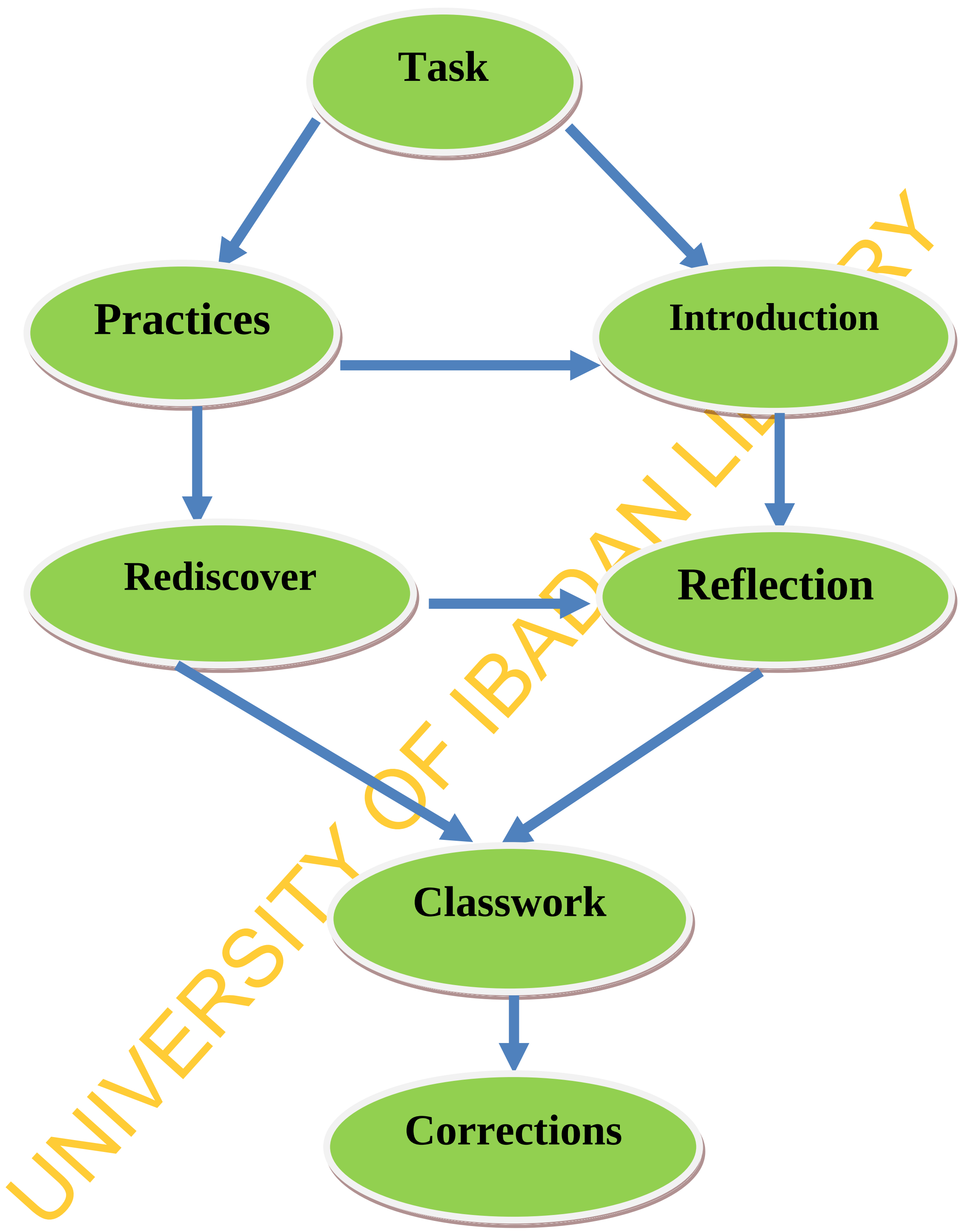
STEP 4. Re-discover (new concepts)

STEP 5. Reflection (students check back)

STEP 6. Classwork (assigned interesting topics)

STEP 7. Correction (do necessary corrections)

Figure 2.2: Skills Model of Practice-Invention Strategy



Source: Adegoke 2015

2.2 Conceptual Framework

Urgent attention of teachers and educators is constantly drawn to the need for quality education in 21st century. This, in realization of the fact that, quality education is the bed rock of sustainable development in any nation (Duru and Chinwe, 2010). To this effect, educators and researchers are highly challenged to discover more authentic pedagogical methods that will enhance teaching and learning. There is therefore a serious search for pedagogical methods that will adequately develop students' potentials and assess and report their achievements more appropriately

Modern science was established in the Nigerian school curriculum in the late 1940s. Long before this period, traditional objects and processes were based on scientific knowledge and principles. Around 1843, nature studies took the place of science in primary schools in the country where each class had a nature corner. Around 1920, science teaching was given a boost and prospect of helps by the Stoke Commission's tour of the British West primary schools.

As the nation was close to independence around late 1950s, the place of science education became glaring as Nigeria would be called upon to man her technological development. By the 1960s, there was a wide review of the philosophy of science teaching in schools. Primary science was identified as the foundation of Science and Technology super–structure. In later years, what looked like science was taught in the form of general science or elementary science in programmed (APSP) as was launched in Kano. This plunged the state governments and interest groups into developing primary school curriculum. By 1978, the primary school science curriculum programmes were developed for both primary and secondary schools. Also, the Primary Reference Committee of the Joint Consultative Committee (JCC) set up a panel to produce a "core – curriculum" for science education. The panel, with the Science Teacher Association of Nigeria (STAN), came up with the Nigerian Integrated Science Teacher Project which was published around 1982. In recent years, due to educational reform efforts, Nigeria had a metamorphosis of the science curriculum as the Universal Basic Education Commission (UBEC) changed Integrated Science into Universal Basic (NERDC, 2007). This implies that the Integrated Science offered in Primary and Post–Primary schools metamorphosed to Basic Science.

2.2.1 The Nature of Integrated Science / Basic Science

The preliminary efforts towards the formation of Integrated Science began with Committees working on the separate disciplines of Physics, Chemistry and Biology. This was followed by joint working sessions of representatives from the committees to make an attempt at integrating the disciplines. The result is contained in the STAN'S Newsletter No: 1 on an Integrated Science Course, which consists guidelines for affecting such a course for the junior forms of the secondary school (noted by the Association then). The concept of integration is concerned with natural enquiry of the children. Hence, integrated science is a unifying curriculum that provides the whole science as one.

Mohammed *et. al.* (2008) defined Integrated Science as a course of study which is devised and presented in such a way that students gain the concept of the fundamental unity of science and the commonality of approach to problems of scientific nature. It is also a design to gain an understanding of the roles and functions of science in everyday life the science is based on the assumption (if not fact) that attempts to provide knowledge for the understanding of this unity (Okafor 2007). As expected, Integrated Science combines subjects common to all the science and the processes of science and its skills. It treated the great themes of science such as Energy, Force and Particles theories, Conservation, Balance and Cycles in Nature and more importantly brings out in clear terms, the relevance of science to everyday life (Mohammed *et. al.* 2008).

In science, it is hand-on and mind-on-activities which involve active participation of the learners in the learning process. In this approach, the learners are involved throughout the learning process and the responsibility for learning shifts from the teacher to the learner. One of the major philosophy of Integrated Science is that the pupils at the basic level of education are not matured enough to appreciate the boundaries among the science disciplines of Biology, Chemistry and Physics. Then, its belief can only appear as artificial, man-made idea which seriously interferes with the unified view of nature as a whole and which the children bring to the classroom with them. Learning at this level should be by direct experience because by so doing, the pupils will be motivated to acquire both academic and practical skills (Nneji, 2006). This is quite in agreement with the popular saying that:

Hear and Forget,

See and Remember

Do and Understand.

It also agrees with the fact that science is a way of discovery through experimentation. Accordingly, activities should form the basis of teaching Integrated Science. As observed by Ivowi (2006), a skill is said to be developed / acquired if it can be demonstrated correctly at least in every two out of three occasions that demand it, at least for the basic education.

It makes a shift from the teacher-centered method of teaching science to child-centered activity based method which encourages and develops in the child the spirit of inquiry; an attempt to make students fully aware as well as understand the ways scientists work; it is also a way of equipping and preparing students for their possible carriers in Science and Technology which led to the development of process skills (Akinbobola, 2006). It is worthy of note that for science teaching to be meaningful and relevant, it must adequately reflect the nature of science. That is, it must not only be process-oriented, but it should also promote affective reaction to science and stress the attitudes such as honesty, open and critical mindedness, curiosity suspended judgment and humility which characterize scientist and the scientific enterprise (Akinbobola, 2008).

2.2.2 Basic Science Curriculum

The foundation level which is the basic line of the 9-3-4 system of education has 3 years lower basic education (primaries 1-3), 3 years middle basic education (primaries 4-6), and the upper basic education which is generally called Junior Secondary School (JSS). The curriculum of this basic education reflects depth, appropriateness and interrelatedness of the curriculum contents. Also, emerging issues which covered value orientation; peace and dialogue, including human rights to education, family life/HIV and AIDS education and entrepreneurial skills acquisition education, were all infused into the relevant contents. Some introductory technology topics were introduced at the lower and middle levels, while the upper basic was purely science topics. The overall objectives of this curriculum are to enable the learners to do the following:

- Develop interest in science and technology:
- Acquire basic knowledge and skills in science and technology;

- Apply their scientific and technological knowledge and skills to meet societal needs;
- Take advantage of the numerous career opportunities offered by science and technology;
- Become prepared for further studies in science and technology. (FME, 2007).

In selecting this curriculum contents, three major issues that shaped the development of nations' worldwide and influence the world of knowledge today were identified. These include: globalization and education (Primary 1) and Upper Basic 1 or JSS 1, Upper Basic II or JSS II and Upper Basic III or JSS III, which now becomes the minimum level of education for every Nigerian child.

Its implementation was to start in 2008. However, by 2010 most schools are yet to start the implementation of the curriculum. The new curriculum is almost the same with the old integrated, science curriculum, except for the following new themes that were infused into it:

1. Environmental education.
2. Drug abuse education.
3. Population and family life education.
4. Sexually transmitted infection (STI) including HIV/AIDS (FGN, 2006).

Integrated Science has six themes while Basic Science has four (Duguryil, 2012). You and the environment in the basic science take the place of you, as a living thing, and controlling the environment in integrated science. Living and non-living things in basic science takes the place of living components of the environment and non-living components of the environment while you and energy takes the place of saving your energy. You, technology/science and development in basic science take the place of controlling your environment in integrated science. With the exception of the newly infused topics, the basic science curriculum content is the same with that of integrated science.

On completion of this education, the child is expected to have acquired enough skills and interest that should make him or her self-reliant if fails to continue with formal education and enter any vocational or trade-centre school. In the Basic Science curriculum, teachers are encouraged to enrich the content with relevant materials and information from their immediate environment, by adapting the curriculum to their needs and aspiration. Also, guided inquiry method of teaching was advocated at this level. This is to promote learning by doing and skill acquisition for further use as well as for the achievement of self-reliance by the students on leaving school at this level. Self-reliance involves optimal utilization of local resources with well coordination of sustainable development (Etinubon & Udofia 2009).

2.3 Empirical Review

2. 3.1 Instructional Strategies and Students' Learning Outcomes

The traditional approach to science teaching which is dominated by total reliance on the textbook, expository and authoritative presentation of facts is no longer appropriate. It is even contrary to the nature of science as portrayed by the philosophy of science. Science is a dynamic and changing enterprise. Hence, our teachers need to understand this and orientate the students' right from junior secondary school level where Basic Science is being taught.

Students' Learning Outcomes have been defined as the knowledge, skills, and abilities that students have attained as a result of their involvement in a particular set of educational experiences (Yuba Community College District, 2005). The learning outcomes' approach reflects a conceptual shift towards making learning more meaningful and effective. For many reasons, many students approach education as an "alienated intellectual labour", rather than something that is good for them; a learning that improves their lives. To make education more meaningful to these students they will need to see the educational project as one that leads to a richer, better and more empowered life, rather than a task done primarily to satisfy the demands of others, (such as teachers, lecturers or an educational institution). Educational experiences should be based on what students are able to do with their knowledge, skills and ability, Ogundiwin and Ahamed (2015).

According to YCCD (2005), there are several benefits of using students learning outcomes. Among these are the following:

1. Increased students' awareness of and involvement in their own learning;
2. A common language and framework for discussions about learning with departments or faculties;
3. A context for course design and revision;
4. An approach to curriculum assessment and change;
5. An important first step towards clear communication of expectations to students; and

6. A requirement of accrediting agencies;

Learning outcomes should be measureable and should develop students' critical thinking and intellectual independence. Examples of institutional student learning outcomes are:

a. **Critical thinking**: This is the ability to analyze problems, conceptualize theses, develop arguments, weigh evidence, and derive conclusions. These outcomes include inductive and deductive logical reasoning and methodological processes.

b. **Communication**: This is the ability to articulate the critical thinking outcomes in writing, and/or speaking or by other modes of communication.

c. **Self-awareness and interpersonal skills**: This refers to analyzing one's actions, seeing the perspective of other persons, and working effectively with others in groups.

d. **Personal actions and civil responsibility**: This refers to understanding one's role in society, taking responsibility for one's action, making ethical decisions in complex situations, and participating actively in a democracy or discussion.

e. **Global awareness**: Ability to articulate similarities and contrasts among cultures, times and environments; capacity to demonstrate understanding of cultural pluralism and knowledge of global awareness.

f. **Technological awareness**: This is the ability to understand the applications and implications of technology and use technology in ways appropriate to the situation. This outcome includes information and competing skills.

2.3.2 Active Review Strategy and Students' Attitude.

Attitude as a factor could be viewed as the totality of an individual's inclination towards object, institution or idea. Attitude could be learned, formed,or acquired from members of the family, teacher and peer group. The learner acquires from the teacher, a deposition to form attitude towards learning which could positively or negatively affect his (the learners) performance. Teachers are role models to students because as they act, so do the students demonstrate and perfect such act or behaviour. It is unfortunate that little did many teachers realize that the manner they handled the teaching of Basic Science as a subject, behave and interact with the students as Basic Science teachers could produce major effect on students' achievement. For instance, when teachers frequently absent from classroom, such negative attitude can cause the students to lose interest in science at that basic level.

The delivery of the subject matter handled by such teacher will be done by an array of substitute teachers who may not be specialists in Basic Science. According to Finlayson (2009), the resultant effect of such teachers absenting from school is negative correlation between students' performance and high teacher absenteeism. Some teachers seem to have developed negative attitude towards the teaching of this subject (Biology) that is very vital to human living. This may have been responsible for the negative attitude developed towards the learning of Biology by the students.

Other factors, according to Adodo (2005), identified to be related to students' attitude in science includes teachers' teaching method, teachers' attitude, age of students cognitive styles , interest of students and social implication of science among others. Ali and Aigbomian (2009) have argued that the extent a student prefers a subject, to that extent the student works hard to achieve in it. A close examination of the submission of Ali and Aigbomian (1990) and Adodo (2005) revealed that academic achievement may be dependent upon positive attitude from the teachers and the students in the teaching/learning processes.

Considering the attitude of Nigerian students to science, it could be observed that very few students have love for studying the subject. Those who study it are mostly those who want to use it as "job ticket", as integrated science is made up of these various science subjects which many students regard as "hard" subject, having been mis-informed by senior students who are not interested in the science subjects. Students also develop a negative attitude towards certain aspects of Integrated Science: those topics that Adodo and Aigbomian (2012) highlighted. Many research studies have confirmed that students develop negative attitude to science learning. This may after all be due to the fact that teachers are unable to satisfy the students' aspiration or goal. Sometimes, some teachers who teach in sciences have no bearing on students' practical life or their goals, and sometimes do not provide the career incentives and opportunities for them to appreciate the roles of the scientists. This has led to variations in goals between learners, teachers, parents and industries.

The danger inherent in this trend is that we might have been succeeding in producing science students and graduates without those attributes and skills we claim science could impart. Science education can provide such attitudes as honesty, patience, respect for evidence, etc. Today, it is quite evident that many science teachers are not capable of making their students appreciate these values of life as many of the students are always in a "hurry", which is very clear from their actions. It is high time teachers started to assess students' aspiration and the extent to which the science they teach could help the students to attain their goals and ambitions in life. The situation whereby science students acquire data without the ability to apply such data to solve personal domestic problems required the urgent attention of the science teachers.

The research of independent science educators (Goodlad, 1984), showed that the most common method of teaching is from a textbook. This suggested that the solution to attitude change lies in the hands of the teachers. They believed that teachers should start introducing other teaching methods, as this change will not only bring about a more positive attitude towards science for their students, but will also give their students the scientific skills required to perform experiments and use logic to solve problems.

2.3.3. Active Review Strategy and Students' Achievement

A well-designed review strategy helps students to organize the materials to be studied. Studies show that perhaps, emphasis should be on total study time but not on the way students study (Gurung, 2005). Much stronger relationship has been found between test scores and time spent organizing the course content than with total study time (Dickson and O'Connell, 2005). One way to reach more students in a review strategy would be to present the material in a different form than it was presented in class. If PowerPoint was the main form of presentation for example, then you should distribute or use overhead transparencies or handout or other graphic representation. Conversely, if transparencies of Charts and Graphs were used, then a PowerPoint presentation could be used to restructure the material and allow students to visualize the materials in another way.

Students could be encouraged to create their own concepts, maps, or outlines that will group and organize the materials in their minds cooperatively to show active learning. If the behaviour is modeled for them, students can leave class and try it while studying. Support for this suggestion comes from an experiment comparing examination performance between two groups of students who had attended different types of review strategy. One group was provided with basic questions and answers, on review strategy, the other in addition to time allotted for questions reviewed examination content in an outlined form. All the major concepts were discussed and then time was allowed for questions; results showed that the students who attended the second type of review strategy out-performed those in the former.

Traditional review strategy often uses a reiterative question and answer approach which lead to content deficits in student learning. Rarely does this approach lead to deep learning or prepare students for an exam. To put learning at the forefront of the review process and to reach those students most at risk, we redesigned the review strategy. First, we changed was the timing of the review and incorporated it within the regular class schedule. If struggling students needed my help the most, then why arrange for an extra session they are unlikely to attend? By labelling the session as “review” or “test preparation” on the syllabus, we guaranteed near-perfect attendance.

Second, we changed the focus from “content” to “problems.” In his recent address and article, that, the explosion of physiology knowledge has made it impossible for faculty members to teach and undergraduates to learn in a single course (DiCarlo, 2009). He argued that, “to attempt” to cover the content “would limit students to simply learning facts without the ability to apply their knowledge to solve novel problems.” Disciplinary content functions to provide knowledge based which is used to develop problem-solving skills. It is not something to be covered. Because of the vast amount of information in textbooks and other electronic media, most students today have a difficult time discerning the essential content of the discipline and how it might be used to solve problems.

With such an intensive content focus, an attribute often recognized as “rigor,” students may spend 80–90% of their time reading, listening, and organizing content with little time devoted to thinking through applications of content to solve problems. Covering content without providing an opportunity to use, link, or apply it, is of little educational value for current and future physiologists. We have used two similar but different strategies that incorporate both active learning (Carvalho, 2009) and peer Cortright, (2005); approaches to facilitate students’ learning. These strategies have turned my poorly attended and often less helpful content-driven review strategy into learning opportunities for both the faculty members and students.

With this approach, we came to class with overhead transparencies and a set of markers. We began the session by asking each students to write the five most important facts, theories, or concepts from the current section of the course. After a few minutes, we have students pair up with three other students and compare their answers. We then took a quick tally by listing topics on the overhead and noting the frequency in which they were cited by students. We then added concepts that students might have omitted.

Finally, we rearranged the topics for students in order of importance, and we discussed why these are critical topics to focus on for the upcoming exam. This exercise helped me to understand their current state of their thinking. What do they think is important? When discrepancies exist between my list and theirs, we will often ask students, time permitting, why they selected the topics they did. Regardless of the reason, this activity provides me the opportunity to refocus their efforts on the most essential topics and concepts. However, we do not stop there. Their questions are rarely well devised, but the purpose is for them to take critical content areas and think about how the content might be used in an examination question. Each group then brings their questions to the overhead, and we collectively answer them. Students regularly question each other on confusing language or selection of the answer, again revealing what students know (or don't) and how they know it.

In higher education, active learning has been used in a variety of education programs such as web-based learning (Lohr & Ku, 2003), online learning environments (Johnson & Aragon, 2002), and engineering (Anthony, 1996; Vos & Graaff de, 2004). Duron, Limbach, & Wauth (2006) asserted that faculty should provide multiple opportunities for students to engage in the analysis, synthesis, and evaluation levels of Bloom's taxonomy since active learning in these levels helps students think critically.

The Group Peer Review Strategy was based on the best practice of teaching and learning. Students participated in a group peer review activity. Topics were based on issues that were of concern to nursing and had been addressed by nurse researchers. Goals were clearly stated and evaluation tools were shared with students, who then evaluated their classmates' work. Formative feedback was given during the collaborative process so that students could incorporate the changes into their final papers. This allowed students to grow in their understanding of the critique process without being penalized. Faculty then provided summative feedback at the conclusion of the process. At the end of the peer activity, students were provided with an opportunity to evaluate their satisfaction with the process and assess individual accountability.

The instructors and students in this course felt that peer review was a valuable learning technique. These findings support those of peer review in an educational research course. Factors that were detrimental to process were the preparation time needed for the groups to read the articles and critiques and the extensive time needed to evaluate five critiques in class. Faculty identified another factor: some students had not prepared for the peer review activity by reading the critique drafts and articles that were posed on WebCT. Similar issues have not been in article discussions regarding active learning strategies.

Overall, the peer review process was an effective method for encouraging active learning and, through its focus on evaluation; it leads to higher levels of thinking on Bloom's taxonomy in the students. They were able to effectively evaluate a peer's critique using the grading rubric. Sometimes, students had difficulty identifying whether a peer had met a given criterion or not. This information provided the instructors with knowledge about what to emphasize the next time the course was taught. Since the procedure was done in groups, students learned from each other and developed insights into what they needed to improve upon in their own papers. The instructors frequently overheard students making comments that they now had a better understanding of what was required when conducting a critique after evaluating a classmate's paper. Students in the study also indicated a better understanding of how to write a research paper after participating in the peer evaluation process.

Before beginning the critique process, students had to review five articles of varying length and complexity ahead of time in order to assess another group's work. Many students had not prepared by reading the articles and critiques and were not prepared to discuss the other group's work. Because of this dilemma, the faculty recommended that research articles be selected by the instructor and that groups be assigned fewer critiques to review. All the students gave each other high ratings, despite the fact that not all students were prepared. This may be related to the students being unsure of their role as an evaluator and the fact the evaluations were not anonymous. Some evaluator uncertainty was noted as evidence by students asking whether they could write comments on the research papers and with cautious regarding making comments.

2.3.4 Active Review Strategy and Science Process Skills

The Science Process Skills are the foundation of problem-solving in science and the scientific method. They are the skills that facilitate learning in physical sciences, ensure active students' participation, have students develop the sense of undertaking responsibility in their own learning, increase the permanence of learning, and also have students acquire research ways and methods that, is, they ensure thinking and behaving like a scientist. They are inseparable in practice from the conceptual understanding that is involved in learning and applying science. While the process skills are viewed as central to elementary school science education and important enough to be taught in their own right, they are often combined with science content, enabling children to learn both science process and content at the same time-in a seamless learning experience (Bamidele, 2014).

For instance, children may practice the skill of observation while identifying the properties of rock. Learning science goes beyond scientific knowledge acquisition since it includes the acquisition of cognitive skills such as the science process skills. They are an important method in teaching science lessons and also the building-blocks of critical thinking and inquiry in science. Learning science lessons by apprehending requires using science process skills (Babayemi, 2014).

Having science process skills acquired at the same time means preparing future scientists; having scientific literacy acquired, that is, enabling students to use science information in daily life (personal, social and global). Science process skills are based on scientific inquiry and teaching science by inquiry involves teaching students' science process skills as well as critical thinking and scientific reasoning skills used by scientists. They are acquired through training and direct experiences (Njoku, 2002). They are intellectual skills with learned capabilities which scientists used as self-management procedure in carrying out their scientific activities. Njoku (2002) explained that these science process skills are cognitive and psychomotor skills which scientists use in problem identification, objective inquiring, data collection and analysis. These skills are retained after the cognitive knowledge of science has been forgotten.

The Science Process Skills, according to Wetzel (2010), are the methods used by students to conduct investigations and understand how we know about the world in which we go beyond the textbook and supplement the core-content within textbooks with hands-on, mind-on activities. It also means using your course content as a means for exposing students to the real process skills which are separated into two categories; Basic and Integrated (Weatzel, 2008). The five basic science process skills which are of interest to this study are as follow:-

Observing – Using the five senses to find out information about objects: an objects' characteristics, properties, similarities and other identification features.

Recording – The process or art of writing down and storing information for official purpose or for awarding marks to an object.

Drawing – The art or skills of making pictures, plans e.t.c. using a pen or pencil.

Manipulating Apparatus - This is handling or treating materials and equipment skillfully, effectively and safely. This skill is manifested in arranging equipment and materials needed to conduct an investigations; handling chemicals in a safe manner; understanding sterile techniques etc.

Labeling – The act of using line to indicate name or identify objects or parts of a diagram. The skills help to ensure that students make the connection between science processes involved within an investigation and science content (Karen, 2009).

2.3.5 Practice-invention Strategy and Students Attitude to Basic Science

Attitude toward science is closely related to achievement in science (George, 2000), and attitude toward science predicts achievement in science (Kan and Akbas, 2006). Positive attitude / favourable attitude may lead to significant / higher achievement in science. The attitude of the teachers, to a large extent, affects achievement and attitude of students in science (Adetunji, 2000; Abram, 2004). Dorothy and Louisa (2003) studied the use of research by teachers. They studied information, literacy, access and attitudes of teachers to research. The study found that, attitudes tended to vary significantly in relation to research experience and the subject taught. Teachers that were undertaking research-based study tended to be more positive about research (80.6% positive). Those who had undertaken action research at some time also tended to be more positive (66.4% positive). Attitude towards research varied in relation to specific subjects taught. Those teaching Mathematics tended to be more negative about research and those teaching science and technology were less positive about research (29.1% positive).

2.3.6 Practice- invention Strategy and Students Achievement in Basic Science

Research evidence suggests that students need opportunities for both practices to invent. The findings from a number of research studies show that, when students discover mathematical ideas and invent mathematical procedures, they have a stronger conceptual understanding of connections between mathematical ideas. Boarler, (1998). Therefore, a balance must be maintained between the times students spend practicing routine procedures and the time they devote to inventing and discovering new ideas. To increase opportunities for invention, teachers should frequently use non-routine problems; periodically introduce a lesson involving new skill by posing it as problem to be solved (Backhouse, *et. al*, 1999).

In addition, structuring around carefully chosen problems, allowing students to interact when solving problems, and providing opportunities for them to share their solution methods result in increased achievement on problem solving measures (Grouws & Cebulla, 2000). Research has shown also that when students have opportunities to develop their own solution methods, they are better able to apply mathematical knowledge in science area.

Research evidence suggests that, students need opportunities for both Practices-inventions. To increase opportunities for invention, teachers should frequently use non-routine problems periodically, introduce a lesson involving a new skill by posing it as a problem to be solved. (Backhouse, et al, 1999).In addition, structuring instruction around carefully chosen problems, allowing student to interact when solving problem, and providing opportunities for them to share their solution methods result in increased achievement on problem solving measures. (Grouws & Cebulla, 2000).Science teacher grasps the interest of science students when positive attitude is developed by the students. Effort needs to be concentrated on fostering desirable attitudes toward science and the teaching of science (Lucas and Dooley, 2006).

An attempt to foster positive attitude in the learner calls for the teacher to ask the following salient questions: what do I teach? And how do I teach? Where can I get relevant information on what to teach? When a Basic Science teacher is sufficiently prepared in terms of his attitude, quality, materials and methods, there is tendency for learners to develop positive attitude towards his or her subject (science). So, the strategy, (practice-invention) will promote effective learning in basic science since it is hands-on and mind-on rather than chalk and talk method of teaching.

2.3.7 Practice- invention Strategy and Students Science Process Skills in Basic Science

Ergul; Simsekli, Calis, Ozdilek Gocmencelebi and Sanli, 2011, defined science process skills as transferable skills that are applicable to many sciences and that reflect the behaviours of scientists. They are the skills that facilitate learning in physical sciences, ensure active students' participation, have students develop the sense of undertaking responsibility in their own learning, increase the permanence of learning, and also have students acquire research ways and methods; that is, they ensure thinking and behaving like a scientist (Ergul; Simsekli, Calis, Ozdilek Gocmencelebi and Sanli, 2011). They are inseparable in practice from the conceptual understanding that is involved in learning and applying science. While the process skills are viewed as central to elementary school science education and important enough to be taught in their own right, they are often combined with science content, enabling children to learn both science process and content at the same time-in a seamless learning experience (Menchling *et. al.* 1994). For instance, children may practice the skill of observation while identifying the properties of rock. Learning science goes beyond scientific knowledge acquisition since it includes the acquisition of cognitive skills such as the science process skills. They are an important method in teaching science lessons and also the building-blocks of critical thinking and inquiry in science. Learning science lessons by apprehending requires using science process skills. Having science process skills acquired at the same time, means preparing future scientists. Also having scientific literacy acquired, is also a way of, enabling students to use science information in daily life (personal, social and global) (Harlen, 1999, in Ergul *et. al* 2011). Science process skills are based on scientific inquiry and teaching science by inquiry involves teaching students' science process skills as well as critical thinking and scientific reasoning skills used by scientist. They are acquired through training and direct experiences (Njoku, 2002). They are intellectual skills with learned capabilities which scientists used as self-management procedure in carrying out their scientific activities (Shaibu and Mari, 1997). They are also acquired during practical teaching of science in the laboratory (Oginni, 2009). Njoku (2002) explained that these science process skills are cognitive and psychomotor skills which scientists use in problem identification, objective inquiring, data collection and analysis. These skills are retained after the cognitive knowledge of science has been forgotten.

Integrating the science process skills as one of the teaching strategies requires no drastic changes in one's teaching style (Wetzel, 2010). It merely involves making the processes of science more explicit in lessons, investigations and activities you are already using in your science curriculum. The science process skills, according to Wetzel (2010), are the methods used by students to conduct investigations and understand how we know about the world in which we go beyond the textbook and supplement the core-content within textbooks with hands-one mind-on activities. It also means using your course content as a means for exposing students to the real processes of science.

The science process skills are separated into two categories-Basic Science Process Skills (BSPS) and Integrated Science Process Skills (ISPS) (Wetzel, 2008).The skills listed under the basic science process skills are:

- **Observing** – using the five senses to find out information about objects: an objects' characteristics, properties, similarities and other identification features
- **Classifying** – the process of grouping and ordering objects
- **Measuring** – comparing unknown quantities with known quantities, such as: standard of unit of measuring and estimation of errors. This information is considered quantitative data. Measurements are to be recorded in an orderly and systematic fashion with labeled units of measure.
- **Communicating** – using multimedia, written, graphs, images, or other means to share findings. This is needed to reflect the true nature of science.
- **Inferring** – forming ideas to explain observations i.e. interpreting or explaining observation. More than one inference may be presented to explain an observation.
- **Predicting** – forecast a future event based on prior experience, i.e. observation, inference, or experiments. It is forming an idea of an expected result-not a guess-but a belief of what will occur based upon present knowledge and understanding, observations, inferences. A prediction is to clarify ideas and reveal any misconception or missing information.

Basic Science process skills provide the intellectual groundwork in scientific inquiry. These skills are those which must be acquired as fundamental to the teaching and learning of science.

For Integrated Science process skills, the skills are:

- evaluating information,
- controlling variables,
- defining operationally,
- hypothesizing, and
- experimenting (Ong and Kenneth, 2005).

The Integrated Science process skills are structured on basic skills. They are the terminal skills for solving problems or doing science experiments (Karamustafaoglu, 2011).

The ability to carry out Integrated Science process skills is attributed to hypothetico-deductive reasoning (Huppert, Lomask and Lasarowitz, 2002).

The Curriculum Development Centre (CDC) of the Malaysian Ministry of Education also listed seven (7) and five (5) skills respectively for BSPS and ISPS in all its science syllabuses for primary, secondary and post secondary levels. The twelve (12) skills and their precise definition according to Ong and Kenneth (2005) were listed in Table II below. Students are expected to be familiarized with the language of science process skills right from the start as they experience the practical and the theoretical aspects of science.

Table II Definition of Science Process Skills as stipulated in all the Malaysian Science Syllabuses

No	**Skill**	**Explanation**
1	Observing	Process of gathering information about an object or phenomenon using all or some of the senses. Instruments could be used to assist the senses. The observation could be quantitative, qualitative or change.
2	Classifying	Observing and identifying similarities and differences between objects or phenomena, and gathering them in terms of similar characteristics.
3	Measuring and using numbers	Observing quantitatively using instruments with standardized units. Ability to use numbers is central to the ability to measure.
4	Inferring	Giving explanation to an observation of event or object. Usually, past experiences and previously collected data are used as a basis for the explanation, and it could be correct or otherwise.
5	Predicting	Process of conjecturing a coming event based on observation and previous experience or availability of valid data.
6	Communicating	Presenting idea or information in varied modes such as orally, in written form, using graphs, diagrams, models, tables, and symbols. It also involves ability to listen to other's idea and respond to the idea.
7	Using space and time relation	Describing changes in parameter with time. Examples of parameters are location, direction, shape, size, volume, and mass.
8	Interpreting data	Process of giving rational explanation of an object, event or patterns from the gathered information. The gathered information may come in different forms.
9	Defining operationally	Making definition of a concept or variable by stating what it is, and how it could be carried out and measured.
10	Controlling of	Identifying the fixed constant variable, manipulated variable

	variables	and responding variable in an investigation. The manipulated variable is changed to observe its relationship with the responding variable. At the same time, the fixed variables are kept constant.
11	Hypothesising	Ability to make general statement that explains a matter or event. This statement must be testable to prove its validity.
12	Experimenting	This is an investigation that tests a hypothesis. The process of experimenting involves all or combination of the other processes.

Source: Ong and Kenneth (2005)

These methods (i.e. science process skills) involve making explicit references to the science and allowing students time to reflect on how they participated in the process. It also helps ensure that students make the connection between science processes involved within an investigation and science content (Karen, 2009). Science process skills are special skills that simplify science learning, activate students, develop students' sense of responsibility in their own learning, increase the permanency of learning, as well as teach them the research methods (Karamustafaoglu, 2003). They are the thinking skills that we use to get information, think on the problems and formulate the results. Scientist, use them in their studies.

These skills are appropriate for all fields of science, and they reflect on the correct behaviours of scientists while they are solving a problem and planning an experiment. They constitute the essence of the thinking and research within science. It is more important for the students to learn how to apply science than learn reality, concepts, generalizations, theories and laws in science lessons. Therefore, it is necessary for them to pick up the habit of science process skills. These skills according to Karamustafaoglu, (2011), are considered to be efficient in learning and teaching. They engage a significant place in various countries' teaching programs, such as 'Science-A Process Approach' (SAPA) developed by the American Association for the Advancement of Science between 1963 and 1974.

In this approach the teaching of science process skills was specifically focused-on in elementary and high school science curricula. In the nature of many children is already the curiosity for searching and this curiosity leads them to search. That is to say, the skills and processes students use and develop are the same as those that scientists use while studying.

This implies that the ways of thinking in science are called science process skills. When we are doing science we ask questions and find answers to questions, these are actually the same skills that we all use in our daily lives as we try to solve everyday questions. When we teach students to use these skills in science, we are also teaching them skills that they will use in the future in every area of their lives (Ergul, et al, 2011). The use of science process skills by students increases the permanence of learning. For learning by doing,(Minner, Levy and Century, 2010), a student uses almost all of his or her senses and learning becomes more permanent and hands-on activities get him to acquire experience. Research skills not only get students to learn some information about science, but also learning these skills helps them to think logically, ask reasonable questions and seek answers, and solve the problems they encounter in their daily life.

Literature suggested that there are various factors that influence the acquisition of cognitive skills such as science process skills, which is one of the variable of interest in this study. Teachers play an important role in learning, including acquisition of science process skills. Also, Harlen (2000) identified three main aspects of the teacher's role: (1) setting up the learning environment, (2) organizing classroom activities, and (3) interacting with students. Among these three aspects, the most important aspect is teachers' interaction with students during their teaching. Apart from teachers' factors, readiness is another factor that influences the acquisition of science process skills.

Research studies in the 70s and 80s tended to support the link between active student involvement and the development of science process skills (Shaw, 1983; Wideen (1975) in Ong and Kenneth (2005). Shaw (1983), in Ong and Kenneth (2005) studied 83 sixth-grade students randomly assigned to four science classes (2 classes in experimental group and 2 in control group). The experimental group received science instruction with an emphasis on process skills while the control group emphasized strictly science content. Two teachers taught the four classes alternating between the control and experimental to reduce teacher's effect. Using t-test to determine the significant difference between the two groups, it was found that the experimental group had a significantly higher mean score on the process skill test compared to the control group.

Also, Beaumont-Walters and Soyibo (2001) determined the level of performance on science process skills among Jamaican ninth and tenth-graders who participated in the Reform of Secondary Education as compare to those that did not. They found that the mean of those participated in the reform was slightly higher than those that did not. Jusoh (2001), in Ong and Kenneth (2005) in his own study investigated Forms 2 and 4 students' performance in science process skills' test using the translated version of the instrument developed by Burns, Okey, and Wise (1985). Comparing the performance in science process skills level by level, it was found that there was a statistically significant difference between form 2 and form 4 students with the form 4 students performing better than the form 2 students.

2.3.8 Conventional Lecture Strategy and Students' Attitude to Basic Science

Scholars have different opinions on the use of conventional lecture instructional strategies in the teaching and learning of science. Ogundare (2008) observed in his study that the conventional lecture method commonly used by science teachers is monotonous; makes students passive listeners and prevents them from active thinking and learning. Consequently, students tend to perceive science subjects as difficult and having negative attitude toward science. They further argued that it has always resulted to under-achievement among students.

However, Ajayi (2001) in his study highlighted that instructional strategies should be varied as no instructional strategy is perfect for the teaching and learning of all concepts. He further maintained that the use of conventional lecture instructional strategies enhance better learning outcomes in term of positive attitude, formation and skills in the teaching and learning process of some subjects or concepts. It also saves time and cost as many students can be reached within a very short time. He concluded by recommending conventional lecture method in the teaching and learning of some concepts in science. Brenda and Robert (2003) argued that the conventional lecture method cannot be totally ignored, any innovation of instructional strategies is to complement the conventional lecture method, hence traditional method is still very much useful and a powerful instructional strategy.

2.3.9 Conventional Lecture Method and Students' Achievement in Basic Science

Studies have shown that generally, the conventional methods of teaching reading in primary and secondary schools are similar but have not been effective (Idogo, 2011; Yusuf 2010, 2011). Adesoji (2004) listed reasons which make teachers refuse to change their conventional teaching strategy

a. Lack of instructional facilities,
b. Overloaded curriculum,
c. Lack of training programs/ Workshop, and
d. Lack of skill in handling difficult concepts.

Abimbola (2013) agreed that the teacher-centered methods of teaching science predominate in Nigeria secondary schools. Olatoye and Adekoya (2010), James and Olajide (2011), and Oludipe and Oludipe (2010) in their studies of methods of teaching science in Nigerian secondary schools also established that the conventional method of teaching science is ineffective.

2.3.10 Conventional Lecture Strategy and Students Science Process Skills in Basic Science

In the learning of Basic Science, there are three types of skills that the learners can acquire, which are:

a. **Process skills,** such as observing, measuring, collecting, sorting, recording, reporting, analyzing, predicting Etc.
b. **Manipulative skills,** which include; drawing, cutting, coupling, dissecting, fitting equipment's, painting, fixing etc.
c. **Social skills,** such as socializing, relating, cooperating, sharing, etc.

All these skills are easily acquired during the learning of Basic Science when strategies which are child-centered and full of activities are employed. Learners are grouped, which draws them together and closer. Skills for manipulating can be developed when they are allowed to carry out simple laboratory exercises and outdoor activities (Federal Ministry Education, 2013). Practical works in science (Physics, Chemistry, Biology and Agricultural Science) are important component of science which give opportunity for the learner to learn first-hand the process of science. Science process skills, which could also be referred to as practical skills could only be acquired through frequent exposure to practical sessions (Omosewo, 2010; Boyo, 2011).

Practical skills are the skills the learners demonstrate as they carry out practical investigations in the process of solving a defined problem. Onwioduokit (1989) cited by Babajide (2010), identified six skills involved in practical or laboratory activities. These are;

Cognitive skills: These involve planning and designing an investigation in which students predict results, formulate hypothesis and design procedure.

Manipulative skills: These involve the handling of apparatus and effective eye-hand coordination; carrying out the experiment in which the students' make decision about investigative technique and equipment.

Measurements skills: These involve taking accurate measurement of variable manipulated, taking correct reading of measuring instrument, voiding error of parallax and general ability to use standard instruments to measure correctly.

Observation skills: These center on the ability to use various senses to give information, the use of eye and hand to record the measured values correctly, with the correct unit of measurement and following a specific trend or pattern.

Computational skills: These refer to the ability of the learners to analyse and explain recorded data; apply results to new situation and discuss results; explore relationship and formulate more questions and problems from observed data, perform simple arithmetic and meaningful arrangements of data as well as plot graphs.

Reporting skills: These refer to the skills used in answering verbal questions, reporting the significance of relevance of the experimental work done as well as writing conclusions and making some suggestions for further study.

2.3.11 Parental Educational Background and Students' Learning Outcomes

Parental Educational Background (PEB) is one of the factors or variables that determine the socio economic status of parents. The level of education determines other variables such as, type of environment or home lived in, number of children in the family, number of people living in the house, type of school the children attend, type of educational resources the children play with at home, language spoken at home, and others. These variables collectively determine socio-economic status of learners; consequently, research findings have shown that these variables determine greatly the learners learning outcomes.

For example, Adodo (2007) shows that parental educational background affects learners' learning outcomes positively in terms of achievement, problem-solving ability and students' attitude towards Basic Science. Similarly, he established in his study that parent's educational background produced significant differences in learning outcomes of learners. Ahove and Alabo (2000) also concluded that PEB creates a significant difference in the performances of learners in environmental knowledge, attitude and problem solving skills, in favour of the learners from high parental educational background. Adeogun (2009) observed that PEB has significant effect on the relationship between students' attitude and achievement in mathematics and science subject respectively. However, researchers have found that PEB would make no noticeable contribution to achievement in subject, problem solving and achievement in concept abstract and difficult concepts in Basic Science and Science related disciplines (Nduka, 2005).

Students' achievement in Basic Science in Junior Secondary School Certificates Examinations (JSSCE) has been unsatisfactory over many years. Various reasons have been attached to this problem by scholars. Dinah (2013) concluded that availability of text books, laboratory apparatus and other learning resources contribute significantly to the performance of students in Basic Science examination. He added that students with positive attitude towards the subject have better performance than those who had a negative attitude. Those with positive attitude are motivated to work hard and this is reflected in the good marks they scored in the examinations.

Suman (2011) conducted a research on influence of parents' education and parental occupation on academic achievement of students. He concluded that education and occupation of students positively influence the academic achievement of children Femi (2012) concluded that education qualification of parent and health of teachers and students are significant factors that affect the academic performance of students. According to Akinsanya *et. al.* (2014), parents' education has the highest significant influence on the academic achievement of students. This is because the child from educated family has a lot of opportunities to study hard due to his/her access to internet, newspaper and television. They are also to be taught extra lessons at home and students raised from an illiterate family have limited access to that.

It has been observed that the economic status of the parents relates with the falling academic standard in Nigeria. Because of the economic situations of the country, many poor parents do ask their children to do menial jobs before going to school. These children are confused on that they can help their family through that. However, poverty among parents has elastic effect on their children's academic works as they lack enough resources and funds to sponsor their education, not to talk of good housing facilities, medical care and social welfare services. Ogunsola (2012) in his study observed socio-economic and educational backgrounds of parents are not significant factors in students' performance. Osuafor (2013) in a research on influence of family background on academic achievement of secondary school biology students established that family structure, parents' occupation and educational level did not have significant influence on students' achievement in Biology.

Memon (2010) in his study established that majority of students whose parents were well educated perform better in matriculation examination as compared to those students whose parents were less educated or illiterate.

2.3.12 Gender and Students Learning Outcomes in Basic Science

Gender in education has become an issue of concern in the past few years. As schools and educational institutions are becoming more structured, sex differences in education and students' learning outcome assume new and more focus of researchers. Stephen and Sandra (2006) described gender as the social and historical constructions of masculine and feminine roles, their behaviour and attributes. Also, researchers have found that, gender plays a significant role in the learning outcomes of students. In a related study, Chase and Edward (2002) noted that female students show positive attitude towards learning computer courses and manifested increased learning outcomes.

Ukwungu (2002) applied mental-analytic techniques to 34 students, assessing the magnitude and direction of Integrated Science using the statistics. The result indicated that gender difference in performance in Integrated Science in Nigeria is small ($d = 0.13$) and in favour of males. The value $d = 0.13$ translating to $r = 0.06$ which implies that only 0.4% of the variance in performance of Integrated Science is accounted for by gender. However, the Binominal Effect Size Displace (BESD) shows that this proportion of variance accounted for by gender is equivalent to increasing success rate from 47% to 53%. A difference of 6% would provide an advantage over girls in a final or selection examination. Girls therefore need greater attention during Integrated Science classes.

Besides, Gaigher (2004) worked on the significant gender difference in learning outcomes in science courses. The scholar observed that a significant difference exist and is in favour of the boys. However, Raimi and Adeoye (2002), Akinbobola (2006) and Alake (2007) concluded in their studies that there is no significant difference in the performance of boys and girls in science classes. However, Odebode (2001) reported that girls performed better in verbal tests and obtained higher grades than boys while boys, excel in Mathematics and all science related subjects. She observed that girls are heroines and fearful, while the boys show greater courage and achievements. Throughout the world, women are higher in verbal ability than men, but are lower in Mathematics and spatial ability. Men are superior to women in problem-solving tasks and specific abilities related to problem solving (Asoegwu, 2008).

Literature also established significant gender difference in attitude towards, and interest in science, with girls losing interest faster than boys in secondary school (Gonen and Basavan, 2008; and Elster, 2007). Also, Logan and Skamp (2008) indicated that these gender differences were most likely to be connected with a number of variables related to classroom experiences, and pedagogy. Onah and Ugwu (2010) in their study to determine the factors which predict performance in secondary school level in Physics and the findings of Oredein and Awodun (2013) revealed significant difference in the aspect of gender difference in favour of boys in Physics achievement. Also, Ogunleye and Babajide (2012) observed that there is gender inequality in science, technology and mathematics.

Conversely, Igbokuuwe (2004), Ma (2002) and Coley (2010) in their separate comparative analysis of SSCE and NECO results in Ohaukwu Local Government Area of Ebonyi state on gender differences in learning outcomes, background and differences in gender-gap comparisons across racial/ethnic groups in education and work respectively reported that there is no significant effect of gender on achievement of Physics.

2.4 Appraisal of Reviewed Literature

It has been shown in the review of literature that Basic Science is a major school subject in the Nigerian Junior Secondary School curriculum and that it has the potential of developing students in all aspect of life. Most of the studies reviewed have revealed the dominance of teacher-centered conventional strategies that disallow students' from active participation in the learning process. Besides, the review of literature and research, evidence available indicated that an attempt to improve the teaching and learning of Basic Science for a better achievement and encouraging attitude in the subject have led some researchers to experiment with many effective student-centered instructional strategies such as Jigsaw II instructional strategies, crossword-picture; activity-based and inquiry base strategies among others. All these researchers investigated various instructional approaches on students' achievement in Basic Science: achievement in and attitude to Basic Science in the junior secondary schools. Although these earlier studies have produced some useful insight into effective teaching and learning of Basic Science, the annual decline in performance still persists.

More importantly, most of the studies did not stress the importance of using Active Review and Practice-invention strategies in teaching Basic Science in the Junior Secondary Schools. Some other studies have reported significant relationship between students' variables, such as student's attitudes and achievement in various school subjects like Mathematics, Biology, Chemistry and Social studies, but the extent to which these variables could predict students' achievement in Basic Science has not been extensively investigated especially in Oyo state.

Literature on a well-designed Active Review Strategy, affirmed that the strategy help students to organize materials to be studied. Studies showed that perhaps, emphasis should be on total study time but not on the way students study (Gurung, 2005). Much stronger relationship has been found between test scores and time spent organizing the course content than with total study time

Research evidence suggested that students need opportunities for both practices to invent. The findings from a number of research studies showed that, when students discover mathematical ideas and invent mathematical procedures, they have a stronger conceptual understanding of connections between mathematical ideas.

Literature had been reviewed on conventional strategy. Studies have shown that generally, the conventional method of teaching reading in primary and secondary schools are similar but have not been effective. Literature on Parental Educational Background (PEB) showed that PEB is one of the factors or variables that determine the socio economic status of parents. The level of education determines other variables such as parent's education, type of environment or home lived in, number of children in the family, number of people living in the house, type of school the children attend, type of educational resources the children play with at home and language spoken at home, among others.

From the review of literature on gender, it is clear that gender issue has become an issue of concern in the past few years. As schools and educational institutions are becoming more structured, sex differences in education and students' learning outcome assume new and more focus of researchers.

Furthermore, the review of empirical literature showed that on Basic Science, the extent to which mentioned student variables could predict students' learning outcomes in Basic science has not been fully determined. It is therefore, expected that the present study, which investigated the effects of active review and practice-invention strategies on students' attitude to, achievement, and process skills in Basic Science, will fill this important gap.

CHAPTER THREE

METHODOLOGY

This chapter focuses on the research design, population, sample and sampling procedures, research instruments, validity and reliability of the instruments, procedure for data collection and data analysis.

3.1 Research Design

The study adopted a pretest, posttest, control group, quasi-experimental research design. The design may be symbolically represented as follow:

01	X1	04	E1
02	X2	05	E2
03	X3	06	C

Where 01, 02, 03 represent the pre-tests for the experimental group: 1, 2, and control group respectively.

X1 = Treatment 1 involving Active Review Session (ARS).

X2 = Treatment 2 involving Practices- invention Strategy (PIS).

X3 = Control group – Conventional / Traditional Strategy (CTS).

The design employed a 3 x 3 x 2 factorial matrix with the instructional strategy as treatment at three levels, parent educational background at three levels (High, Medium and Low) and gender at two levels (Male and Female). The matrix is presented in Table below: 3.1.

Table 3.1: 3x3x2 Factorial Matrix of the Study.

TREATMENT	GENDER	PARENTAL EDUCATIONAL BACKGROUND		
		High	Medium	Low
Active Review Session	Male			
	Female			
Practices-invention Strategy	Male			
	Female			
Conventional Strategy	Male			
	Female			

3.2 Variables of the Study

The variables in the study include:

1. Independent Variable

This is the instructional strategy, which forms the treatment that varies at three levels:

(i) Active Review Strategy

(ii) Practice-invention Strategy

(iii) Conventional Lecture Strategy

2. Moderator Variables

There are two moderator variables in this study:

(i) Parents' Educational Background at three levels (High, Medium and Low).

(ii) Gender of students at two categories (Male and Female).

3. Dependent Variables: These are students' learning outcomes:

(i) Attitude to Basic Science.

(ii) Achievement in Basic Science.

(iii) Science Process Skills in Basic Science.

3.3 Population

The population of the study consisted of all the Basic Science Students in Junior Secondary Schools in Oyo State, Nigeria.

3.4 Selection of Participants

The participants were chosen from three Senatorial Districts of Oyo state (Oyo North, Oyo Central and Oyo South). Three (3) Local Governments Area were randomly selected from one senatorial district (Oyo North). The three Local Governments were Iseyin, Itesiwaju and Kajola with 15, 10 and 16 public schools respectively. Three (3) schools were randomly selected from each local government area making a total of nine (9) schools and JSS II Basic Science students of intact class were involved.

The participants for the study consisted 387 (164 male and 223 female). The teachers of selected classes 3 teachers per local government were also involved in the study. The nine schools were distantly located from each other to avoid interaction between or among students from the selected schools for the study. The treatment was randomly assigned to the three schools one school for Active Review Strategy, one school for Practices- invention Strategy, and one school for Conventional Strategy in each Local Government Area of study.

The criteria for the selection of schools were based on:

i. The school is a public co-educational secondary school.

ii. The JSS 2 students in the school have completed the JSS 1 Basic Science Curriculum at the time of data collection.

iii. The school must have produced candidates for public examinations like JSSCE for not less than 5 years.

iv. Willingness of the required members of staff to participate in the study.

The choice of JSS II Basic Science students was made because they have been exposed to introductory aspects of living and non-living things, chemicals, work, energy and power and types of energy in (JSS II) Basic Science subject and JSS 1 Basic Science which act as pre-requisites for the study of the chosen concepts. The students were likely to be more receptive to the teaching strategy as they were not under the pressure of preparing for external examination. The teaching of the concepts was appropriate to the scheme of work at this stage of their spiral curriculum.

3.4.1 Criteria Used for the Selection of Basic Science Concepts for the Study

Ncharam's (2011) study on the relationship between students' learning difficulties and achievement in Junior Secondary School Three (JSS3) Integrated Science (Basic Science) content showed that poor achievement in Integrated Science concepts is consistence with the perceived difficulty by students in energy concepts. Abimbola, Olorundare, Omosewo, Ahmed, Johnson and Yahaya (2011) identified difficulty in ecological concept. Njoku (2005), Ncharam (2011) and Abimbola *et. al.* (2011) identified areas of difficulties in secondary school science curriculum as one of the reasons for low achievement in the subject. Abimbola *et. al*. (2011) pointed out that the performance rate is poor because of difficult topics in the subject, which are often ignored by students and even teachers. These researchers recommend that there should be a re-evaluation of the difficult concepts. There are reasons for such difficulty:

1) There is inadequacy of resources for teaching these concepts;
2) Teachers generally use unsatisfactory resources and even when available, they use it wrongly; and
3) There is also the general unsatisfactory field and practical work in schools (Abimbola *et. al*., 2011).

The concept selected for the study required resources, field and practical work which were provided for in the study. The content covered four topics: Living and Non-living things, Types of Energy, Work, Energy and Power and Crude Oil and Petro-chemicals. All the concepts taught in the study and on which the test was based are in the former Integrated Science curriculum, with the exception of one concept which is an addendum in the new Basic Science curriculum (that is, information and communication technology). Following the thematic approach to content organization of Basic Science Curriculum (NERDC, 2007), the following topics were covered:

1. Learning about our environment (Living and Non- living things).
2. You and Energy (Types of Energy)
3. You and Energy (Work, Energy and Power)
4. Science and Development (Crude oil and Petrochemicals)

These topics where chosen to ensure that some new issues (topics) in Basic Science curriculum (NERDC, 2007) and other topics perceived difficult (Njoku, 2005; Ncharam, 2011; Abimbola *et. al*., 2011) were examined in the study to make the teaching and learning of Basic Science interesting and effective.

3.5 Research Instruments

Nine instruments were used in this study. These include:

A. Students' Basic Science Attitude Scale (SBSAS)

B. Students' Basic Science Achievement Test (SBSAT).

C. i. Students' Basic Science Activities on Process Skills (SBSAPS)

ii. Students' Basic Science Process Skills Rating Scale (SBSPSRS).

D. Instructional guide on Active Review in Basic Science (IGARBS).

E. Instructional Guide on Practice-invention Strategy in Basic Science (IGPiSBS).

F. Instructional Guide on Conventional Strategy in Basic Science (IGACSBS).

G. Evaluation sheets for assessing teacher performance on the strategies (ESATPS) on Active Review Strategy.

H. ESAT on Practice-invention Strategy.

I. ESAT on Modified Conventional Strategy

3.5.1 Students' Basic Science Achievement Test (SBSAT)

This instrument was developed by the researcher which aimed at testing the JSS II students' achievement in Living things, Work, Energy and Power and Types of Energy, and Crude oil and Petrol chemicals. The test contained twenty five multiple choice objective test items. There were two sections with Section A, containing demographic information, such as Name of School, Student's Name, Class, Sex, and highest Parent's Educational Background, while Section B contained the constructed test items as presented in Table 3.2. The alternative answers for the questions ranged from A to D. One mark was awarded for each correct option and zero for wrong option. This means that, the total mark obtainable was 20. The test items were generated to cover the cognitive domain of knowledge, understanding and thinking in accordance with Okpala and Onocha (1995), in which the six levels of Bloom's taxonomy was reduced to three levels. This was done in this research to show the thinking skills that the researcher was based upon.

Table 3.2: Table of Specification for SBSAT

Cognitive level Topic/Content	Remembering (Knowledge, Recall)	Understanding (Comprehension & Application)	Thinking (Analysis, synthesis and Evaluation)	Total (100%) Number of Items
Living things	(1) 6	(1) 3	(2) 10,13	4
Work, Energy and Power	(1) 18	(3) 8,11,19	(2) 9,16	6
Types of Energy	(2) 4,7	(1) 15	(2) 5.17	5
Crude oil and Petrochemicals	(2) 1, 14	(2) 2,12	(1) 20	5
Total	**6**	**7**	**7**	**20**

Source: Okpala and Onocha (1995)

3.5.1.1 Validation and Determination of Reliability coefficient of (SBSAT)

The initial draft of forty multiple choice items were given to some lecturers in Science Unit of the Department of Teacher Education, Faculty of Education, University of Ibadan, Ibadan; three Ph.D. students in the field of Basic Science and two lecturers in School of Science, Emmanuel Alayande College of Education, Oyo. These people are experts in the field of Science Education and they were able to remove twenty items while twenty were also retained. This was done to ascertain the face, content and validity of the instrument. It was later trial-tested on a sample of 30 students in Methodist High School Bodija, Ibadan, which is not part of the secondary school that were selected for the main study. The data collected were analyzed using Kuder-Richardson formula (KR20). The reliability coefficient of 0.80 and an average item difficulty index of 0.49 were obtained.

3.5.2 Students' Basic Science Attitude Scale (SBSAS)

SBSAS aimed at investigating or testing the affective domain of the students based on their attitude towards Basic Science. The instrument was developed by the researcher. It was divided into two (2) sections.

Section A was demographic. It sought information on the name of the school, name of student, class of student, sex, parent educational background, and time allowed for the test.

Section B was assessed students' attitude toward Basic Science. It comprised 4 likert-scale statement of 20 items: 10 positive and 10 negative. The scoring of SBSAS was as follows:

Strongly Agree (SA) -4 marks -
Agree (A) -3marks
Disagree (D) -2marks
Strongly Disagree (SD) -1 mark

The above goes for positively worded statement while the reverse was used for negatively worded statements i.e.

Strongly Agree (SA) -1 mark
Agree (A) -2 marks
Disagree (D) -3 marks
Strongly Disagree (SD) -4 marks

3.5.3 Validity of Students' Basic Science Attitude Scale (SBSAS)

The face and content validity of the instrument was censured by two experts in the field of Basic Science in the Department of Teacher Education, Faculty of Education, University of Ibadan. The test instrument was also examined by researchers' supervisor in order to determine whether the items measured the intended contents. Their suggestions were incorporated in the final draft. The Cronbach Alpha formula procedure was applied by the researcher to find the reliability co-efficient. The instrument was trial tested on some students which were out of the study area in a separate school to determine the reliability co-efficient of the instrument. The reliability (Cronbach Alpha Co-efficient) of 0.86 was obtained and it was considered high enough for the instrument to be used for this study.

3.5.3.1 Students' Basic Science Activities on Process Skills.

This was a series of activities in line with selected topic/content to help in carrying out a research in the area of acquisition of Basic Science's practical skill by the students. It contained two sections, Section A sought information on the students personal data while Section B contained series of activities to be carried out by the students in line with seven steps provided. The research assistant with the help of other science teachers used the Students Basic Science Process Skills Rating Scale (SBSPSRS) in appendix IIIB to score observation, recording, drawing, labeling and manipulating apparatus skills. Each student was scored while performing each experiment and the scores added. The activities were from the four topics selected for the study, (Living and Non-livings, Types of Energy, Work, Energy and Power and Crude oil and Petrol-chemicals).

The activities were given to two Junior Secondary School Basic Science teachers for review and all their suggestions were incorporated in the activities. Later, it was given to two lecturers in the Teacher Education Department, University of Ibadan, for them to reconstruct the skills and the inter-rater reliability was then estimated using scott π. The inter-rater reliability index obtained was 0.76.

3.5.3.2 Students' Basic Science Process Skills' Rating Scale (SBSPSRS)

This was made up of twenty items on a 5-point rating scale from 0-5 marks to measure Basic Science Students' process skills. The four items picked from the chosen concepts (Living things, Types of Energy, Work, Energy and Power and Crude oil and

Petrochemicals) were distributed among the five Basic Science process skills which are observing, recording, drawing, labeling and manipulating apparatus. The rating scales used were: Very Good = 5, Good = 4, Very Fair = 3, Fair = 2 and Poor = 1. Research assistant with the help of science teacher score the Basic Science students when activities were in progress.

3.5.3.3 Validation of SBSPSRS

The face validity of SBSPSRS was done by showing the items to four science educators with bias in Basic Science at the Department of Teacher Education, University of Ibadan, Ibadan, to determine their suitability in terms of language of presentation, clarity of ideas and class level, length and relevance or applicability to the study. Seven activities were reduced to four activities from the concept selected and the final draft by experts were used for the study to measure observation, recording, drawing, labeling and manipulating apparatus skills in Basic Science. Cronbach Alpha reliability co-efficient for each of the skills observed are: observation, 0.75, recording 0.76, drawing 0.75, labeling 0.77 and manipulating apparatus 0.76.

3.5.4.1 Teachers' Instructional Guide.

3.5.4.2 Teachers' Instructional Guide on Active Review Strategy (TIGASS)

Active Review Strategy Guide included the following steps:

Step 1: Research assistant introduced the lesson by asking the students' questions to arouse their interest and activate their background knowledge.

Step2: Students responded to the questions posed by the teacher based on their experience.

Step 3: Research assistant grouped and presented the lesson in different forms on the same topic by explaining and illustrating the concepts (Living things, Work, Energy and Power, Types of Energy and Crude oil and Petrol chemicals) being taught, using active review Strategy to arouse feedback from the students. The same time was being allocated for each review session.

Step 4: The students pointed out the new contents as the teacher carefully monitored their progress and provides support; feedback and scores are awarded to each group.

Step 5: The students practiced the new concepts or skills on their own in the classroom.

Step 6: Research assistant gaves a clarification to each group.

Step 7: Research assistant evaluated the lesson and gave assignment to be done at home so as to have pre-knowledge before the next lesson.

3.5.4.3 Validation of TIGASS

Some Basic Science educators in higher institutions of learning were consulted as to the suitability of content, coverage, ambiguities and standard of language used. The recommendations given were used to reconstruct the guide and the inter-rater reliability estimated scott π obtained was 0.74.

3.5.5 Teachers' Instructional Guide on Practice-invention Strategy (TIGPAIS)

The Teacher gave students' opportunities to practice in Basic Science-

Step 1: Students embarked on task assigned to them in selected Basic Science contents (Living things, Work, Energy and Power, Types of Energy and Crude oil and Petrol chemicals)

Step 2: Students were given opportunity to practice using non-routine method.

Step 3: Research assistants periodically introduced a lesson involving a new skill by posing it as a problem to be solved. He/she maintained the time students spent practicing routine and time devoted to inventing and discovering new ideas.

Step 4: Students were allowed to re-discover new concepts themselves using apparatus provided with research assistant guiding the students.

Step 5: Students evaluated the steps which led to the answer if error was found (reflection) and looked at alternative approaches made by other group in problem-solving situations and shared experiences with each other on carefully chosen problems.

Step 6: Research assistant assigned interesting problems as classwork and moved about the classroom as the students worked keeping track of the strategies students were using.

Step 7: The student's work-book were marked and exchanged to discover mistakes and to discuss necessary corrections.

3.5.4.4 Validation of TIGPAIS

Some Basic Science educators in higher institutions of learning were consulted as to the suitability of content, coverage, ambiguities and standard of language used. The recommendations given were used to reconstruct the guide and the inter-rater reliability estimated Scott π obtained was 0.76.

3.5.5 Teachers' Instructional Guide on Conventional Strategy (TIGCS)

The followings were the steps in conventional strategy:

Step 1: Teacher introduced the lesson.

Step 2: Teacher discussed the content of the concepts on the board and asked the students to write in their note books.

Step 3: Teacher gave an overview of the lesson.

Step 4: Teacher evaluated his lesson by asking question from the students.

Step 5: Teacher concluded the lesson by giving homework to the students.

3.5.5.1 Validation of TIGCS

Some Basic Science educators in higher institutions of learning were consulted as to the suitability of content, coverage, ambiguities and standard of language used. The recommendations given were used to reconstruct the guide and the inter-rater reliability estimated scott π obtained was 0.78.

3.5.6 Evaluation Sheet for Assessing Teachers' Performance on the use of the Strategies (ESAT).

During the training of the participating teachers for two weeks, the researcher request the teachers to give demonstration of lesson which was assessed by the researcher using the Evaluation Sheet for Assessing Teachers', Performance (ESAT), to ensure teacher's strict compliance to the guide. This was the guideline for evaluating performance of the trained teachers on the effective use of the following strategies:

1. Active review.

2. Practice-invention.

3. Modified Conventional Method.

This is rating scale that was made up of two sections:

Section A: This contained the personal data of the trained teacher containing name, school, period, class taught, date and the summary of the concept discussed in the class. **Section B:** This contained items to be evaluated. The items were placed on 5 points Likert rating scale ranging from very good (5), Good (4), Average (3), poor (2), very poor (1).

3.5.6.1 Validation of ESAT

The instruments were trial tested to ensure reliability. Experts' attention was drawn to ascertain the appropriateness of the concepts and methods to the Basic Science education. The observation and comments of these experts were taken into consideration while preparing the final draft.

3.6 Trial Testing

The study was trial tested at three representative schools different from the schools the researcher selected for the main experiment. The schools possessed all the characteristics required for the main experiment. The instrument was trial tested with the purpose of testing the efficacy of the evaluative instruments, the experimental design and the procedure used in the main experiment. The results of the trial tested study were used to diagnose those possible weaknesses in design and procedure; corrections were also affected before the main study.

3.7 Procedure for Data Collection

Work Schedule

1. Training of teachers 1st – 2nd weeks
2. Administration of pretest, 1 week
3. Application of treatment in experimental and control group, 8 weeks
4. Administration of posttest, 1 week

A total of twelve weeks was used.

3.7.1 Training of Teachers as Facilitator

Teachers who participated in the study were adequately trained on the purpose, principles and procedures governing each group and the use of each treatment. The training materials (Instructional Guide) were given to them. The teaching instrument for all groups covered the following content areas of Basic Science: Living things, Work, Energy and Power, Types of Energy and Crude oil and petrol chemicals.

The research assistants (teachers) were trained on how to administer the instruments. The pre-test materials were given to them shortly after the training. Their first contact with the students in the classroom was to introduce the strategies, prepare the students mind, and inform them of the purpose, principles and procedures governing the research. They were told the benefits they could gain if they participated fully from the beginning of the programme to the end. More importantly, this research incorporated topics to be taught for the term and this would contribute to their promotion examination. They were reminded that the class teacher might not have another opportunity to re-teach these topics before their certificate examinations.

3.7.2 Pre - Test

After the teacher had prepared the students, the pre-test was applied, this include: Students' Basic Science Achievement Test (SBSAT), Students' Basic Science Attitude Scale (SBSAS) and Students' Basic Science Process Skills Rating Scale (SBSPSRS). Each treatment used all the three Basic Science periods of 80 minutes per week for 8 weeks.

3.7.3 Treatment Procedure

The treatments were carried out on all the JSS II students in all the nine representative schools on the experimental and control groups. During the period, students were taught concepts such as Living things, Work, Energy and Power, Types of Energy and Crude oil and petrol chemicals by the research assistants using the three strategies (Active Review, Practice–invention as experimental and Conventional Strategy as control).

3.7.3.1 Experimental Group I: Active review strategy. Active Review Strategy guide included the following steps:

Step 1: Research assistant introduced the lesson by asking the students' questions to arouse their interest and activate their background knowledge.

Step2: Students responded to the questions posed by the teacher based on their experience.

Step 3: Research assistants grouped and presented the lesson in different forms on the same topic by explaining and illustrating the concepts (Living things, Work, Energy and Power, Types of Energy and Crude oil and petrol chemicals) being taught, using active review strategy to arouse feedback from the students. The same time was being allocated for each review session.

Step 4: The students pointed out the new contents as the teacher carefully monitored their progress and provided support; feedback and scores were awarded to each group.

Step 5: The students practiced the new concepts or skills on their own in the classroom.

Step 6: Research assistants gave a clarification to each group.

Step 7: Research assistants evaluated the lesson and gave assignment to be done at home so as to have pre-knowledge before the next lesson.

3.7.3.2 Experimental Group II: Practice-invention Strategy

Step 1: Students embarked on task assigned to them in selected Basic Science contents (Living things, Work, Energy and Power, Types of Energy and Crude oil and Petrol chemicals).

Step 2: Students were given opportunity to practice using non-routine method.

Step 3: Research assistant periodically introduced a lesson involving a new skills by posing it as a problem to be solved and maintained the time students spent practicing routine, inventing and discovering new ideas.

Step 4: Students were allow to re-discover new concepts using apparatus provided with research assistant guiding the students.

Step 5: Students check backed through the steps which led to answers if error was found (reflection) and looked at alternative approaches made by other groups in problem-solving situations, then shared experience with each other on carefully chosen problems.

Step 6: Research assistants assigned interesting problems as class work and moved about the classroom as the students worked, keeping track of the strategies students were using.

Step 7: The students' work- books were marked and exchanged to discover mistakes and discuss necessary corrections.

3.7.3.3 Control group: Conventional Strategy

Step 1: The teacher introduced the lesson by asking questions based on previous knowledge.

Step 2: Teacher discussed the content of the concepts on the board and asked the students to write in their note books.

Step 3: Teacher gave an overview of the lesson

Step 4: Teacher evaluated the lesson by asking questions from the students.

Step 5: Teacher concluded the lesson by giving homework to the students

The students were taken through the four topics for eighty minutes duration each week and this lasted eight weeks.

3.7.4 Post Test

All the JSS II students in the nine representative schools that were selected for the experimental and control groups were given post tests on all the evaluative instruments. The post-tests were as follows: Students' Basic Science Achievement Test (SBSAT), Students' Basic Science Attitude Scale (SBSAS) and Students' Basic Science Process Skills Rating Scale (SBSPSRS).

3.8 Method of Data Analysis

The data obtained from the study were analyzed using descriptive statistics (mean and standard deviation); the inferential statistics used was Analysis of Covariance (ANCOVA) using the pre-test scores as covariate. Estimated Marginal Mean (EMM) was used to find out the magnitude of the difference in the various groups where there was significant effect. To determine the actual source of the significant differences; Scheffe

Post-Hoc test was performed on the mean scores of the groups. Also, line graphs were used where there were significant interaction effects.

CHAPTER FOUR

RESULTS AND DISCUSSION

Interpretation of Results

4.0 Introduction

The focus of this study is to investigate the effects of Active Review and Practice-invention strategies on students' attitude to, achievement and process skills in Basic Science. This chapter presents the results of the findings and discussion of the data gathered during the research.

4.1 Descriptive Statistics

Descriptive Statistics Associated with Treatment

Table 4.1 Summary of Descriptive Statistics Associated with Treatment

	Achievement Scores			Attitude Scores			Science Process Skills		
	ARS	**PIS**	**MCS**	**APS**	**PIS**	**MCS**	**APS**	**PIS**	**MCS**
No of cases	131	125	131	131	125	131	131	125	131
Pre-test mean	6.45	8.59	8.92	44.04	46.32	41.29	5.95	8.19	7.33
Pre-test S.D	0.85	0.92	0.98	1.85	1.99	2.12	0.65	0.71	0.75
Post-test mean	14.62	14.64	13.08	51.11	53.54	45.28	12.43	11.29	6.24
Post-test S.D	0.62	0.67	0.72	1.89	2.04	2.17	1.44	1.55	1.66
Mean Grain	8.17	6.05	4.16	7.07	7.22	3.99	6.48	3.10	-1.09

- **ARS** – Active Review Strategy
- **PIS** – Practice-invention
- **MCS** – Modified Conventional Strategy
- **S.D** – Standard Deviation

Table 4.1. displays the descriptive statistics on the students' achievement, attitude and science process skills' scores. The post test scores improve for Active review strategy in attitude to, achievement in and process skills scores as 7.07, 8.17, 7.07, 6.48 respectively. Practice-invention Post test scores show improvement with 6.05, 7.22 and 3.10 respectively. In case of Modified Conventional Strategy, the post test scores improve with scores 4.16 and 3.99 respectively, but no improvement is recorded for Science Process Skill (-1.09). The mean gain of achievement in descending order is Active Review strategy had higher mean gain than Practice-invention, while Practice-invention had higher mean gain than modified conventional strategy.

Fig 4.1 Displayed the Bar Chart showing the Magnitude of Descriptive Statistics of the Students' Achievement Scores associated with Treatment as presented earlier in Table 4.1

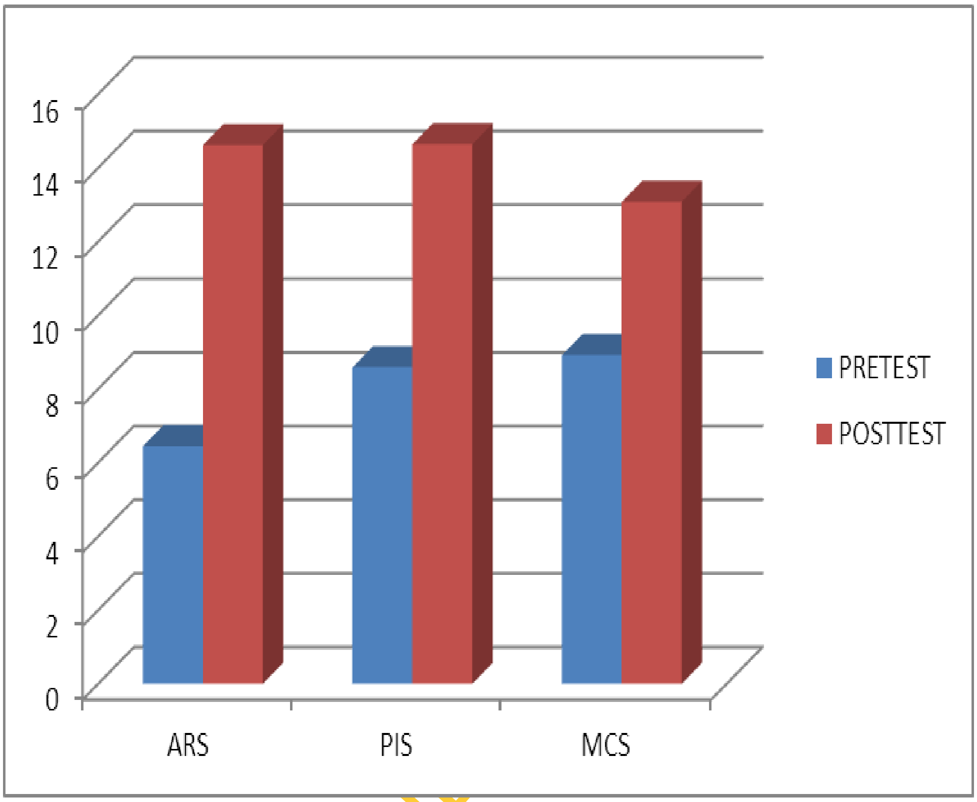


Fig 4.1 Bar Chart showing Descriptive Statistics associated with Treatment on Achievement Mean Scores.

The posttest scores improve for Active Review Strategy in achievement scores by 8.17 (pretest mean = 6.45, post test mean = 14.62), and Practice-invention post test scores show improvement with 6.05 (pretest mean = 8.59, post test mean = 14.64). In case of modified conventional strategy, the post test scores show improvement with 4.16 (pretest mean = 8.92, post test mean = 13.08). The mean gain in descending order is; Active review strategy had higher mean gain than Practice-invention while Practice-invention, had higher mean gain than modified conventional strategy.

Figure 4.2: Bar chart showing the magnitude of descriptive statistics of students' attitude scores associated with treatment as presented earlier in Table 4.1

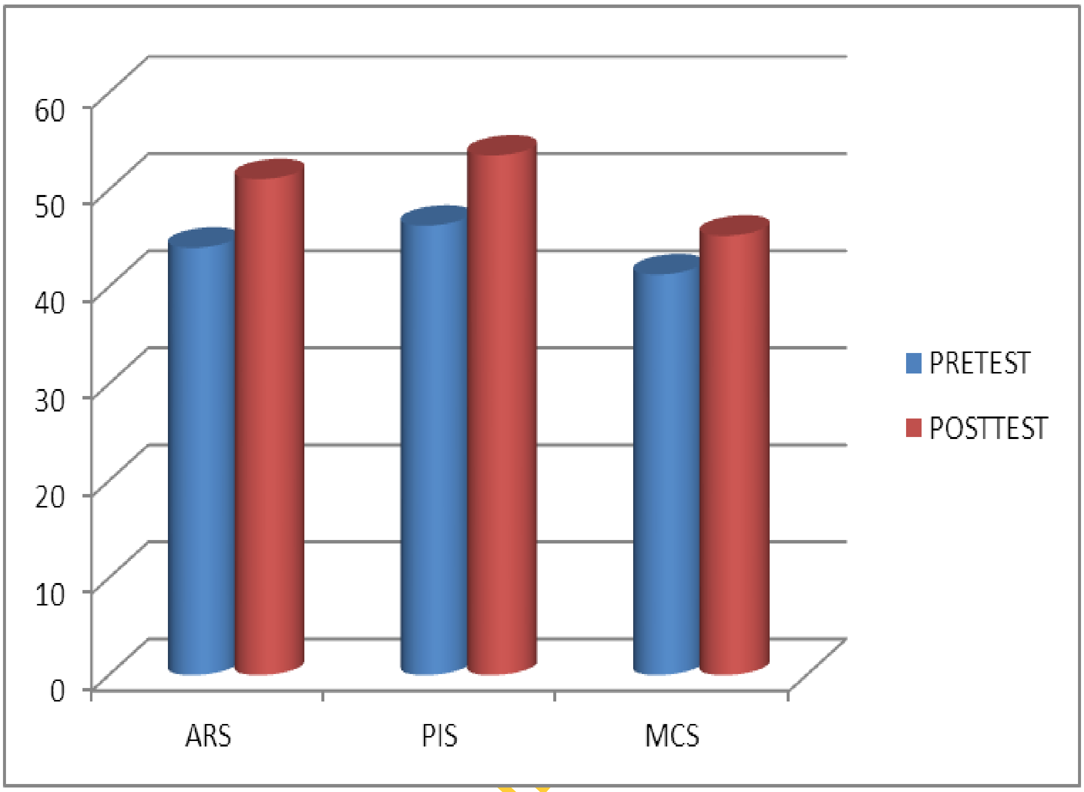


Figure 4.2 The Bar Chart showing Descriptive Statistics associated with Treatment on Attitude Mean Scores.

The post test scores improve for Active Review strategy in attitude scores by 7.07 (Pretest mean = 44.04, post test mean = 51.11). Practice-invention post test scores show improvement with 7.22. (Pretest mean = 46.32, post test mean = 53.54). In case of Modified Conventional Strategy, the post test scores improve with 3.99 (pretest mean = 41.29, post test mean = 45.28). The mean gain in descending order was: A Practice-invention strategy had higher main gain than Active Review strategy, while Active Review strategy had higher mean gain than Modified Conventional strategy.

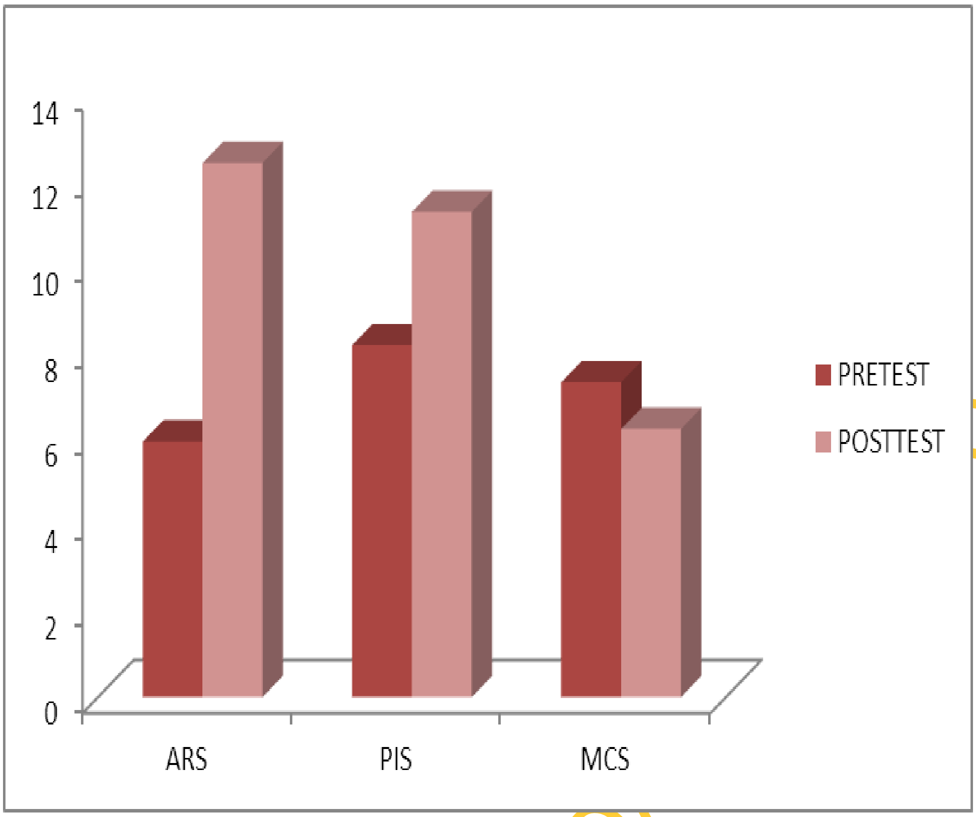


Figure 4.3 Bar Chart Showing Descriptive Statistics associated with Treatment on Science Process Skill Mean Scores.

The post test scores improve for Active review strategy in science process skill by 6.48. (Pretest mean = 5.95, post test mean = 12.43). Practice-invention post test scores show improvement with 3.10 (pretest mean = 8.19, post test mean = 11.29). In case of modified conventional strategy, the post test scores do not improve in science process skill (pretest mean = 7.33, post test mean = 6.24). The mean gain in descending order is: Active Review Strategy had the higher mean gain, followed by Practice–invention while Modified Conventional Strategy had the least mean gain.

4.1.2 Descriptive Statistics Associated with Parents' Educational Background

Table 4.2 Summary of Descriptive statistics Associated with Parents' Educational Background

	Achievement Scores			Attitude Scores			Science Process Skills		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
No of cases	216	99	72	216	99	72	216	99	72
Pre-test mean	7.23	7.80	8.93	43.35	43.72	44.59	7.14	7.36	6.98
Pre-test S.D	0.73	0.59	1.42	1.59	1.29	3.07	0.57	0.46	1.09
Post-test mean	13.96	14.23	14.15	49.78	50.66	49.51	9.44	9.97	10.55
Post-test S.D	0.54	0.44	1.04	1.63	1.33	3.15	1.24	1.01	2.40
Mean Grain	6.73	6.43	5.22	6.43	6.94	4.92	2.30	2.61	3.57

4.1.2 Descriptive Statistics Associated with Parents' Educational Background

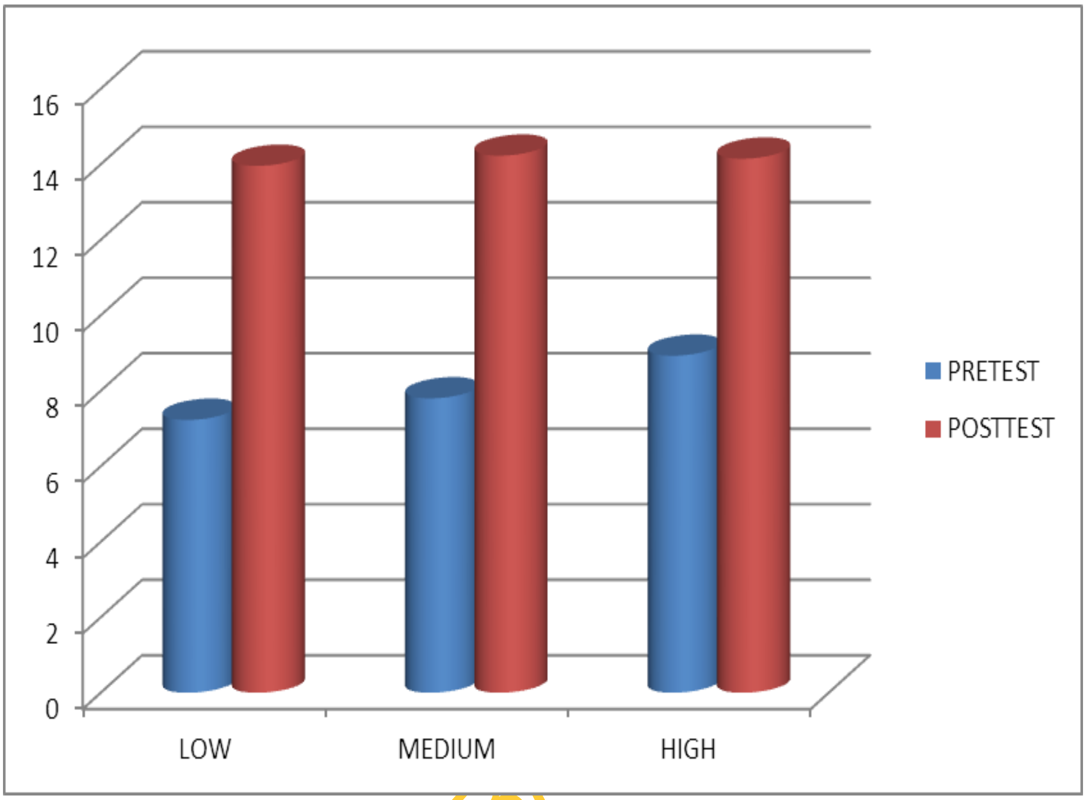


Table 4.2 displays the Descriptive statistics of the Students' Achievement, Attitude and science process skills scores with Parents' Education Background of the students. The mean gain in descending order is: for achievement, low parents educational background had higher mean gain than medium parent educational background, while medium parents' educational background had higher mean gain than high parents' educational background.

Figures 4.4, 4.5 and 4.6 are the Bar Chart showing the magnitude of Descriptive Statistics of the Students' Achievement, Attitude and Science Process Skill scores associated with Parent Educational Background as presented in Table 4.2

Figure 4.4.: Bar Chart showing Descriptive Statistics of Achievement associated with Parent Educational Background

Figure 4.4 is the bar chart showing the descriptive statistics associated with achievement according to parents' educational background. There are improvement in students scores with low Parents' Educational Background, medium and High parents' educational background post test achievement scores: 6.73 (pretest mean = 7.23, post test mean = 13.96), 6.43 (pretest mean = 7.80, post test mean = 14.23) and 5.22 (pretest mean = 8.93, post test mean = 14.15) respectively.

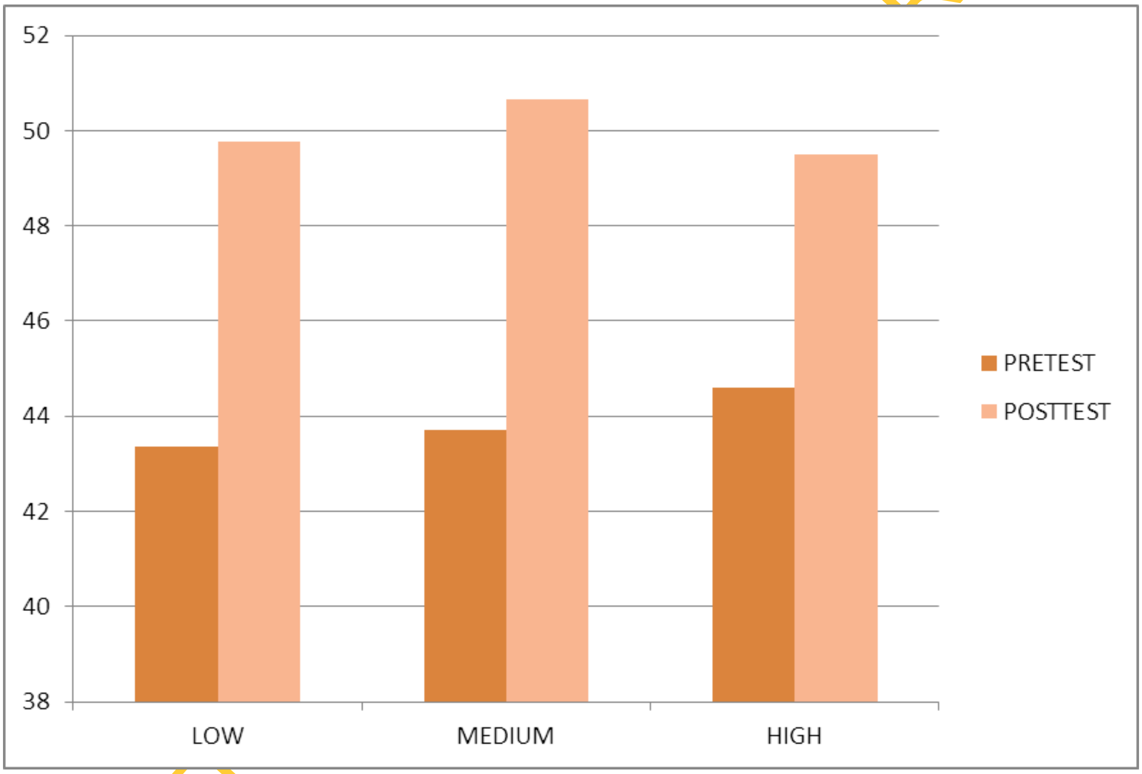


Figure 4.5: Bar Chart showing Descriptive Statistics of Attitude associated with Parents' Educational Background

There are improvements in scores of students in low, medium and high parents' educational background, according to attitude scores 6.43 (pretest mean = 43.45, post test mean = 49.78), 6.94 (pretest mean = 43.72, post test mean = 50.66) and 4.92 (pretest mean = 44.59, post test mean = 49.51).

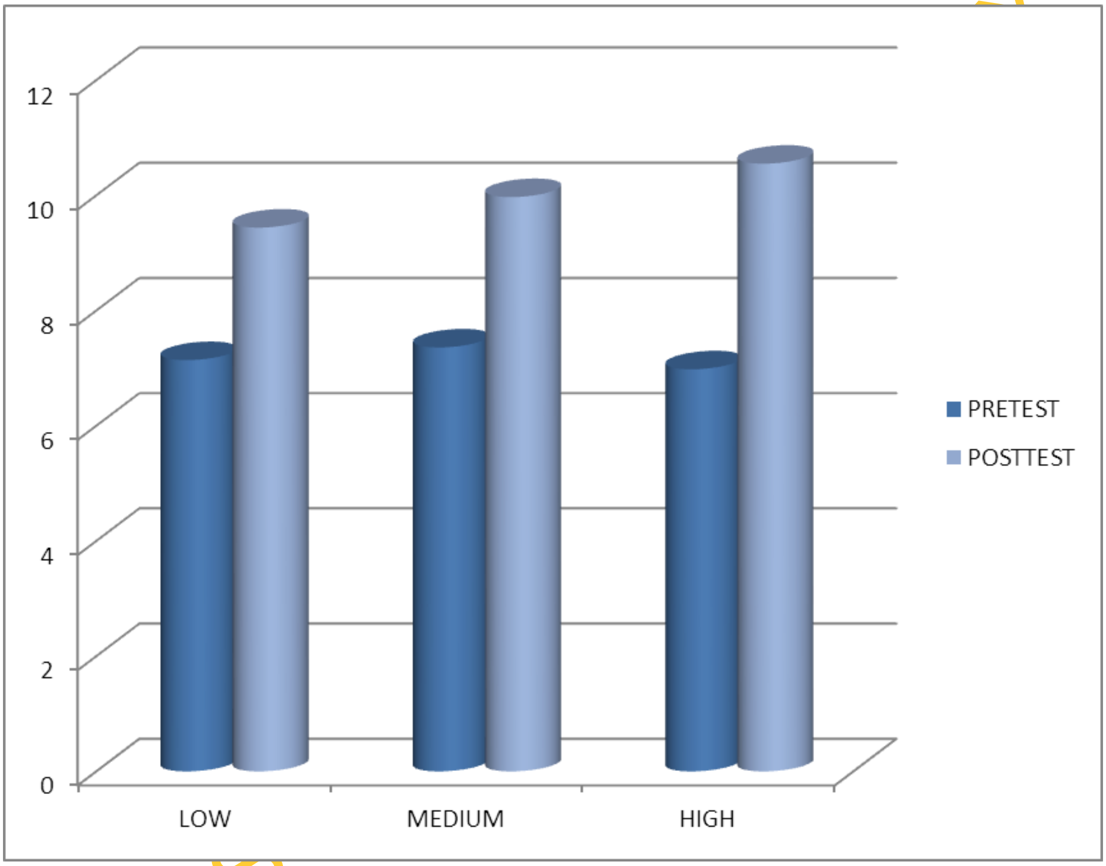


Figure 4.6: Bar Chart showing Descriptive Statistics associated with Science Process Skills according to Student's Parents' Educational Background

Figure 4.6 is the Bar Chart showing Descriptive statistics associated with Science Process Skills according to student's Parents' Educational Background. There were improvement in low, medium and high students scores in science process skill according to parents' educational background 2.30 (pretest mean = 7.14, post test mean = 9.44), 2.61 (pretest mean = 7.36, post test mean = 9.97) and 3.57 (pretest mean = 6.98, post test mean = 10.55) respectively.

4.1.3 Descriptive statistics Associated with Gender

Table 4.3 Summary of Descriptive Statistics Associated with Gender

	Achievement Scores		Attitude Scores		Science Process Skills	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
No of cases	164	223	164	223	164	223
Pre-test mean	7.87	8.11	43.19	44.58	7.06	7.25
Pre-test S.D	0.95	0.88	21.06	17.15	0.73	0.68
Post-test mean	13.75	14.48	49.37	50.60	9.46	10.51
Post-test S.D	0.70	0.64	2.11	1.95	1.61	1.49
Mean Grain	5.88	6.37	6.18	6.02	2.40	3.26

Table 4.3 shows the Descriptive statistics of Students' Achievement Attitude and Science Process Skills Scores associated with gender. There are improvements in the mean achievement scores of both male (5.88) and female (6.37) students', improvements in mean attitude scores of both male (6.18 and female 6.02). and in science process skill, there are improvements in both male (2.40) and female (3.26).

Figures 4.7, 4.8 and 4.9 are the bar charts showing the magnitude of Descriptive Statistics of the students' achievement, attitude and science process skills scores associated with gender as presented in Table 4.3.

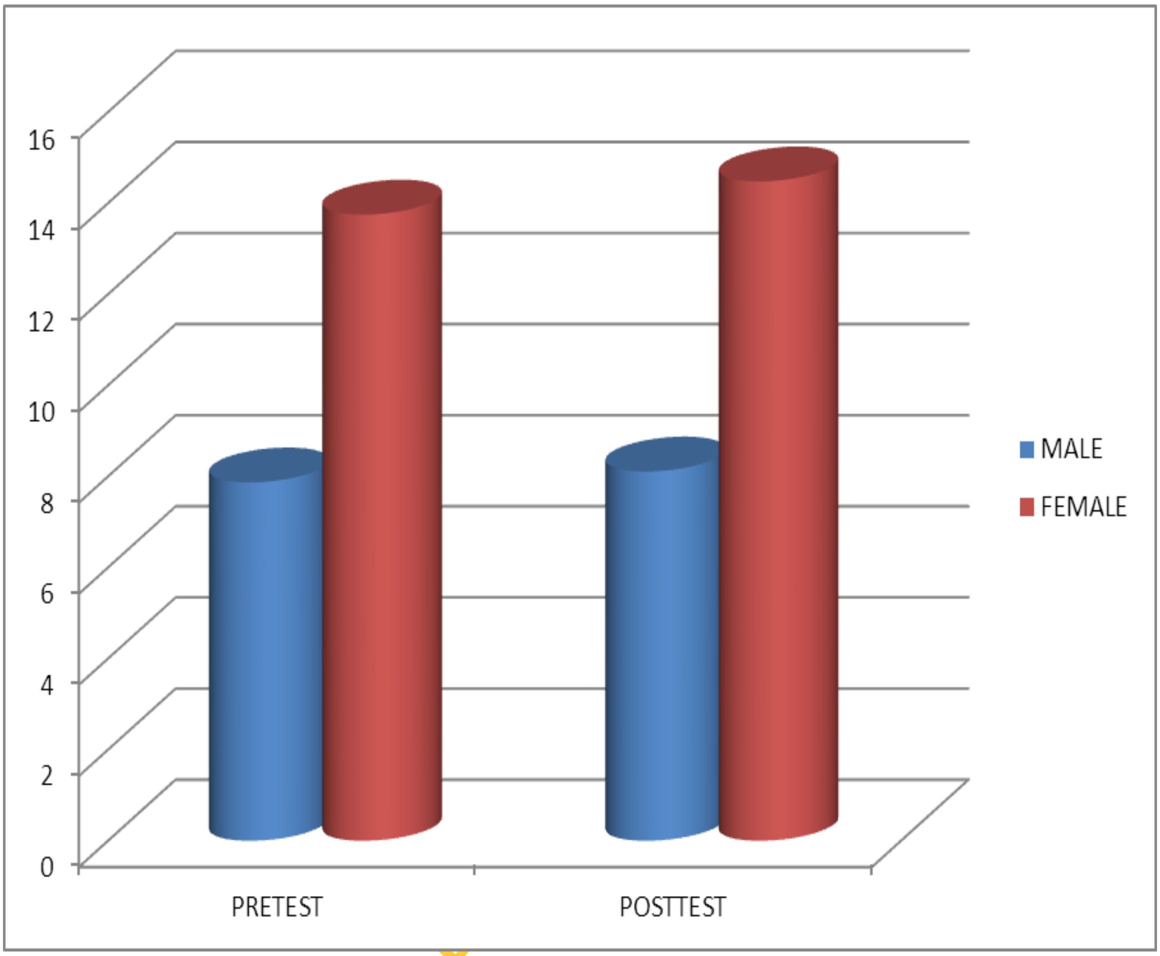


Figure 4.7: Bar Chart showing Descriptive Statistics of Achievement associated with Gender.

Figure 4.7 is the Bar Chart showing Descriptive Statistics of Achievement associated with gender. There are improvements in the mean achievement scores of male by 5.88 (pretest mean = 7.87, post test mean = 13.75) and female by 6.37 (pretest mean = 8.11, post test mean = 14.48).

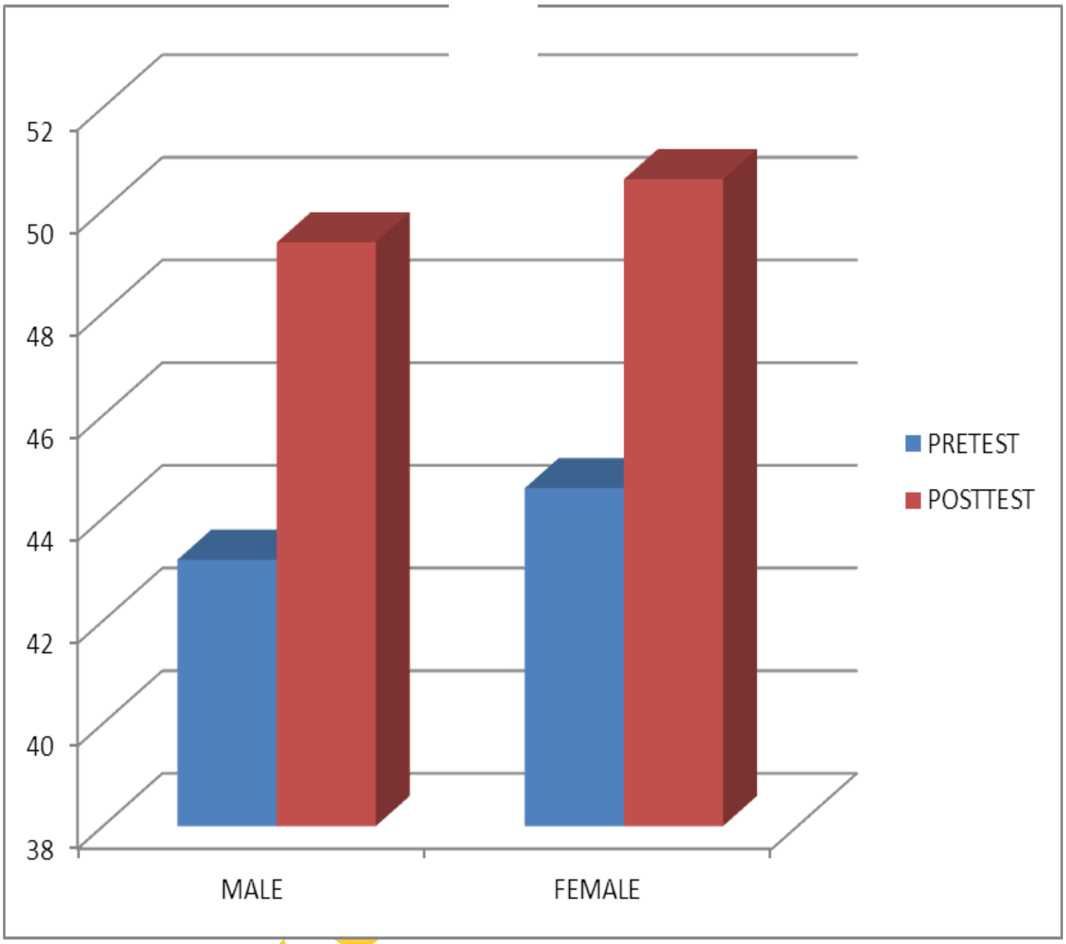


Figure 4.8: Bar Chart showing Descriptive Statistics of Attitude associated with Gender.

Figure 4.8 is the Bar Chart showing Descriptive Statistics of attitude associated with gender. The mean shows greater improvement in male attitudinal scores by 6.18 (pretest mean = 43.19, post test mean = 49.37) and female attitudinal scores improve by 6.02 (pretest mean = 44.58, post test mean = 50.60).

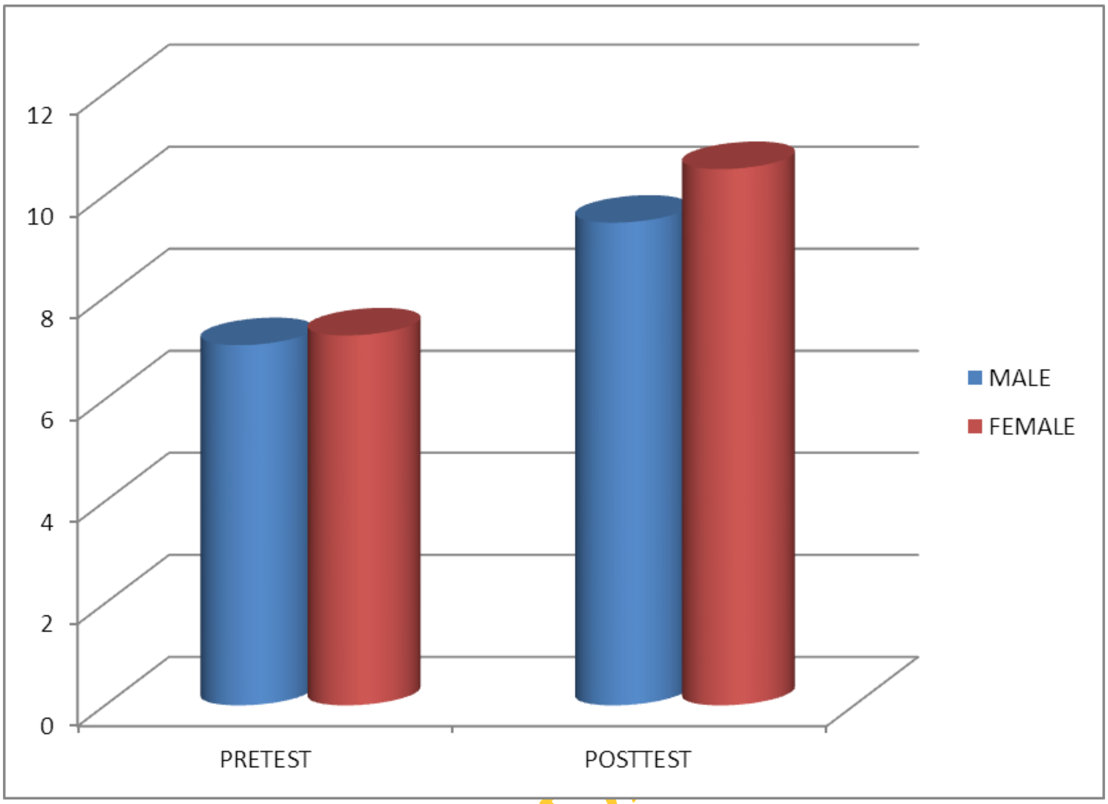


Figure 4.9: Bar Chart showing Descriptive Statistics of Science Process Skill associated with Gender.

Figure 4.9 is the Bar chart showing Descriptive Statistics of Science Process Skill associated with gender.

The mean science process skills scores of female students show greater improvement by 3.26 (pretest mean = 7.25, post test mean = 10.51) than that of male students by 2.40 (pretest mean = 7.06, post test mean = 9.46).

4.2 Testing the Null Hypotheses

4.2. 1a. HO1a: There is no significant main effect of Treatment on Students' attitude towards Basic Science

Table 4.4: 3x3x2 ANCOVA of Post-test Attitude Scores of Students by Treatment, Parent Educational Background and Gender.

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Square
Main Effect:	9164.051	18	509.114	10.539	.000	.339
Pretest Attitude to Basic Science	3746.660	1	3746.660	77.561	.000	.173
Treatment groups	1284.342	2	642.171	13.294	.000*	.067
Parent Educational Background	88.909	2	44.454	.920	.399	.005
Gender	21.901	1	21.901	.453	.501	.001
2-way Interactions:						
Treatment group x PEB	230.636	4	57.659	1.194	.313	.013
Treatment group x Gender	55.935	2	27.967	.579	.561	.003
Qualification x Gender	141.910	2	70.955	1.469	.232	.008
3-way Interaction:						
Treatment x PEB x Gender	82.360	4	20.590	.426	.790	.005
Explained	9164.051	18	509.114			
Residual	17873.204	369	48.306			
Total	27037.254	387				

*Significant at P<0.05

Table 4.7 shows that there is significant effect of treatment on students' attitude towards Basic Science (F (2.369) = 13.294; P<.05; η^2 = 0.067). On this basis, hypothesis 1a is rejected. This means that the difference between the attitudes score of students exposed to treatment group is significant. To find out the magnitude of mean scores of the group performance. Table 4.8 is presented as follows.

Table 4.5: Estimated Marginal Means of Attitude score of students According to treatment group.

	Mean	Std. Error	Upper Bound	Lower Bound
Active Reviews	51.11	1.89	52.13	50.09
Practice-Invention	53.64	2.04	55.86	51.22
Modified Conventional	45.28	2.17	46.52	44.04

Table 4.8 shows that students in the Practice-invention group had the highest adjusted posttest mean attitude scores ($\bar{x}$=53.64), followed by those in Active Review group ($\bar{x}$=51.11), while students in the modified Conventional Strategy group had the least adjusted mean attitude scores ($\bar{X}$=45.28). Further, the source of the significant difference obtained is traced using Scheffe Post hoc test in Table 4.9

Table 4.6: Scheffe Post-Hoc of Attitude score of students According to treatment group.

Treatment	N	Mean	Active review	Practice-Invention	Modified Conventional
Active Reviews	131	51.11			*
Practice –Invention	125	53.64			*
Modified Conventional	131	45.28	*	*	

The result from post-hoc analysis in Table 4.9 shows that attitude mean scores of students in Practice-invention is significantly better than that of Modified Conventional Strategy in their mean attitude scores. This shows the direction of increasing effect of instructional strategy (treatment) on attitude as Modified Conventional Strategy does not perform better than Active Review Strategy, while Practice-Invention Strategy performs better than Active Review Strategy.

4.2.1 HO1b There is no significant main effect of treatment on Junior Secondary Schools Students' Achievement in Basic Science.

Table 4.4 represent the summary of ANCOVA results on students' post test achievement scores.

4.2.1a HO Ib. There is no Significant main effect of Treatment on Students' Achievement in Basic Science

Table 4.7: 3x3x2 ANCOVA of Students' Post-test Achievement Scores by Treatment, Parent Educational Background and Gender

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Square
Main Effect:	1315.969	18	73.109	20.066	.000	.494
Pretest Achievement in Basic Science	1000.392	1	1000.392	274.574	.000	.426
Treatment groups	256.850	2	128.425	35.248	.000*	.160
Parent Educational Background(PEB)	11.738	2	5.869	1.611	.201	.009
Gender	20.656	1	20.656	5.669	.018*	.015
2-way Interactions:						
Treatment group x PEB	32.474	4	8.119	2.228	.065	.024
Treatment group x Gender	4.651	2	2.325	.638	.529	.003
PEB x Gender	40.517	2	20.259	5.560	.004*	.029
3-way Interaction:						
Treatment x PEB x Gender	24.631	4	6.158	1.690	.152	.018
Explained	1315.969	18	73.109			
Residual	1348.073	369	3.643			
Total	2664.041	387				

*Significant at P<0.05

Table 4.4 shows that treatment has significant main effect on students' post-test achievement scores (F (2,369) =35.248;p<.05, η^2 =.160). On the basis of these findings, hypothesis 1b is rejected. To find the magnitude of the mean scores of the group's performance.

Table 4.8: Estimated Marginal Mean scores of the Treatment Group's Performance.

	Mean	Std. Error	Upper Bound	Lower Bound
Active Review	14.62	0.62	16.89	12.35
Practice –invention	14.64	0.67	15.68	13.60
Modified Conventional	13.08	0.72	14.08	12.08

Table 4.8 shows that students in the Practice-invention group have the highest adjusted review posttest mean achievement scores ($\bar{x}$=14.64), followed by those in Active review group ($\bar{x}$=14.62) while students in the conventional lecture strategy group have the least adjusted mean achievement scores ($\bar{x}$=13.08). Furthermore, the source of the significant difference obtained in Table 4.3 is traced using Scheffe Post-Hoc test.

Table 4.9 Scheffe Post-Hoc Test of Achievement according to Treatment

Treatment	N	Mean	Active review (1)	Practice-Invention (2)	Modified Conventional (3)
Active Reviews					
Practice – invention	131	14.62			*
Modified	125	14.64			*
Conventional	131	13.08	*	*	*

The result from post-hoc analysis in table 4.6 shows that practice-invention strategy is the best among the three strategies in enhancing achievement in Basic Science.

4.2.1c. HO1c: There is no significant main effect of treatment on students' science process skills in Basic Science.

Table 4.10: Summary of 3x3x2 ANCOVA of post-test Practices by Treatment, Parents' Educational Background and Gender on Process Skills

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Square
Main Effect:	6033.809	18	335.212	10.910	.000	.347
Pretest Science process skill	1198.833	1	1198.833	39.019	.000	.095
Treatment groups	1806.420	2	903.210	29.397	.000*	.137
Parent Educational Background	41.726	2	20.863	.679	.508	.004
Gender	44.636	1	44.636	1.453	.229	.004
2-way Interactions:						
Treatment group x PEB	194.532	4	48.633	1.583	.178	.017
Treatment group x Gender	180.842	2	90.421	2.943	.054	.016
Qualification x Gender	151.306	2	75.653	2.462	.087	.013
3-way Interaction:						
Treatment x PEB x Gender	171.991	4	42.998	1.399	.234	.015
Explained	6033.809	18	335.212			
Residual	55249.000	369	30.724			
Total	17401.779	387				

*Significant at P<0.05

Table 4.10 shows that there is significant main effect of treatment on students' science process skills (F $_{(2,369)}$ =29.397; $_{P}$< .05, η^2 =.137) Hypothesis 1c is therefore rejected. This implies that there is significant difference in the science process skills of students exposed to the treatment.

Table 4.11: Estimated Marginal Means of Post Test Practices Score by Treatment and Control Group.

	Mean	Std. Error	Upper Bound	Lower Bound
Active review	12.43	1.29	13.44	11.42
Practice – invention	11.29	1.55	12.28	10.30
Modified Conventional	6.24	1.66	6.77	5.71

Table 4.11 shows that students in the Active Review Strategy group have the highest adjusted post test mean science process skill score ($\bar{X}$= 12.43), followed by the Practice-invention group ($\bar{X}$=11.29), while students in the Modified Conventional Strategy group had the least adjusted mean Modified Convention Strategy Score ($\bar{X}$= 6.24).

Further, the source of the significant difference obtained in table 4.10 was traced using Scheffe post-hoc test in Table 4.12

Table 4.12: Scheffe Post hoc of Post Test Practices' Score by Treatment and Control Group

Treatment	N	Mean	Active review	Practice-Invention	Modified Conventional
Active Review	131	12.43			*
Practice – invention	125	11.29			*
Modified Conventional	131	6.24	*	*	

The result from post-hoc analysis in Table 4.12 shows that group 1 (Active Review Strategy) is significant different from Modified Conventional Strategy in their science process skill. Practice-invention Strategy is significantly different from Modified Conventional Strategy in Science Process Skills. These show the direction of increasing effect of instructional Strategy (treatment) on science process skills as Active Review Strategy performing better than Practice-invention Strategy, while practice-invention strategy performs better than Modified Conventional Strategy.

Main effect of Parents' Educational Background

4.2.2a HO_{2a}: There is no significant main effect of Parents' Educational Background on Students' Attitude.

Table 4.7 reveal that there is no significant main effect of Parents' Educational Background of participants on students attitude towards Basic Science (F $_{(2,369)}$ =.920$_P$ > 0 .05, η^2 = .005). The effect size of 0.5 is negligible hence, hypothesis 2b is not rejected.

Table 4.13: Estimated Marginal Means of Post Test Attitude score by Parents' Educational Background Group.

	Mean	Std. Error	Upper Bound	Lower Bound
Low	49.78	1.63	50.78	48.78
Medium	50.66	1.33	53.64	47.68
High	49.51	3.15	50.87	48.15

From Table 4.14 students whose parents have Medium education background have the highest mean $\bar{X}$= 50.66, followed by those with Low parental educational background $\bar{X}$= 49.78, while the least is from those with High parental educational background $\bar{X}$= 49.51.

4.2.2b HO_{2b}: There is no significant main effect of Parents' Educational Background on students' achievement in Basic Science.

Table 4.4 shows that Parent educational background has no significant main effect on the students achievement (F $_{(2,369)}$ =1.611) $_{P}$>0.05, η^2 = .009). The effect size of .9% is negligible. Therefore, hypothesis 2a is not rejected.

Table 4.14: Estimated Marginal Means of Post Test Achievement Score by Parents' Educational Background.

	Mean	Std. Error	Upper Bound	Lower Bound
Low	13.96	0.54	15.02	12.90
Medium	14.23	0.44	15.18	13.28
High	14.15	1.04	14.25	14.05

From Table 4.13 students in Medium parent educational background group have the highest mean score of $\bar{X}$= 14.23, followed by those in High parental educational background group $\bar{X}$= 14.15, while the lowest is $\bar{X}$= 13.96 which comes from low parental educational background. However, the difference in their means scores is not significant.

4.2.2c HO_{2C}: There is no significant main effect of Parents' Educational Background on students' Science process skills.

Tables 4.10 reveals that there is no significant effect on parents' educational background on participants' science process skills (f (2,369) =.679; $p > 0.05$, $\eta^2 = .004$). The effect size of 0.4% is negligible. Therefore, hypothesis 2c is not rejected.

Table 4.15: Estimated Marginal Means of Post Test Science Process Skills' Score by Parents Educational Background Group.

	Mean	Std. Error	Upper Bound	Lower Bound
Low	9.44	1.24	10.43	8.45
Medium	9.97	1.01	11.32	8.62
High	10.55	2.40	12.43	8.67

From Table 4.15, Students with High parent educational background had the highest science process skills $\bar{X}$= of 10.55, followed by students with medium parents' educational background $\bar{X}$= 9.97, while the least is from those parents have low educational background $\bar{X}$= 9.44. The difference is however not significant.

Main effect of Gender

4.2.3a HO_{3a}: There is no significant main effect of Gender on students' attitude towards Basic Science.

As shown in Table 4.7, the effect of gender on participants' attitude towards Basic Science was not significant (F (1,369) =.453; $p > 0.05$ η^2 =.001).

Table 4.16: Estimated Marginal Means of Post Test Attitude Score by Gender.

	Mean	Std. Error	Upper Bound	Lower Bound
Male	13.75	0.70	14.68	12.82
Female	14.48	0.64	15.36	13.60

From table 4.17, female students have higher mean $\bar{X}$= 14.48 while male students have a lower mean of $\bar{X}$= 13.75; the difference is however not significant.

4.2.3b HO_{3b}: There is no significant main effect of gender on students' achievement in Basic Science

Table 4.4 shows that gender has significant effect on students' achievement in Basic Science ($F_{(1,369)}$ =5.669 $p< .05$, η^2 =.015. Therefore, hypothesis 3b is rejected.

Table 4.17: Estimated Marginal Means of Post Test Achievement Score by Gender.

	Mean	Std. Error	Upper Bound	Lower Bound
Male	13.75	0.70	14.75	12.75
Female	14.48	0.64	15.54	13.42

From Table 4.16 female students have higher mean $\bar{X}$= 14.48, while the male students have a lower mean $\bar{X}$= 13.75, though the difference was not significant.

4.2.3c HO_{3c}: There is no Significant Main Effect of Gender on Students' Science Process skills in Basic Science.

From Table 4.10, there is no significant effect of gender on participants' science process skills in Basic Science ($F_{(1,369)}$ = 1.453$p > .5$, η^2 =.004). The effect size 00.4% is negligible. Therefore, the hypothesis is not rejected.

Table 4.18 Estimated Marginal means of post test Science Process Skills' score by Gender.

	Mean	Std. Error	Upper Bound	Lower Bound
Male	9.46	1.61	9.52	9.40
Female	10.51	1.49	9.50	11.52

From Table 4.18, female students have higher mean $\bar{X}$= 10.51, while male students have a lower mean $\bar{X}$= 9.46. Still the difference is not significant.

4.2.4a HO_{4a}: There is no significant interaction effect of Treatment and Parents' Educational Background on students' attitude to Basic Science.

The results from Table 4.7 shows that there is no significant interaction effect of treatment and parent educational background on students' attitude to Basic Science (F ($_{4,369}$ = 1.194; $_{P}$<.05, η^2 = .013). This means that there is no significant interaction effect of treatment and parents' educational background on attitude to Basic Science among participants. Hence, Ho4b is not rejected.

4.2.4b HO_{4b}: There is no significant interaction effect of treatment and Parental Educational Background on students' achievement in Basic Science.

The results from Table 4.4 show that there is no significant interaction effect of treatment and parental supportiveness on students' achievement in Basic Science (F4,369 = 2.228; P >0.05, η^2 = .024). This means that there is no significant interaction effect of treatment and parental educational background on students' achievement in Basic Science. Hence, Ho4a is not rejected.

4.2.4c HO_{4c}: There is no significant interaction effect of Treatment and Parental Educational background on students' Science Process Skills in Basic Science.

The results in Table 4.10 show that there is no significant interaction effect of treatment and parent educational background on students' science process skills in Basic Science (F ($_{4,369}$ = 1.158; $_{P}$< 05, η^2 = .017). This means that there is no significant interaction effect of treatment and parent educational background on science process skills in Basic Science among participants. Hence, Ho4c is not rejected.

4.2.5a HO_{5a}: There is no significant interaction effect of Treatment and gender on Students' Attitude to Basic Science.

The results in Table 4.7 show no significant interaction effect of treatment and gender on students' attitude to Basic Science (F ($_{2,369}$ = .579; P<.05, η^2 = 0.003). This means that there is significant interaction effect of treatment and gender on students' attitude to Basic Science among participants, hence Ho5b was not rejected.

4.2.5b HO_{5b}: There is no significant interaction effect of treatment and Gender on Students' Achievement in Basic Science.

The results from Table 4.4 showed that there is no significant interaction effect of treatment and gender on achievement in Basic Science (F $(_{2,369}$ = .638; $_{P}$<.05, η^2 = .003). This means that there is no significant interaction effect of treatment and gender on students' achievement in Basic Science among participants. Hence, Ho5a is not rejected.

4.2.5c HO_{5c}: There is no significant interaction effect of treatment and gender on Students' Science Process Skills in Basic Science.

The results from Table 4.10 show that there is no significant interaction effect of treatment and gender on students' science process skills in Basic Science (F2,369 = 2.943; P<.05, η^2 = .016).This means that there is no significant interaction effect of treatment and gender on science process skills in Basic Science. Hence, Ho5c is not rejected.

4.2.6a HO_{6a}: There is no significant interaction effect of gender and Parents' Educational Background on Students' Attitude to Basic Science.

The results from Table 4.7 showed there is no significant interaction effect of gender and parents' educational background on students' attitude to Basic Science (F $(_{2,369}$ = 1.469; $_{P}$<05, η^2 = .008). This means that there is no significant interaction effect of gender and parents' educational background on students' attitude to Basic Science. Hence, HO_{6b} is not rejected.

4.2.6b HO_{6b}: There is significant interaction effect of Parent Educational Background and Gender on Students' Achievement in Basic Science.

The results from Table 4.4 show that there is significant interaction effect of parents' educational background and gender on students' achievement in Basic Science (F $(_{2,369})$ = 0.004; P<.05, η^2 = 0.029). This means that there is significant interaction effect of gender and parent educational background on students' achievement in Basic Science. Hence, Ho6a is rejected. Figure 4.10 indicates in descending order, the magnitude of the direction to the significant effect:

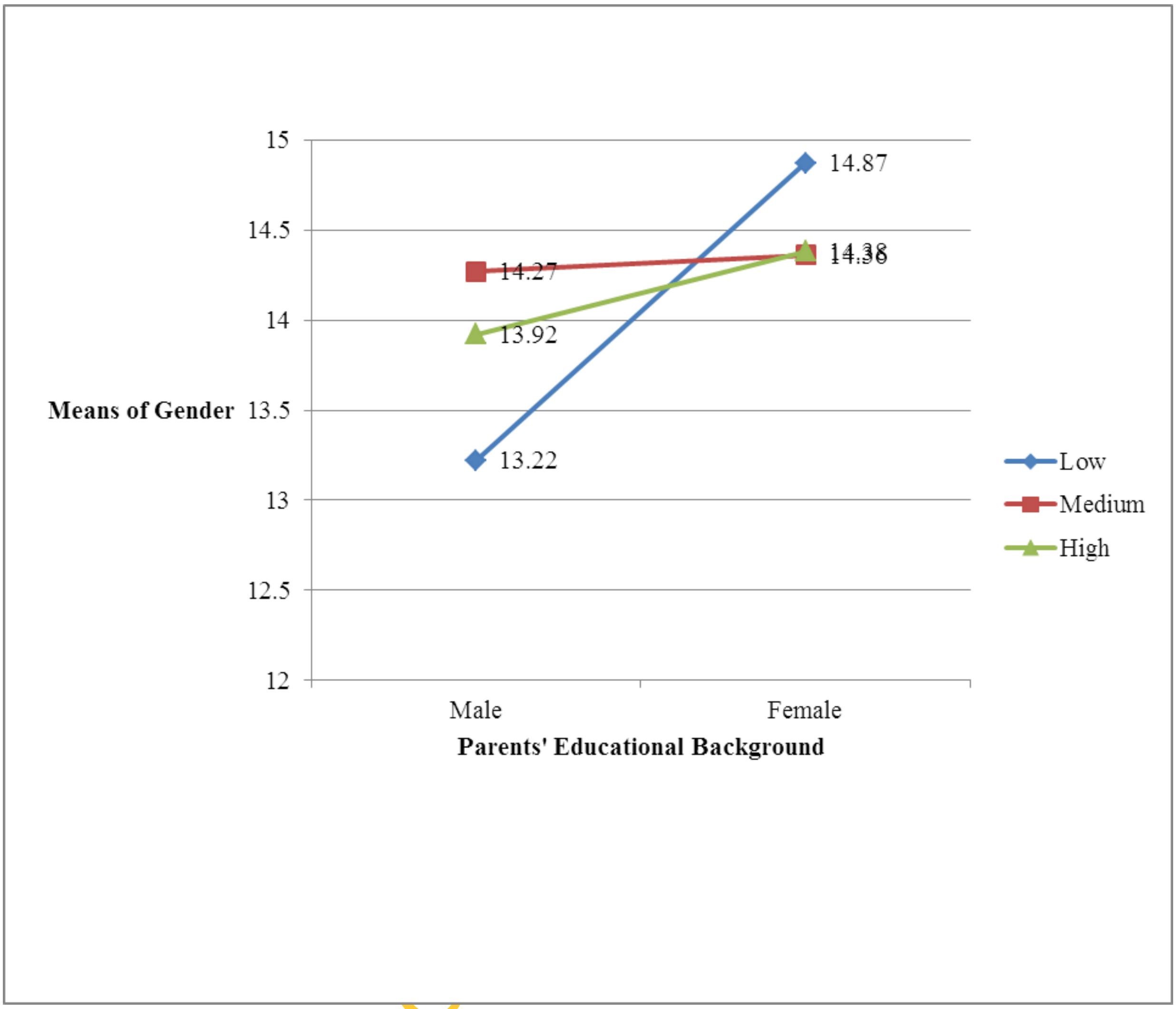


Figure 4.10: Interaction Effect of Gender and Parents' Educational Background on Achievement

The highest contribution and the source of the significant effect comes from female low parent educational background $\bar{X}$= (14.87), followed by the female high parent educational background $\bar{X}$= (14.38), then female medium parents' educational background $\bar{X}$= (14.36), followed by male medium parents' educational background $\bar{X}$= (14.27), followed by male high parent educational background $\bar{X}$= (13.92) and lastly, male low parent educational background $\bar{X}$= (13.22). The graph is ordinal, which shows classification as well as magnitude of what is measured.

4.2.6c HO_{6C}: There is no significant interaction effect of gender and Parental Educational Background on students' Science Process Skills in Basic Science

The results from Table 4.10 show that there is no significant interaction effect of gender and parent educational background on students' science process skills in Basic Science ($F_{(1,369)}$ = 2.462; P<.05, η^2 = .013).This means that there is no significant interaction effect of gender and parent educational background on students' science process skills in Basic Science. Hence, HO_{6c} is not rejected

4.2.7aHO_{7a}: There is no significant interaction effect of Treatment, Gender and Parents' Educational Background on students' attitude to Basic Science.

The results from Table 4.7 show that significant interaction effect of treatment, gender and parent educational background on students' attitude to Basic Science ($F_{(4,369)}$ = .426; P<.05, η^2 = .005). This means that there is no significant interaction effect of treatment, gender and parent educational background on students' attitude to Basic Science. Hence, HO7c is not rejected.

4.2.7b HO_{7b}: There is no significant interaction effect of Treatment, Gender and Parent on students' Achievement in Basic Science.

The results from Table 4.4 showed no significant interaction effect of treatment, gender and parent educational background on students' achievement in Basic Science ($F_{(4,369)}$ = 1.690; P<.05, η^2 = .018). This means that there is no significant interaction effect of treatment and parent educational background on students' achievement in Basic Science. Hence, HO_{7a} is not rejected.

4.2.7c HO_{7c}: There is no significant interaction effect of Treatment, Parent Educational Background and Gender on students' Science Process Skills in Basic Science.

The results from Table 4.10 showed no significant interaction effect of treatment, gender and parents' educational background on students' science process skills in Basic Science ($F_{(4,369)} = 1.339$; $P< .05$, $\eta^2 = .015$). This means that there is no significant interaction effect of treatment, gender and parent educational background on students' science process skills in Basic Science Hence, HO_{7c} is not rejected.

4.3 Discussion

4.3.1 Treatment and Students' attitude towards Basic Science

The results obtained in this study showed that there is a significant main effect of treatment on students' attitude to Basic Science. Practice-invention strategy is more effective than the active review strategy and the modified conventional strategy. The effectiveness of Practice-invention over both active review and modified convention strategies may be as a result of the fact that the students were given opportunity to practice using non-routine method and because they re-discovered new concepts by manipulating apparatus through appropriate heuristic approach.

The finding of this study is in agreement with the submission of Gazi, Oloruntegbe and Orimogunje (2010) and Aremu and Sangodoyin (2010), who found that students' with student centered strategy performed better than those with conventional lecture strategy. The Active Review Strategy is reported to be more effective than conventional strategy. This may be as a result of the fact that the teacher monitored the students' progress in active review, provided support, feedback and scores were awarded to each group. This could have served as reinforcement to them thus changing the attitude towards Basic Science. This is in line with the study of Duron, Limbach, and Waugh (2006), and Gurung (2005).

However, this finding is opposed to that of Brenda (2003), who argued that the conventional lecture method could not be totally ignored. Practice invention shows best positive attitude / favourable attitude which leads to significant / higher attitude in science. The strategy affects, to a large extent, attitude of students in science (Adetunji, 2000; Abram, 2004). While, the result supports the work of Abram (2004) who found that attitudes tended to vary significantly in relation to research strategy used. Teachers that, are undertaking students' centered strategy tend to be more positive about their students' attitude towards the subject (80.6% positive. Attitude towards science varied in relation to specific subjects taught. Those teaching science and technology are more positive about attitude towards the subject.

4.3.2 Treatment and Students' Achievement in Basic Science

The result of this study showed that the treatments have significant effect on students' achievement in Basic Science. The results show that Practice-invention (Pi) strategy is more effective followed by active review strategy and conventional lecture strategy is the least effective. The effectiveness of Practice-invention is as a result of the fact that the students are made to reason in the selected topics and they have opportunity to practice and discover ideas. Also, students were made to compare their results with those of other members to identify possible errors. This finding is in agreement with the finding of Grouws and Cebulla (2000), Abram (2004) and Adegoke and Ibode (2011).

The active review instructional strategy is also more effective than conventional teaching strategy. This may be as a result of the fact that in active strategy, students were allowed to work in groups and teachers also provided support for the learning activities. This finding is in agreement with Gurung's (2005) view that well-designed review help students organise the materials to be studied.

Active review strategy is the magic balm that can alleviate exam woes and stress. It offers students opportunity to gain through understanding of the materials. Research on the use of active review strategies in developing countries, (particularly Nigeria), is still very low, except in South Africa where it has been tested (Ndukka 2005). Hence, Donkor (2006) suggested its use in other African countries in teaching and learning of science. Active Review Sessions are intended to help students learn and prepare for upcoming exams. Most sessions are passive question-and-answer sessions that look backward at content deficits rather than advancing students' learning. Jenson and Moore (2009) noted that students who attended one or more review classes earned higher grades than those that did not.

Okurumeh (2009) used Practice and invention strategy with other retention enhancing strategies to teach the concepts of the sets statistics and probability to 346 SS2 students from Delta State, Nigeria. He reported that the treatment had a significant effect on students' achievement in Mathematics. The result analysis showed that students in the Practice invention strategy group obtained the highest post-test mean score than the other strategies. Based on his analysis, he then concluded that Practice-invention strategy is most effective in improving students' achievement in Mathematics than the modified conventional strategy.

The finding of Okurumeh's (2009) study made the investigation of the effect of this strategy on ecology imperative in the sense that the strategy may also improve the performance of students in statistical concept in ecology, such as population studies, distribution of organisms etc. Abimbola (2013) has shown that when students have opportunities to develop their own solution methods, they apply Mathematical knowledge in Biological science better.

Using Practice and Invention, Ogundiwin and Ahmed (2015) opined that students' work must include tasks that require such reasoning, and the competence in procedures that is stated in the objective and the curriculum include attention to such procedure in which the Science teacher grasp the interest of science students when problem-solving skills is developed by the students. The finding of Ogundiwin and Ahmed (2015) on Practice and Invention Strategy indicated that the strategy enhanced students' problem solving skills in ecology. The increase in the problem-solving skills might be attributed to the fact that the instructional strategies encouraged student-to-student interaction thus enhancing learning through group cooperation. In addition, the students' interest in the subject was enhanced and this led to a positive effect on their problem solving skills.

4.3.3 Treatment and Science Process Skills

The finding of this study reveals a significant main effect of treatment on students' science process skills in Basic Science. Active review is more effective followed by Practice-invention and modified conventional strategy is the least effective. The effectiveness of active review strategy over others may be as a result of the fact that students worked as a team and later practiced the skills on their own in the classroom under the supervision of the teacher. This shows the importance of the teacher in learning activities as the teacher brings his expertise to the learning situation. This finding is in line with the submission of Ivowi (2006), Nneji (2006) and Wetzel (2010).

Process skills facilitate learning in physical sciences, ensure active students' participation, have students develop a sense of responsibility in their own learning and increase the permanence of learning. They also help students to learn research ways and methods, they ensure that students and behave like scientists (Ergul; Simsekli, Calis, Ozdilek Gocmencelebi and Sanli, 2011). They are inseparable in practice from the conceptual understanding that is involved in learning and applying science.

Ergul *et.al.* (2011) concluded that learning science goes beyond scientific knowledge acquisition, since it includes the acquisition of cognitive skills such as the science process skills. They said skills are an important method in teaching science lessons and are also the building-blocks of critical thinking and inquiry in science. Learning science lessons by apprehending requires using Science Process Skills. Having science process skills acquired, at the same time, means preparing future scientists, having scientific literacy acquired, helps students to use science information in daily life (personal, social and global). Science process skills are based on scientific inquiry and teaching science by inquiry involves teaching students science process skills as well as critical thinking and scientific reasoning skills used by scientist. They are acquired through training and direct experiences as supported by Njoku (2002).

4.3.4a Gender and Students' Attitude to Basic Science

The result obtained in this study show no significant interaction effect of treatment and gender on students' attitude to Basic science. The results simply that the female perform better than their male counterpart in attitude and this is in line with Kan and Akbas (2006) and Raimi and Adeoye (2002) who observed significant difference exist in favour of boys. Also, Akinbola (2006) and Alake (2007) discovered no significant difference in the performance of boys and girls in science classes. However, Odebode (2001) reported no gender roles that, girls perform better in verbal tests and obtain higher grades than boys, while boys excel in mathematics and all science related subject.

3.5.4 b Gender and Students Achievement

The result of this study shows that gender has significant effects on students' achievement attitude and science process skills. The female perform better than their male counterpart in achievement, attitude and science process skills and this is in line with Kan and Akbas (2006), though, Raimi and Adeoye (2002) observed that significant difference exist in favour of the boys. Ukwungu (2002) applied mental-analytic techniques on 34 students, assessing the magnitude and direction of Integrated Science using the statistics. The result indicated that gender difference in performance in Integrated Science in Nigeria is small (d = 0.13) and in favour of males. The value d = 0.13, translating to r = 0.06, implies that only 0.4% of the variance in performance of Integrated Science is accounted for by gender. However, the Binominal Effect Size Displace (BESD) shows that this proportion of variance accounted for by gender is equivalent to increasing success rate from 47% to 53%. A difference of 6% would provide an advantage over girls in a final or selection examination. Girls therefore need greater attention during Integrated Science classes.

Besides, Gaigher (2004) worked on the significant gender difference in learning outcomes in science courses. The researcher observed that a significant difference exist and is in favour of the boys. However, Raimi and Adeoye (2002), Akinbobola (2004) and Alake (2007) discovered no significant difference in the performance of boys and girls in science classes. However, to Odebode (2001), girls perform better in verbal tests and obtain higher grades than boys, while boys excel in mathematics and all science related subjects. She observed that girls are heroines and fearful, while boys show greater courage and achievements. Throughout the world, women are higher in verbal ability than men, but are lower in mathematics and spatial ability. Men are superior to women in performing tasks and have specific abilities related to solve problems (Asoegwu, 2008).

Literature also established significant gender difference in attitude towards and interest in science, with girls losing interest faster than boys in secondary school (Gonen and Basavan, 2008; Elster, 2007). Also, Logan and Skamp (2008) indicate that these gender differences are most likely to be connected with a number of variables related to classroom experiences, including pedagogical variables. Onah and Ugwu (2010) in their study to determine the factors which predict performance in secondary school level. Similarly, the findings of Oredein and Awodun (2013) revealed some significance in the aspect of gender difference in favour of boys in Physics' achievement. Also, Ogunleye and Babajide (2012) observed that there is gender inequality in science, technology and mathematics.

Conversely, Igbokuuwe (2004), Ma (2002) and Coley (2010) in their separate comparative analysis of SSCE and NECO results in Ohaukwu local government area of Ebonyi state, gender differences in learning outcomes background and differences in gender gap comparisons across racial/ethnic groups in education and work respectively reported that there is no significant effect of gender on achievement in physics.

4.3.4c Gender and Students' Science Process Skills in Basic Science

The result obtained shows no significant effect of treatment and gender on Students Science Process skills. This in line with Karamustafaoglu, (2011) who considered being efficient in learning and teaching, engages a significant place in various countries' teaching programmes. Also Karen (2009) observed Science Process skills as Practical skills that simplify learning science, activate students, and help them to develop a sense of responsibility in their own learning while Omosewo (2010) and Boyo (2011) referred to Science process skills that could only be acquired through frequent exposure to practical sessions.

4.3.5 Treatment and Parent Educational Background on Students' Attitude

The results obtained in this study showed that the two-way interaction effect of treatment and parent educational background was not significant. This implies that irrespective of students' parental educational background, if effective instructional strategy such as active review and practice-invention instructional strategies are used to teach Basic Science to Junior secondary schools students, they are likely to perform well according to the findings of this study.

4.3.6 Parental Educational Background and Gender on Students' Achievement.

The result obtained show that the two way interaction effect of students' parental educational background and gender on students' academic achievements is significant. The highest contribution and the source of the significant effect is from those in female Low parent educational background .This finding is in support of Ahove and Alabo (2002), who found that parental educational background creates a significant difference in the performance of learners in environmental background.

Also Adeogun (2009) observed that PEB has significant effect on the relationship between students' attitude and achievement in Mathematics and science subject respectively. Parental educational background and gender affect students' achievement in Basic Science according to Dinah (2013), who concluded that availability of text books, laboratory apparatus and other learning resources contribute significantly to the performance of students in Basic Science examination.

He added that students with positive attitude towards the subject register better performance than those who have a negative attitude. Those with positive attitude are motivated to work hard and this is reflected in the good marks they get in the examinations. Suman (2011) conducted a study on influence of education and parental occupation on academic achievement of students. He concluded that education and occupation of parents positively influence the academic achievement of children Ogunsola (2012) concluded that educational qualification of parents and health of teachers and their students' are significant factors that affect the academic performance of students.

Akinsanya *et. al*. (2014), observed that parents' education has the highest significant influence on the academic achievement of students. This is because the child from educated family has a lot of opportunity to study hard due to his/her access to internet, newspaper and television. They are also taught extra lessons at home, while students raised in an illiterate family have limited access to that.

4.3.6 Treatment and Gender on Students' Attitude.

The results obtained in this study show that the two-way interaction effect of treatment and gender is not significant. This implies that irrespective of students' treatment and gender, if effective instructional strategy such as active review and practice-invention instructional strategies on students were used to teach Basic Science to junior secondary school students, they are likely to perform better according to the findings of this study. This is in line with the findings of Achor, Wude and Duguri (2013) that gender stereotypes seem to be a major impediment to the achievement while Oludipe (2012) agreed that gender bias is very prevalent in Africa and particularly Nigeria, he argued that in Nigeria harder tasks are assigned to male while females are given the relatively easy and less demanding tasks.

4.3.7 Parental Educational Background and Gender on Students' Achievement.

The results obtained show that the two-way interaction effect of parent parental educational background and gender on students' academic achievements was significant. Parent educational background does not affect the achievement of either male or female students in the research. This finding is in support of Ahove and Alabo (2002) who said that parental educational background creates a significant difference in the performance of learners in environmental background. Also Adeogun (2009) observed that PEB has significant effect on the relationship between students' attitude and achievement in

Mathematics and science subject while Yaya (2010) concluded that children from broken homes and unstable marriage relations performs poorly in schools.

4.3.8 Three-way Interaction effect of treatment, parental education background and gender on students' achievement, attitude and science process skills in Basic Science.

The three-way interaction effects of treatment, Parents' Educational background and gender on student's achievement, attitude and science and science process skills is not significant. This shows that if same treatment is given to Basic Science students with high, medium and low parental educational background and male and female Basic science students, similar results would be achieved in student's achievement, attitude and science process skills as obtained in this result.

4.4 Summary of Findings

The findings in this study are summarized thus:

1. There was significant main effect of treatment on students' attitude to, achievement in and science process skills in Basic science. Practice-invention is more effective in enhancing students' academic achievement, attitude to Basic science than active review and conventional while the Active review strategy is better than Practice-invention and conventional strategies in science process skills
2. There is no significant main effect of parent' educational background on students' attitude to, achievement in and science process skills in Basic science
3. There is significant effect of gender on students' academic achievement in Basic Science but there is no significant main effect of gender on students' attitude to and science process skills in Basic Science.
4. There is no significant interaction effect of treatment and parental supportiveness on students' attitude to, achievement in science process skills in Basic science.
5. There is no significant interaction effect of treatment and gender on students' attitude to, achievement in science process skills in Basic science
6. There is no significant interaction effect of gender and parents' educational background on students' attitude to and science process skills in Basic Science, but there is a significant interaction effect of gender and parents' educational background on students' academic achievement in Basic science.

7. There is no significant interaction effect of treatment, gender and parents' educational background on students' attitude to, achievement in and science process skills in Basic Science.

CHAPTER FIVE

SUMMARY, EDUCATIONAL IMPLICATIONS, RECOMMENDATIONS AND CONCLUSION

5.1 Summary

This study examined the effects of Active Review and Practice-invention strategies on students' attitude to, achievement and process skills in Basic Science in Oyo State, Nigeria. It also examined the moderating effects of gender of the students and their Parent Educational Background on learning outcomes in selected contents in Basic Science. The research design adopted was pretest-posttest control group, quasi experimental design using a 3 x 3x 2 factorial matrix. Seven instruments were used in this study to collect data:

1) Students' Basic Science Attitude Scale (SBSAS)
2) Students' Basic Science Achievement Test (SBSAT)
3) Students' Basic Science Process Skills' Rating Scale (SBSPSRS)
4) Instructional Guide on Practice-invention strategy in Basic Science (IGPiSBS)
5) Instructional Guide on Active Review Strategy in Basic Science (IGARSBS)
6) Instructional Guide on Conventional Strategy in Basic Science (IGCSBS)
7) Evaluation Sheets for Assessing Teachers' Performance on the Strategy (ESATPS) on Active Review Strategy.
8) ESAT on practice- invention strategy.
9) ESAT on modified conventional strategy.

Three hundred and eighty seven JSS2 Basic Science Students 164 males and 223 females from nine intact classes participated in the study. Four Basic Science topics were used for the study. They are; (i) Work, Energy and Power. (ii) Petrochemicals and Crude Oil (iii) Living things (iv) Types of energy. The following work schedules were adopted: The first two (2) weeks for training of research assistants, one (1) week for pretest (administration of SBSAT, SBSAS and SBSPSRS): and eight (8) weeks for treatment employing the trained research assistants on the listed strategies. These took place simultaneously in all the schools selected and one (1) week for posttest (administration of SBSAT, SBSAS, and SBSPSRS).

Therefore, a total of twelve (12) weeks was spent. The data collected were analysed using Analysis of Covariance (ANCOVA), Estimated Marginal Mean (EMM) and Scheffe post- hoc analysis. Seven hypotheses were formulated and tested at 0.05 alpha levels.

The findings of this study revealed:

1. There was significant main effect of treatment on students' attitude to, achievement in and science process skills in Basic science. Practice-invention was more effective in enhancing students' academic achievement and attitude to Basic Science than Active Review and Conventional Strategies while Active Review performed better than Practice-invention and Conventional Strategies in Science Process Skills.
2. There was no significant main effect of Parent Educational Background on students' attitude to, achievement in and science process skills in Basic Science.
3. There was significant effect of gender on students' academic achievement in Basic Science, but there was no significant main effect of gender on students' attitude to Basic Science and Science Process Skills.
4. There was no significant interaction effect of treatment and parent educational background on students' attitude to, achievement in and science process skills in Basic Science.
5. There was no significant interaction effect of treatment and gender on students' attitude to, achievement in and science process skills in Basic Science.
6. There was no significant interaction effect of Gender and Parent Educational background on students' attitude to and Basic Science process skills in Basic Science, but there was a significant interaction effect of gender and parent educational background on students' academic achievement in Basic Science.
7. There was no significant interaction effect of treatment, gender and parent educational background of students' attitude to, achievement in and science process skills in Basic Science.

5.2 Educational Implications.

By engaging students in Practice-invention strategy and variety of questioning that relates to the idea or content being studied, students develop and apply critical thinking skills. It has also been discovered that children's sense of reality is based on their interactions with the environment and material in it (Piaget, 1954). That is why the use of Practice-invention strategy in which materials and objects from the children's environment enable them to recognize, verify and store experiences, tore-discover new concepts and manipulate apparatus through appropriate heuristic approach (by providing necessary environment and teaching materials through the teachers) is very important.

Jean Piaget a Swiss psychologist, proposed a development theory that has widely been discussed in both psychology and education fields. Learning to Piaget should be holistic in approach. A child constructs understanding through many channels such as reading, listening, exploring (as in the case of Practice-invention where students re-discover new concepts), and manipulating apparatus through appropriate heuristic approach in a necessary environment and with good teaching materials provided by teachers, where a learner is experiencing his environment.

Practice-invention strategy is based on constructivism perspective that sees learning as a construction. Piaget was the first to evolve a constructivist theory of cognitive functioning development from around 1920. The main argument from his theory arose from the weaknesses in the traditional answers put into stages: The first stage being that, human knowledge is innate, and the second human knowledge is directly shaped by experience (Gestalt, 1993). According to Piaget,

> *human beings are capable of extending biological programming to construct cognitive systems that, interpret experiences with objects and other persons*.

Thus, the choice of constructivist theory in this study is based on the assumption that students learn independently with practice-invention, to rediscover new ideas within themselves while research assistants serve as a guardian.

The exposure of the learners to Active review and Practice-invention strategies have been found to be positively enhance the students' attitude to, achievement and Science Process Skills in Basic Science. The findings have therefore revealed the importance of using teaching strategies that are participatory and learner-centered where learners are trained to take control and direct their learning processes for effective learning.

The study also revealed the need to incorporate in our educational system, the Active review and Practice-invention as strategies that could help in providing cognitive achievement in Basic Science, including the right attitudes and necessary science process skills needed to bring about necessary outcomes in Basic Science.

Active Review and Practice-invention strategies provide a means for students of both sexes (males and females) not to just memorize the materials but to critically think about the main terms and concepts. They can provide practice using multiple choices questions and with retrieval cues that can help with recall in an examination (Dickson, Miller & Devoley, 2005). In fact, Dickson *et. al*. (2005) compared two introductory psychology courses. One class was required to complete a study guide (e.g. fill-in-blanks, true and false), and the other was not. The class that, was required to complete the study guide performed significantly better, supporting the notion that study guides of Active strategies do benefit students (males and females) in classes with multiple choice exams as used in this research. However, students in a review strategy complete or discuss study guides in groups as shown in this research and then present or teach that section to the rest of the class, using the study guide as an outline for creating a practice exam through which the students can test themselves.

Practice Inventions is another review option. Studies show benefits to providing a practice exam if given in the same manner as the actual examination. That is, students should study beforehand and take the practice examination without using notes. Students who participate in such an activity have a better idea of how well they would do in the exam without any further practice or studying. This allows them to adjust their studying accordingly or to focus on areas that need more of their attention (Ogundiwin and Ahmed, 2015).

Active review strategy according to Koriat and Bjork (2005) supported this concept of self-assessment. The scholars reported that, judgements of learning following study are generally more accurate than retrospective assessments made following an examination. Holding a review strategy in this format with the high parents' background for both sexes of students also allow students to be engaged in the session because they have the opportunity to answer the questions themselves (either out-loud or mentally), before receiving the answers. The final and perhaps most important component for review sessions is metacognition, defined as the knowledge of one's knowledge, processes, cognitive and affective states and the ability to consciously and deliberately monitor and regulate them (Okurumeh 2009).

With the ability to assess their knowledge in this way, students can study accordingly. So, whichever strategy of study or presentation is modeled, the review session should include the aspect of metacognition. Schools could ask students to rate on a 1 to 7 scale how much of the material they know well, what material they need to study more, to predict their examination score if it was taken today, and so forth.

Practice-invention obviously contains metacognition. Students can see their score on the practice invention, evaluate their confidence with the material, and assess what they know and what they need to study further. Answers to these questions can be encouraged in other forms of the review sessions. Through the presentation of the organized subject matter, for instance, students can reflect on which sections of the content they know and which are more elusive. In a recent study of students' behaviour, Gurung and Bord (2007) found that students who attended review sessions scored significantly higher in exams (80 versus 76 points) than students who did not attend, even after controlling for students' Grade Point Average (GPA).

Two hundred and sixteen (216) students were asked in an 'Introductory Psychology' class to rate which of five different formats they preferred (lecture, group work, trivial game show, mock exam, questions/answer format, PowerPoint's of main points) for reviews sessions. Using a 1 – 5 scale (1=not at all, 5=very much so), students preferred mock exam (mean = 4.06), and PowerPoint (mean = 3.87) formats. Given that, enhancing self-testing and other metacognitive strategies are optimal for learning (Koriat & Bjork, 2005); it is promising to see the mock exam format rated best for review sessions.

5.3 Conclusion from the Study

The right selection and appropriate use of instructional strategies may result into better achievement and favourable attitude and skills on the part of the learners. The study has shown that Active review and Practice-invention teaching strategies were more effective in improving the students' attitude, achievement and process skills in Basic Science than conventional teaching strategy. The study found that Practice invention strategy was more effective than Active review strategy in attitude and achievement in Basic Science, while Active review strategy was more effective than Practice-invention strategy in science process skills. Hence, Practice-invention teaching strategy was more effective than the conventional lecture strategy in teaching the selected concepts in Basic Science. However, Active review and Practice-invention teaching strategies can be used to foster the learning of selected concepts in Basic Science irrespective of gender and parents' educational background.

Effort should be geared towards making students respond like female, low parental educational background students responded. They are ideal critical thinkers that are habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, and orderly in complex matters. They are diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal.

5.4 Contribution to Knowledge

1. The use of Active review and Practice-invention strategies is considered significant in that it provides an empirical basis for evaluating the effectiveness or otherwise of the effects of Active review and Practice-invention strategies on students' attitude, achievement and science process skills in Basic Science.
2. It improves the students' competence in the area of science and creative skills that are needed to answer some higher-order of thinking questions in junior secondary school certificate examinations.
3. The instruments prepred and adopted in this study (which can also be used in other studies) serve as contribution to knowledge.
4. Active review and Practice-invention strategies are active-learning based and they encourage team work and interactions among the students and all categories of learners are helped.
5. The study could form empirical evidence for subsequent researchers in Basic Science and other science related disciplines.

5.5 Recommendations

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

a. Teachers should facilitate the use of Active review and Practice-invention teaching strategies in schools to enhance positive attitude of students and improve their skills and achievement in Basic Science.
b. To improve students' performance in Basic Science, Active review and Practice-invention teaching strategies are recommended to secondary school Basic Science teachers for the teaching of Basic Science.

c. Students should be allowed to use their skills with all instructional resources in Basic Science classroom instruction in order for students to yield positive attitude towards the subject.
d. There is need for training of pre-service Basic Science teachers on the effective use of Active review and Practice-invention strategies for effective teaching and learning through financial support from SUBEB.
e. Government and professional bodies such as STAN, NTI, NUT, etc. should organize in-service and re-training programmes for teachers on the effective use of Active review and Practice-Invention teaching strategies in the teaching of Basic Science to improve learning outcomes.
f. Government should develop a manual for each of the strategy and train teachers on it through the Ministry of Education.
g. Active review and Practice-invention are effective strategies in enhancing students' attitude, achievement and process skills irrespective of their (students') parent educational background and gender

5.6 Limitations of the Study

The study was limited to only Nine (9) public junior secondary schools out of the various junior secondary schools in Oyo State. Also, out of the numerous student factors that could be used to predict students' achievement in and attitude to Basic Science, only three (3) independent variables were investigated in the study. There are several students' learning outcomes existing in Basic Science; the study was limited to only three (students' achievement in, attitude to Basic Science and Science Process Skills in Basic Science). Some constraints were experienced from teachers who were reluctant in assisting the researcher. Also, students were running away from the class activities for fear of examination because of students' achievement test in Basic Science and their Basic Science process skills' rating scale involved in the study. However, despite these limitations and constraints, the findings of the study constitute important milestone in the quest for improved teaching and learning of Basic Science in junior secondary schools for improved positive attitude to the subject among students.

5.7 Suggestions for further Studies

Future research should focus on the use of Active review and Practice-invention strategies in other science subject such as Physics, Biology, Agricultural Science and Mathematics. The study could also be replicated in other geopolitical zones in Nigeria apart from Oyo North Senatorial District, using more local governments, states, schools, teachers and students. To students who may just want more material, briefly discussing the research findings (e.g. during classroom discussion of cognitive psychology or memory research or even before the first exam.) and providing a rationale for the format used will reduce students' resistance and increase their motivation for it.

REFERENCES

Abimbola, I. O. Olorundare, A.S. Omosewo, E.O. Ahmed, M.A, Johnson, U.A and Yahaya L.A. 2011 Way Forward for STEM Education. Science Teachers Association of Nigeria, 52nd Annual Conference, 109-113.

Abimbola, I.O. 2013. The Misunderstood Word in Science Towards a Technology of Perfect UNDERSTANDING for. In 123rd Inaugural Lecture of University of Ilorin (22–31) Unilorin Press.

Abram, R.K. 2004. Attitudes Towards Science: A Quantitative synthesis. *Science Education 106. 21:* 547-567.

Achor, E.E. Wude, M.H. and Duguryil, Z.P. 2013. Do Cooperating Learning Strategies have? The potentials to eliminate Gender Differences in Students Achievement in Biology? The effect of STAND and Jigsaw Cooperative Mathematics and Education (JOSTMED) 101:136-146.

Adedayo, J.O. 2008. Effect of Electronics Artisans' Background and Competence on Science and Technology Advancement in Nigeria. Research in Curriculum Studies, 5.1 2011, Improving Stem Education in Nigeria. 52nd Annual Conference Proceedings, 118-124.

__________2011. Improving STEM Education in Nigeria: The Challenges of Science Educators. Science Teachers Association of Nigeria. *52nd Annual Conference Proceedings, 118-124.*

Adegoke, B.A. and Ibode, F.O. 2011. Knowledge of English Language as a Predictor of Students' Cognitive Achievement in Senior Secondary School Mathematics. *European Journal of Educational Studies* 3.2:26-37.

Adeniyi, A. G. 2005. Science and Technology Education in Secondary Schools: Need for Manpower Development. *Journal of the Science Teachers Association of Nigeria*. 40.1 & 2: 63-67.

Adeogun, O. B. 2009. The Roles of Socio-economic Variables on Students Achievement Senior Secondary School Chemistry in Ogun State Nigeria. *Journal of Science Teachers Association of Nigeria.18.4:*15-27

Adesoji, F. A. 2004. Science and Curriculum Development; and Unpublished M.Ed. Lecture Note.

Adetunji, F.O. 2000. A Study of Some Nigerian Primary School Teachers Attitude to Mathematics. *African Journal of Educational Research 61.1: 92-99*

Adeyemi, B. O. 2006 Revitalizing Decayed Educational System through Instructional Technology. *African Journal of Historical Sciences in Education* 2.1: 40-51.

Adeyemi, T. O, 2006. *The Education Industry in Ondo State, Nigeria. An Evaluation 2nd Edition.* Ado-Ekiti Adebayo publishers Nigeria.

Adodo, S. B. 2007. *Science Education and Science Teaching Methods.* Lagos Atlantic.

Adodo, S.O. (2005). Correlates of Student Variables and Achievement in Integrated Science. *Journal of Educational Research & Development, 1.2, 208-214*

Adodo, S.O. and Gbore, L.O. 2012, Prediction of Attitude and Interest of Science Students of Different Ability on their Academic Performance in Basic Science. International Journal of Psychology and Counseling.4.6:68-72.

Afuwape, M. O. and Olatayo, R. A, 2004: Students' Integrated Science Achievement as a Predictor of Later Achievement in Biology, Chemistry and Physics. *Journal of the Science Teacher Association of Nigeria* 39, 1 & 2, 10-15.

______________, M.O. 2002, Simulation Game-Assisted Instruction, Student's Cognitive Style and Numerical Ability as Determinants of Learning Outcomes in Integrated Science in Oyo-State, Nigeria. Ph.D.

Agoro, A. A. 2012. Effects of Reflective-Reciprocal Teaching and Reflective-Reciprocal Peer Tutoring Strategies on Pre-Service Teachers' Achievement and Science Process Skills in Integrated Science. A Post Field Seminar Paper Presented at the Joint Staff/Higher Degree Students' Seminar Series, Department of Teacher Education, Faculty of Education, University of Ibadan.

Ahove, M. A. N. & Alabo, A. A. 2000. Perception and Attitude to Environmental Concepts in Chemistry Texts. A call for collaborative action research among female teachers. *Journal of Science Teacher Association of Nigeria.3.7:*18-37

Aina J.K. 2013 Effective Teaching and Learning in Science Education through Information and Communication technology (ICT) *Journal of Research and Method in Education 2.5:* 43-47.

Ajayi, A.C. 2005. Effect of Concept Mapping on Students' Achievement and Interest in Integrated Science, PHD. Thesis. University of Ado-Ekiti, Nigeria.

Ajayi, D. O. 2001. Assessment of Teacher's Effectiveness in Teaching Biology. Essential Ingredient for the 21st Century Biology Educators. *Journal of Ekiti-State Science Teacher's Association of Nigeria* 1.3:19-18.

Ajila, P.K. (2003). Comparative Effects of Explicits and Enhanced-explicit Teaching on Learning Outcomes in Primary Science in Ikere-Ekiti Local Government Area, Nigeria. PhD. Thesis. University of Ibadan.

Ajisegiri, E.S.A 2010. Stakeholders Roll Out Map for New Education Minister. Nigerian Tribune, April 22, 2010. p.25.

Akanbi, A.O.2014. Trend in Physics Education in Secondary School in Kwara State. *Lafiagi Journal of Science Education*, 5(1-2), 69-75.

Akinbobola, A. O. 2006. *Effects of Teaching Methods and Study Habits on Students' Achievement in Senior Secondary School Physics, using a Pictorial Organizer*. Ph.D Thesis. Uyo: University of Uyo

_____________(2008). Facilitating Nigerian Physics Student's Attitude Towards the Concept of Heat Energy. *Scientia Paedagogica Experimentalis,* 45, 353-366.

Akinfe, E., Olofinniyi O. E, and Fashinku C. O, 2012. Teachers' Quality as Correlates of Students Academic Performance in Biology in Senior Secondary Schools of Ondo State, Nigeria online Journal of Education Research ISSN 2277-0860; Volume 1, Issue 6, pp 108-114; October 2012.

Akinsanya, O, Ajayi K O, and Salomi M. O.(2014) Relative Effects of Parents Occupation, Qualification and Academic Motivation of Words on Students Achievement in Senior Secondary School Mathematics in Ogun State Journal of Education and Practice, 5 (22),99-105.

Akinbobola, A.O. 2006. Effects of teaching methods and study habits on students' achievement in Senior Secondary School Physics, Using a Pictorial Organization Ph.D. Thesis. Uyo: University of Uyo. Ix – 198.

Akinsayo, O. Ajayi, K. O. and Salomi, M. O. (2014) Relative Effect of Parents Occupation, Qualification and Academic Motivation of Wards on Students Achievement in Senior Secondary School Mathematics in Ogun State. *Journal of Education and Practice, 5(22)*, pp 99-105s

Alake, E. M. 2007. Utilization of Floor Puzzle in Improving NCE Students' Achievements in some Integrated Science Concepts: Proceeding of the 48th Annual Conference of STAN, 150-153.

Ali, A., & Aigbomian, D. (1990). Level of Content Competence in Physics Attained by Respective Teaches for Teaching Secondary School Physics in Nigeria. *Journal of Science Teachers Association of Nigeria, 27, 63-72.*

Amjad, I. P and Mohammed F. (2012). Measurement of Scientific Attitude of Secondary School Students in Pakistan. *Academic Research International 2 (2)* 379-392.

ANCOPSS, Feb.3, 2011. An Open Letter to the People of Oyo State. m. thenigerianvoice.com/news/…/an-open……3 Feb, 2011.

Anthony, G; 1996. Active Learning in a Constructivist Framework. Educational Studies in Mathematics 31, (4), 349 – 369.

Aremu, A and John. A., 2005: Gender Implication of the Use of Video Drama Environmental Education. Issues in Language, Communication and Education. A book in honour of Caroline.

A. Okedara., Dada A. Akinbade and O.O. Kolawole Eds. Ibadan: Constellation Books pg. 342- 352.

Aremu, A. and Sangodoyin, A.2010. Computer Animation and Academic Achievement of Nigerian Senior Secondary School Students in Biology. *Journal of the Research Center for Educational Technology (RCET) 6.2:148-161.*

Asikhia, O.A. 2010. Students and Teachers Perception of the Causes of Poor Academic Performance in Ogun State Secondary Schools (Nigeria): Implications for Counseling for National Development. *European Journal of Social Sciences*, 13(2), 229.

Asoegwu, A. O. 2008. Problems and Prospects of Gender and STM Education in Curriculum Development in Nigeria. *Science Teachers Association of Nigeria*. 49th Annual Conference Proceedings. HEBN (PLC), 186-188. Association Publishers.

Ausubel, D.P. 1960. The Use of Advance Organiser in Learning and Retention of Meaningful Verbal Materials. *Journal of Educational Psychology* 15(5)

Ausubel, D.P. 1963. The Psychology of Meaningful Verbal Learning. Grune Station. New York.

Ausubel, D.P. 1968. Educational Psychology A cognitive View. New York. Holt Rinehart and Winston.

Ayanda, O. E. 2006: The Influence of Teachers Acquisition, Preservation and Improvisation of Biological Specimens on Students' Learning Out-comes in Selected Secondary Schools in Lagos State. An Unpublished Master Degree, Project, Teacher Education Department, University of Ibadan.

Azzarito, L., & Ennis, C. October, 2003: A Sense of Connection: Toward Social Constructivist Physical Education. *Sport, Education & Society*, 8(2), 179. Retrieved May 10, 2009, from Academic Search Premier Database.

Babajide, V.F.T. 2010. Generative and Predict-Observe-Explain Instructional Strategies as Determinants of Secondary School Students Achievement and Practical Skills in Physics. An unpublished Ph.D Thesis University of Ibadan.

Babayemi, J.O. 2014. Effects of Crossword Picture Puzzle and Enhanced Explicit Teaching Strategies on Students' Learning outcomes in Basic Science in South Western Nigeria. XIV – 246.

Backhouse, John. 1999- Improving the learning of mathematics. Wellington House, London.

Bamidele, A.D. 2014. Effects of Peer-led Guided Inquiry and Classwide Peer Tutoring Instructional Strategies on Senior Secondary School Students' Performance and Practical Skills in Chemistry. Xviii – 149.

Beaumont-Walters, Y. and Soyibo, K. 2001. An Analysis of High School Students' Performance of Five Integrated Science Process Skills, *Research in Science and Technological Education*, 19 (2), 133-145.

Blair, K. Schwartz, D. L., Biswas, G., and Leelawong K. 2007: Pedgogical Agent for Learning and Teaching: Teachable Agents. *Educational Technology, 47(1), 56-61.*

Boarler, J. 1998. Open and Closed Mathematics Student Experiences and understandings. *Journal for Research in Mathematics Education* (Reston, V. A.) Vol. 29: 41-62.

Bolorunduro, O. M. 2005. The Impact of the Instructional Strategies of the Nigeria Integrated Science Teacher Education Project on Students' Learning Teacher Education Project on students' learning outcomes at Junior Secondary School level. An Unpublished Ph.D. Thesis, University of Ibadan.

Boyo, A. 2011. Identifying the Problem Associated with Studying Physics in Lagos State, Nigeria in http://www/wcpsd/org/poster/education/Boyo-Ar.

Brenda, T. & Robert L. 2003. Assessment of Active Learning with Upper Division Computer Science Students. 33rd–ASEE/TEE. *Frontiers in Education Conference*, November 5-8. 2003. Bounder Co.

Burns, J.C. Okey, J.R. and Wise, K.C. 1985. Development of an Integrated Process Skills Tests: Tips II. *Journal of Research in Science Teaching, 22(2),* 169-177.

Carvalho, H. 2009, Active Teaching and Learning for a Deeper Understanding of Physiology. *AdvPhysiolEduc* 33: 132-133.

Chamber, D. G 2009. The Effects of Gender-based Class Grouping on Middle School Student Achievement: Teachers' Administrators' and Parents' Perceptions. Ed. D, Anambra State University, CIA World Facebook 2010, 'Nigeria.

Charles Wwes;ey (1788). Baptist Hymnal with Choruses: Published and printed by Intec Printers Limited (2000eds) Pg. 61.

Chase, J. and Edward G. O. 2002. "Combining Cooperative Learning and Peer Instruction in Introductory Computer Science" Thirty First SIGSCSE, Technical Symposium on Computer Science Education. Pp. 372-376.

Chen, Q. 2009. Family Background, Ability and Student Achievement in Rural China: Identifying the Effects of Unobservable Ability Using Famine-Generated Instruments. *Gansu Survey of Children and Families Papers*.

Christopher, M.2013. Student Re-engagement Strategies for Large Lectures.

Cobb, P, Vackel, E & Wood, T. 1992: A Constructivism Alternative to Representational View of Mind in Mathematics Education. *Journal for Research in Mathematics Education* (Reston. V. A.) Vol. 23, p 2-23.

Coley, R (2010) Differences in the Gender Gap Comparisons Across Racial/Ethnic Groups in Education and Work.

Cook, C. J. 2006. Exploring the Use of Interactive Multimedia as an Instructional Resource in Middle Schools of Ohio. Unpublished PhD Thesis, College of Bowling, Green State University, Ohio.

Cortright, RN, Collins HL, Dicarlo SE, 2005, Peer Instruction Enhanced Meaningful Learning: Ability to Solve Novel Problems. Advance Physiology Education 29: 107-111.

Danmole, B.T., (2011) Emerging Issues on the Universal Basic Education Curriculum in Nigeria: Implications for the Science and Technology Component. *Pakistan Journal of Social Sciences* 8(1). 62-68.

DiCarlo, SE 2009, Too Much Content, Not Enough Thinking, and Too Little FUN! Adv. PhysiolEdu 33: 257-264.

Dickinson, D. J. & O'Connell, D. Q. 2005. Effect of Quality and Quantity of Study on Student Grades. *Journal of Educational Research*, 83, 227-231.

Dickson, L.K., Miller, M.D., & Devoley, M.S. 2005. Effect of Texbook Study Guides on Students Performance in Introductory Psychology. Teaching of Psychology, 32, 34-39.

DiEnno, C., & Hilton, S. & Fall, 2005: High School Student's Knowledge, Attitudes, and Levels of Enjoyment of an Environmental Education Unit on Nonnative Plants. *Journal of Environmental Education, 37 (1)*, 13-25. Retrieved May 10, 2009, from Academic Search Premier Database.

Dijkstra, B. 2006. Idols of Perversity. *New York:* Oxford University Press.

Dinah C. Samikwo (2013) 'Factors which Influence Academic Performance in Kenya; A Perspective for Global Competitiveness International Journal of Current Research 5(12), pp 4296-4300.

Donkor, A. B. 2006. An Interactive Approach to Teaching Science, Ghanaian *Journals of Education*, 20 (3), 60-64.

Dorothy, W. & Louisa, C. (2003). The use of Research by Teachers: Information Literacy, Access and Attitudes.

Duguryil, P.A. (2012). Effect of Cognitive reasoning ability and exposure to content on Junior Secondary School two students' achievement and retention in Integrated Science. PhD Thesis in the Department of Curriculum and Teaching Benue State University, Makurdi.

Duron, R., Limbach, B., & Waugh, W (2006). Critical Thinking Framework for any Discipline. *International Journal of Teaching and Learning in Higher Education, 17(2), 160-166*

Duru, V.N. and Okereke, C. 2010. Effect of Multiple Intelligence Teaching Strategies (MITS) on Students' Achievement in Integrated Science. *51st Annual Conference of Science Teachers' Association of Nigeria (STAN):* 190-199.

Edomwonyi-out, L. and Avaa, A. 2011. The Challenge of Effective Teaching of Chemistry: A case study. Retrieved on 24th of December, 2012 from http://ejpt.academicdirector.org/A1.8/001-008.htm.
Education Research (2) pp.136-146.

Esther (2007). Student Interest – The German and Austrian ROSE Survey. *Journal of Biological Education*, 42(1),pp 5-11.

Ergul, R., Simsekli Y., Calis, S., Ozdilek, Z., Gocmencelebi, S., and Sanli, M. 2011. The Effect of Inquiry-Based Science Teaching on Elementary School Students' Science Process Skills and Science Attitudes. *Bulgarian Journal of Science and Education Policy, vol.5 (1).*

Etuibon, R. U. &Udofia, T. M. 2009. Promoting and Sustaining Educational Research for Self-reliance. *International Journal of Educational Research and Administration* 6(1).

Fasasi , N, R.A. 2014 Development of an Ethnosciences Database and Its Effects on Students' Learning Outcomes in Basic Science in Southwestern Nigeria Ph.D. Thesis. Department of Teacher Education, University of Ibadan.

Federal Ministry of Education (2013), *National Policy on Education*. Lagos: Federal Government Press.

Federal Ministry of Education (FME) (2007). *9-Year Basic Education Curriculum: Home Economics*. Abuja: Nigerian Educational Research and Development Council (NERDC).

Federal Ministry of Education, (2007). *9-Year Basic Education Curriculum:* Basic Science for Junior Secondary 1-3

Federal Republic of Nigeria (2006). Universal Basic Education Commission. Universal Basic Education Programme. A flag tip programme of the Federal Government of Nigeria Abuja: Federal Government Publication

Federal Republic of Nigeria 2004: National Policy on Education, Lagos, NERDC.

Federal Republic of Nigeria (NPE).2014. Science, Technical and Vocational Education. Fourth Edition. 23-29.

Fink, L. D. 2007. Idea on Teaching University of Oklahoma-Instructional Development Program *File:/A:university%20%Oklahoma-% Instructiomal%20Development %20 Program*

Finlayson, M. (2009). The Impact of Teachers' Absenteeism on Students' Performance. The Case of Cobb Country School District. Dissertation Abstract. Kennesaw State University. Retrieved Online on 7th October, 2011.

Gaigher, E. 2004. Effects of Structured Problem Solving Strategy on and Conceptual Understanding of Physics. A Study in Disadvantaged South African Schools. Ph.D. Thesis University of Pretoria, htt://uped.up.ac.za/thesis/available/etd-@2022006-160908. Retrieved on January, 10, 2008.

Gale Encyclopedia of Education, Encyclopedia of Education Parenting Influence of Parents Level of Education. Date retrieved, 15/03/2013.

Gazi, M. A., Oloruntegbe, K. O. and Orimogunje, T. 2010. Volumetric Analysis and Chemistry Students Performance: Combined Influence of Study Habit, Research and Essay 5 (11) 1325-1332.

Gestal, F., 1993 in Burnett, Jane 2002 Student Grouping for Reading Instruction. Retrieve on 18/06/2006. http:IIwww.ed.gov/database/ERICDigested434435.html.

Gbodi, E. B., 2007. The Design and Development of Learning and Instructional kit for Primary Science. *Journal of Educational Media and Technology (JEMT),* 12(2), 1-10.

Gbore, L.O 2013. Relative Contributions of Selected Teachers' Variables and Students' Attitudes Toward Academic Achievement in Biology among Senior Secondary School Students in Ondo State Nigeria. 4(1) 243-250.

George, R. 2000. Measuring Change in Students' Attitude Toward Science Over time. *Journal of Science Education and Technology,* 9(3), 213-225.

Gibson, B. 1991. Research Methods Jeopardy: A Tool for Involving Students and Organizing the Study Session. Teaching of Psychology, 18, 176-177.

Glasersfeld, E., *Constructivism in Education Year =1989.* Oxford Publication.

Gonen, S. and Bassava, B. (2008), 'The New Method of Problem-solving in Physics Education by Scorn-compliant Content Package. Turkish Online Journal of Distance Education – TOJDE. 9(3), 112-120.

Goodlad JI (1984). A place called school: Prospects for the future. New York: McGraw Hill.

Grouws, D. A. & Cebulla, K. J. 2000.Improving Students Achievement in Mathematics Geneva, Switzerland: International Academy of Education.

Gurung, R. A. R. & Bord, D. 2007. What Makes Review Sessions Optimal? Manuscripts in Preparation. For a copy, email: *gurungr@uwgb.edu*.

Gurung, R. A. R. 2005. How Do Students Really Study (and does it matter)? Teaching of Psychology, 32, 39-41.

Harlen, W. 2000. *Teaching, Learning and Assessing Science* 5-12 (3rd ed.). London: Paul Chapman Publishing.

Hitwatig , A.D.F. 2008. Ethno-scientific Teaching Approach, Student Proficiency, and Attitude Toward Sciences and Ethnic Culture. Education Quarterly, 66:1-3-21.

Huppert, J, Lomask, S. and Lazarowitz, R. 2002 Computer Simulations in High School: Student's Cognitive Stages, Science Process Skills and Academic Achievement in Microbiology. *International Journal of Science Education*, 24 (8), 803-821

Ibraheem, T. L. & Oladele, O. 2010. Information and Communication Technology (ICT) Availability, Accessibility and Usability in the Teaching-Learning Process in Michael Otedola College of Primary Education (MOCPED) Noforija-Epe.*Journal of Applied Education and Vocational Research*, 7(2): 168-177.

Idogo, G. 2011. Instructional Strategies in Primary Schools in Ibadan North Local Government Area: In Empirical Investigation of the Effect of Children's Basic Reading and Comprehension Skills *African Journal of Education and Technology*, Vol. 1, No. 1:1-14

Igbokuuwe, G. (2004). Comparative Analysis of SSCE and NECO result in Ohuakwu Local Government Area of Ebonyi State. Unpublished PHD Thesis, Enugu State University of Science and Technology (ESUT).

Ige, J. A and Arowolo J.G., 2011. Cognitive Coaching: A Tool for Boosting Students' Achievement in Basic Science *Journal of Research in Education and Society 2(1)*, 78-86.

Ige, T. A. 2001, Concept Mapping and Problem Solving Teaching Strategies as Determinates of Achievement Secondary School Ecology: Ibadan. *Journal of Educational Studies Volume 1-(1) May 2001.*

Igwe, I. O. 2002. Relative Effect of Framing and Term-assisted Instructional Strategies on Students' Learning Outcomes in Difficult Chemistry Concepts in Parts of Ibadan. Ph.D. Thesis. University of Ibadan.

Ivowi, U.M.O. (2006): *Re-Engineering Primary Education for Scientific and Technological Skills Acquisition.* In Okafor, N. (Ed.) Enhancing the Status of Science Education. A proceedings of EYES Workshops, Lagos, Mukugamu and Brothers Enterprises.

Jabor, M. K, Machtmes K, Kungu K, Y, Buntat, Y & Nordin, M. S. (2011). Does Parent Educational Status Matter on the students' Achievement in Science? *International Conference on social science and Humanity* IPEDR vol. 5.

Janosz, G. (1998). A place to learn: Lessons from Research on learning Environments. United Nations Educational, Scientific and Cultural Organization.

James, T. and Olajide, J. O. 2011: Developing Entrepreneurship Teaching Approach Using "Words and Picture" Games in Integrated Science Classroom. *European Journal of Scientific Research. ISSN 1450-216X Vol. 52 No. 1 (2011), pp70 -74 Eorojournals Publishing, Inc. 2011.*

Jegede, S. A, 2007 Students Perceptions of Technical words in Senior Secondary Curriculum. *Pakistan Journal of Social Sciences 7 (2),* 109-111.

Jenson, P. A, Moore RJ. 2009, What Do help Sessions Accomplish in Introductory Science Courses? J CollSci Teach 38: 60-64.

Johnson, S. D., and Aragon, S. R. 2002. An Instructional Strategy Frame work for online Learning Environment in T.M. Egan & S.A. Lynham (Eds.), Proceedings of the Academy for Human Resources Development (1022 -1029). Bowling Green, OH: AHRD.

Jinto, S. and Dibiasio, D. 2006. Experimental Learning Environments. Do they Prepare our Students to be Self-directed. Life Long Learners? *Journal of Engineering Education*

Juch, A. 2003. Personal Development: Theory and Practice in Management Training. Chichester, UK:, Wiley.

Kan, A and Akbas, A. 2006. Affective Factors that Influence Chemistry Achievement (Attitude and self efficacy) and the Power of these factors to Predict Chemistry Achievement. 1 *Journal of Turkish Science Education* 3(1) 77-85.

Karamustafaoglu, S. 2011. Improving the Science Process Skills Ability of Science Student Teachers Using I Diagram. *Eurasian Journal of Physics and Chemical Education* 3(1) 26-38.

Karen, L. L. 2009. Process Skills for Life Science Training Guide.*http://soinc.org/tguides.htm.Downloadon10/19/2010*.

Kato, Y. and Kamii, C. 2011: Piaget Constructivism and Childhood Education in Japan, Prospects, XXXI (2) 161-173.

Koriat, A and Bjork, R. A. 2005. Illusions of Competence in Monitoring Ones Knowledge During Study. *Journal of Experimental Psychology* 31, 187-193.

Koriat, A., & Bjork, R. A. 2005: Illusions of Competence in Monitoring Ones knowledge during study. *Journal of Experimental Psychology,* 31, 187-193.

Lemon, L. 2011. The Importance of Activities in the Classroom. Retrieved July 01, 2012 from http://image.slideshareedn.com/theimportanceofactivitiesintheclassroom-110609172731.

Logan, M & Skamp K, (2008) Engaging Children Across the Primary–secondary Interface: Listening to the Students' Voice. *Research in Science Education*. 38, pp501-527.

Lohr, L. L., & Ku, H. 2003. Development of a web based template for active Learning. *The Quarterly Review of Distance Education*, 4(3), 213-226.

Lucas, K. B. & Dooley, J. H. 2006. Student Teachers' Attitudes Toward Science and Science Teaching. *Journal of Research in Science Teaching* 19(9), 805-809. http:/www3.interscience.wiley.com/journal Retrieved: 18/02/2010.

Lucas, K. B. & Dooley J. H. 2006. Student Teachers' Attitudes toward Science and Science Teaching. *Journal of Research in Science Teaching* 19 (9), 805 – 809. http:/www3. interscience.wiler.com/journal Retrieved: 18/02/2010.

Ma, X, (2007) Gender Differences in Learning Outcomes Background. Paper prepared for the Education for All Global Monitoring Report Retrieved from ED/EFA/MRT/PI/80,http//Unesdoc.org/images/0015/001555/155593epdf.2007.

Macmillan, M. J., 2012. School Location Versus Academic Achievement in Physics: Does Computer-assisted Instruction (CAI) Has Any Effect? *Journal of Educational and Research*, 2(8) 54-62.

Marzano, R. J., Pickering, D.J., & Pollock, J.E. 2002. *Classroom Instruction that Works: Research-based Strategies for Increasing Student Achievement.* Virginia: ASCD.

Mechling, K. 1994. *A Recommended Science Competency Continuum for Grades K-6 for Pennsylvania Schools.* Harrisburg, P.A. Pennsylvanian Department of Education.

Memon, G.R, Muhammad Farouq Joubish and Muhammad Ashraf Kurram (2010) 'Impact of Parental Socio-economic Status on Students Educational Achievement at

Secondary Schools of District Malir, Karachi Middle-East'. *Journal of Scientific Research* 6(6), pp678-687

Meyers, C. and Jones, T.B. 1993: Promoting Active Learning: Strategies for the College Classroom. San Francisco: Jossey-Bass, 1993.

Minner, D.O., Levy, A.J. and Century, J. 2010. Inquiry-Based Science Instruction – What is it and does it matter? Results from a Research Synthesis Years 1984-2000 *Journal of Research in Science Teaching*, 4(7) 474-496.

Mohammad, B.A. (2009). Accessing the Process Skill in Practical Chemistry of SSCE Students. A Conference paper presented at the School of Science. National Conference held at Federal College of Education. Zaria.

Mohammed, A.U., Gwandu, A.D. & Abdulmuminu U. (2008): *Understanding the Meaning of Integrated Science as a Foundation Course for All Sciences.* A papers Presented at the 2008 National Conference of SSCOE, Sokoto.

Mok, M. C. & Flynn, M. 2008. The Quality of School Life and Self-concept Among Elementary School Students Int. J. Hum, Sci. 5 41-54.

Muller, D., Sharma, M., & Reimann, P. 2008: Raising Cognitive Load with Linear Multimedia to Promote Conceptual Change. *Science Education, 92 (2), 278-296.* Retrieved May 10, 2009 from Academic Search Premier Database.

Naderi, E. Hajizard, M., Madari, A. S. & Naraghi, M. S. (2011). A Survey and Comparison of Basic and Human Sciences' Teachers' Professional Skills in Order to Propose for Methods of the Skills in Junior High School. American *Journal of Scientific Research* ISSN 1450-223X Issue 24 (2011):160-168. *http://www.eurjournals.com/ajsr.htm*, Retrieved: 23/09/2011, 2:19a.m

Ncharam, S.E. 2011. The Relationship between Students Learning Difficulties and Achievement in Junior Secondary School Three (JSS3) Integrated Science Content in Plateau State, Science Teacher Association of Nigeria, *52nd Annual Conference, 212-215.*

Nduka, J. A. 2005. Concrete Teaching. Active Learning Strategies in 21st Century. *Journals of African Science Education* Vol. 37(6) pg 73-76.

NERDC (Nigerian Educational Research and Development Council). 2007. 9-Year Basic Education Curriculum. Basic Science for JS 1-3.

___________ 2012 Junior Secondary School Curriculum: Basic Science and Technology JSS 1-3.

Njoku, Z. C. 2002. Enhancing Girls' Acquisition of Science Process Skills in Co-Educational Schools: An Experience with Sex Grouping for Practical Chemistry. *Journal of STAN* 37 (1&2) 69-75.

Nneji, N.G. 2006: *Methods of Acquiring Scientific and Technological Skills at the primary School Level.* In Okafor, N. (Ed.) Enhancing the Status of Science Education. A Proceedings of EYES Workshops, Lagos, Mukugamu and Brothers Enterprises.

Odebode, S.O. 2001. Re-examining Gender Balance Education in Agricultural Science Technology and Mathematics in Nigeria: An Overviews. Ibadan, Nigeria.

Oginni, A.M. 2009. Selected Students' Aptitude Indices and School Factors as Predictors of Senior Secondary School Student Learning Outcomes in Chemistry in Lagos State- An unpublished PH.D Thesis University of Ibadan.

Ogundare, S. A. 2008. Effects of Cooperative Active Learning Strategies on Junior Secondary School Students' Achievement and Attitudes to Integrated Science. Unpublished M.Ed Thesis. University of Ibadan.

Ogundiwin O. A. and Ahmed A. A. (2015), Effects of Meaning Focus, Practice and Invention, Strategies on Problem-Solving Skills of Senior Secondary School Students in Ecology. *Journal of Education and Policy Review, 7, (1)*, 28 – 48.

Ogunleye, B. O. & Fasakin O. A., 2011, Everybody Phenomenon in Physics Education: Impact on Male and Female Students' Achievement, Attitude and Practical Skills in Urban and Pri-urban Settings in Nigeria. *Pakistan Journal of Social Sciences 8(6)*, 316-324.

Ogunleye, B. O. & Babajide, V. F. T. (2012), Commitment to Science and Gender as Determinants of Students Achievement and Practical Skills in Physics. JSTAN Journal.

Ogunshola, F. & Adewale, A, M., (2012) 'The Effect of Parental Socio-economic Status on Academic Performance of Students in Selected Schools in Education L.G.A of Kwara State Nigeria International Journal of Academic Research in Business and Social Sciences, pp.2(7), 230-239.

Ogunwuyi, O. 2000. A Casual Model of Teacher and Student Factors as Determinants of Achievement in Secondary School Integrated Science. Unpublished Ph.D. Thesis. University of Ibadan, Ibadan. iv-248.

Okafor, N. (2007): *Instructionalization of EYES Clubs in Nigerian Primary Schools: Panacea for Scientific and Technological Skills Acquisition.* In Okafor, N. (Ed.) Enhancing the status of Science Education. A proceedings of EYES Workshops, Lagos, Mukugamu and Brothers Enterprises.

Okpala, N. N & Onocha C. O. 1995. Difficulties in Students Performance of Hierarchical cognitive Tasks. A function of Time to Learn. UNESCO Africa, (A Six Monthly Journal of the Dakar UNESCO Regional Office).

Okurumeh, A. E. 2009. The effect of Meaning Focus Practice and Invention, Interaction and Discussion Strategies on Achievement and Problems Solving Skills of Senior Secondary School Students in Mathematics. Unpublished Ph.D. Thesis University of Ibadan. iv-213.

Olagunju, A.M; Adesoji, F.A., Iroegbu, T.O. & Ige T.A 2003. Innovations in Science Teaching for the New Millennium; In Bamisaiye, O.A., Nwazuoke, J. A, and Okediran, A. (Eds) Education, this Millennium- Innovations in theory and practice, Ibadan; Macmillan pp. 219-233.

Olagunju, A.M, 2002. Environment Education for Sustain the Development in Nigeria. Implication for Biological Conference Proceeding of STAN on difficult Concepts in STM Abeokuta.

Olagunju, A. M; Adesoji, F.A. Iroegbu, T.O. & Ige T.A. 2003. Innovations in Science Teaching for the new Millennium; I. Bamisaye, O.A; Nwazuoke, J.A, and Okediran, A. (Eds) Education, this Millennium – innovations in theory and Practice, Ibadan Macmillan. 219 – 223.

Olaniyi, F.O. 2009. Effects of Jigsaw II and Group – Investigation Cooperation learning models on pre – service Teachers' Learning Outcomes in Selected Environmental Concepts in Integrated Science. Unpublished Ph.D. Thesis Department of Teacher Education. University of Ibadan. Xi -290.

Olasehinde, K. J & Olatoye, R. A. 2014. Scientific Attitude, Attitude to Science and Science Achievement of Senior School Students in Kastina State, Nigeria. *Journal of Educational and Social Research 4 (1),* 445-452.

Olatoye, R. A. & Adekoya Y. M. 2010: Effect of Project-based, Demonstration and Lecture Teaching Strategies on Senior Secondary Students' Achievement in an Aspect of Agricultural science. *International Journal of Education Research and Technology; vol. 1(1) June 2010 19-29.*

Olatoye, R.A & Aderogba, A. A. 2012. Harnessing the Power of Emotional Intelligence, Scientific Literacy and Problem-solving skills for Successful Literacy Living. *Pacific Journal of Science and Technology, 13 (1*) 403-417.

Olajemgbesi, A. 2006. Effects of Concept Mapping and Processing Solving on the Achievement of Senior Secondary Student in Chemistry Unpublished M.Ed. dissertation. Faculty of Education, University of Ibadan. Ix – 140.

Oludipe, B. & Oludipe I. D. 2010: Effect of Constructivist-based Teaching Strategy on Academic Performance of Students in Integrated Science at the Junior Secondary School Level. *Educational Research and Reviews Vol. 5 (7), pp. 347 - 353 July 2010.*

Oludipe, D. I. 2011.Developing Nigerian Integrated Science Curriculum. *Journal of Soil Science and Environmental Management 2.8: 134-145.http://www.academic journals.org/JSSEM.*

________2012, Gender Differences in Nigeria Junior Secondary Students Academic Achievement in Basic Science. Journal of Education and Social Research. 2.1:93-100.

Omosewo, E.O. 2010. Poor Practical Classes: Teachers Implementation of the Practical Component of Senior Secondary Physics Curriculum with Strategies for Improved Physics in Kwara State. Retrieved on April 14, 2012 from http//www.unilorin.edu.ng/publication/omotosho2.

Onah, M. and ugwu, E.I (2010). Factors which Predict Performance in Secondary Schools Physics in Ebonyi North Educational Zone of Eboyi State, Nigeria .

Ong, E.K. and Kenneth, R. 2005. Acquisition of Science Process Skills amongst Form 3 Students in Malaysian Smart and Mainstream Schools. *Journal of Science and Mathematics Education in S.E. Asia* Vol. 28 No 1.

Oni, J.O. 2014. Teacher Quality and Students Academic Achievement in Basic Technology in Junior Secondary Schools in South–West Nigeria. *Journal of Educational and Social Research*, 4(3) 397-402.

Oredein and Awodun 2013. Impact of Teachers Motivational Indices on Science Students' Academic Performance in Nigerian Senior Secondary Schools. International Educations Studies, 6(2) 27-35.

Osborne, J. 2003. Attitude Towards Science: A Review of the Literature and Its Implications. *International Journal of Science Education*, 25(9), 1049-1079.

Oshodi, O. O. 2006. Effect of the Use of Learning Outcome Specification on Students' Achievement in Primary Science in Lagos, Nigeria. An Unpublished Ph.D. Thesis, University of Ibadan.

Osokoya, M.M. 2006. Modern Trends in the Teaching of Secondary Schools Chemistry in Ayodele S. O. (ed) Teaching Strategies for Nigerian Secondary Schools pp. 213-229.

Osonwa, O. K, Adejobi A. O, Iyam M. A, & Osonwa R.H (2013) 'Economic Status of Parents, a Determinant on Academic Performance of Senior Secondary School Students in Ibadan, Nigeria' *Journal of Educational and Social Research, 3(1)*, pp 115-122.

Osuafor, A. & Okonkwo I. (2013) 'Influence of Family Background on Academic Achievement of Secondary Schools Biology Students in Anambra State' an *International Multidisciplinary Journal, Ethiopia, 7(3),* pp.156-169.

Osuafor, A. M. 2008. Extent of Involvement of Secondary School Science, Technology and Mathematics (STM). Teachers in conduct of research and Participation in Science Teachers Association of Nigeria (STAN) activities: implication of STM development in Nigeria. *Journal of Science Teachers Association of Nigeria. 48 (10),* 81-92.

Owen, L. A. Robert C. D. Jeho-Forbes & Susan H. P. 2002. "Active Learning in Small to Large Courses. 32nd ASEE/JEEG fortifiers in education conference Nov. 6-9, 2002. Boston, M. A.

Oyediran, A. M, Agoro, A. A. & Fabiyi, O. O. 2009. A Multimedia Approach to the Teaching of some Difficult Topics in Integrated Science. *Journal of the Science Teachers, Association of Nigerian 39.1.2: 108-112.*

OYO SUBEB, 2009. Oyo SUBEB Success Stories. *OYO SUBEB NEWS* Vol. 2 no 8.

Padilla, M. J. 1990. Science Process Skills. *National Association of Research in Science Teaching Publication: Research Matters–to the Science Teacher (9004).*

Piaget, J:1954. The Theory of Stages in Cognitive Development in Green D, Ford M. and Tamed (Ed) 1971. *Measurement and Piaget.* New York; McGraw till 1-11.

Raimi, S. M. & Adeoye, F. A. 2002. Gender Difference among College Students as Determinants of Performance in Integrated Science. *African Journal of Science Education.* 20.9:1043-1059.

Raimi, S. M. (2003). Gender Difference in Acquisition of Practical Skills, Unpublished Paper Presented at the *1st National Conference on Science, Technology and Mathematics Education.* School of Science, St. Andrew's College of Education, 17th-20th, July.

Richardson, V. 2003: Constructivist Pedagogy. *Teachers College Record, 105 (9), 1623-1640.* Retrieved May 10, 2009, dio:10.1046/j.1467-9620.2003.00303.x.

Seweje, R. O. 2001. "The challenge of Science Teaching in Nigerian School Today". *Journal of Educational Foundation and Management; 1, 1 -15*

Shaibu, A. A. M. & Mari, J. S. 1997. Gender-related Difference in Understanding of Science Process kills Amongst Junior Secondary Schools. *Journal of Science Teachers Association of Nigeria.* Vol. 32, 1&2: 21-27.

Stephen, G. & Sandra A. 2006. Use of Gender for Educational Purposes: Will Today's 36(3). 256-271. Teacher Candidates use them in the Future? *Journal of Research on Technology in Education.*

Steve, B., Giuseppe, M. & Jim, T. 2008. Dept. of Economics, University of Lancaster.

Suman, B., (2011) 'Influence of Parental Education and Parental Occupation on Academic Achievement of Students', *International Referred Research Journal, 3(30), pp32-33.*

Ukwungu, J. O. 2002. Gender Difference study of Performance in Integrated Science. A summary of studies conducted in Nigeria. *Journal of the Science Teachers Association of Nigeria 37.* 1 & 2: 55-59.

Vos, H; & Graaffde, E. 2004. Developing Meta Cognition a basis for active learning. *The European Journal of Engineering Education, 29 (4), 543 – 548.*

Vygostsky, L. S. 1978 Mind in Society .Cambridge, M.A Havard University.

Wang, Q. 2008: A Generic Model for Guiding the Integration of ICT into Teaching and Learning. Innovations in Education & Teaching International, 45 (4), 411-419. Retrieved May 10, 2009, doi:10.1080/14703290802377307.

Wetzel, D. 2008. Science Investigation Skills is Important for Problem Based Learning Source; http: II Ezine Articles. Com/? Expert = David Wetzel Download on 10/19/2010.

Wetzel, D. 2010: Tips for Integrated Science Process Skills in Lesson Retrieve.

Yara, P. O.2009. Relationship between Teachers Attitude and Students Academic Achievement in Mathematics in some Selected Senior Secondary School in South West, Nigeria. *European Journal of Social Science, 11 (3*), 364-369.

Yaya, P. O 2010. Socio-Economic Background and Mathematics Achievement of Students in some selected Senior Secondary Schools in South-Western Nigeria. *Pakistan Journal of Social Science. Vol. 7(1), 23-2.7*

YCCD, 2005. Student Learning Outcome Community College System Approved Program Approved by Academic Senate, March 10, 2005.

Yusuf, H. O. 2010. A Comparative Study of the Effectiveness of Language Development and Vocabulary Methods in Teacher Reading Comprehension in Primary Schools Implications for Teachers and Curriculum Planners. *Educational Research*, Vol. 1 (8) 276-284.

Yusuf, H. O. 2011. The Effect of Using Instructional Conversation Method in Teaching Reading Comprehension in selected Junior Secondary Schools in Kaduna metropolis, *Journal of Language Teaching and Research*, Vol. 2, No. 1 pp. 55-59.

APPENDIX 1

UNIVERSITY OF IBADAN
DEPARTMENT OF TEACHER EDUCATION
FACULTY OF EDUCATION
STUDENTS' ACHIEVEMENT TEST IN BASIC SCIENCE (SATIBS)

The purpose of this test is to collect data on students' academic achievement in some selected concepts in basic science.

SECTION A

Name of School____

Student Name____

Class_____________ Sex; Male ☐ Female ☐ Age________

Location of School____

Local Government Area_______________________________________

Highest qualification of parents: Cannot Read/write (1) ☐ Primary Six (2) ☐

JSS III Certificate (3) SSCE ☐ Certificate (4) ☐

NCE/ Polytechnic (5) ☐ Graduate (6) ☐

Masters Degree (7) ☐ PhD Others _______ ☐

Time allowed: One hour

SECTION B

Instruction: Attempt all questions, and mark ( ) the correct options on your answer sheet.

1. The following are classes of chemical based on used except the following:
   - (a) Nuclear
   - (b) Agrochemical
   - (c) Solid
   - (d) laboratory

2. The following are types of chemicals

i. Highly hazardous and toxic

ii. Moderately hazardous and toxic

iii. Industrial

Which of the following groups of chemicals are based on intended used and hazardous nature?

(a) i and ii

(b) i

(c) ii

(d) ii and iii

3. Explain the following term work

(a) A job done for somebody

(b) Ability to do something

(c) Work involves trekking from one place to another

(d) Work is done when force is applied at a specify direction.

4. What is the major factors that, affect evaporation in the following list

(a) Water

(b) Boiling point

(c) Solid

(d) Gasses

5. Predict the kinetic theory assumption that, shows/ indicates evaporation

(a) Molecules in liquid states obtain kinetic energy when heated and leave the container

(b) Molecules are in random motion

(c) Molecules are static

(d) Molecules formed a shape of containing vessels

6. What is the formula of power

(a) Time x work

(b) Force x distance

(c) Velocity X time

(d) Work done divided by time

7. When do we say melting occurs in matter

(a) When liquid change to gas

(b) When gas change to solid

(c) When solid change to liquid

(d) When water change to ice

8. Explain why man is unique among living things

(a) Man has eye other living things do not have

(b) Man can reason more than other organism

(c) Man can grow other can grow

(d) Man can eat while other can eat

9. Predict what will happen to a rat that, is formed in aquatic environment

(a) The rat find it easier to swim

(b) The rat breath very well

(c) The rat runs very well

(d) The rat cannot survive

10. 25 joules of work done by a body at 5 seconds, what is it power?

(a) 6 watts

(b) 7watts

(c) 5waatts

(d) 3watts

11. Choose from the least of the habitant listed below

i. Terrestrial

ii. Herboreal

iii. Aquatic

The habitat of toad

(a) Terrestrial and aquatic

(b) Herborea

(c) Terrestrial

(d) Aquatic

12. Apply one of these basic safety measures for a child using water, acid base in orderto recognize

these chemicals

(a) Ensure storage of chemicals

(b) Observe chemical packages

(c) Ensure proper labeling of chemicals

(d) Taste the chemicals

13. What would happen if a car suddenly start moving on the wall

(a) Initial velocity is equal to final velocity

(b) Potential energy is converted to kinetic energy

(c) The kinetic energy is converted to potential energy

(d) No energy is involved

14. Define chemicals

(a) Chemicals are liquid substances

(b) Chemicals are use to produce drugs

(c) Chemicals substance used in the laboratory

(d) Chemicals are substances which may be hazardous or non-hazardous and used for changes in nature

15. Explain the main idea of boiling in liquid

(a) Boiling occurs when bubbles are formed

(b) Boiling occur when the temperature has reach the boiling point

(c) Boiling occurs when the whole liquid melt

(d) Boiling occurs when the container is hot

16. Determine how many 5ml teaspoon of water can fill one hundred nil of a bottle of coke

(a) 25ml

(b) 28ml

(c) 20ml

(d) 30ml

17. Use the kinetic theory to explain why a solid has a definite shape

(a) The molecules of solid as static and have electrostatic force of attraction

(b) The molecules are at random motion

(c) the collide with the wall of the container

(d) the molecules are held together by vander-waal force of attraction

18. Growth changes occur in the following except

(a) Height

(b) Weight

(c) Size

(d) Nail

19. Developmental charges are classified as the following except

(a) temporary

(b) Permanent

(c) Temporary and permanent

(d) Divided

20. How would you say a chemical hazardous in nature?

(a) When it affects directly or indirectly the life of living organisms

(b) When the chemicals are capable of killing

(c) When the chemicals are injurious to plant only

(d) When the chemicals are capable of preventing pathogens

APPENDIX II

STUDENTS BASIC SCIENCE ATTITUDE SCALE (SBSAS)

SECTION A: TESTEES PARTICULARS

NAME OF STUDENTS:_________________________________

NAME OF SCHOOL:___________________________________

CLASS:_____________________DATE:_____________________

SEX:_______________________AGE:______________________

LOCATION OF SCHOOL:_________________________________

HIGHEST QUALIFICATION OF PARENT:___________________

SECTION B:

INSTRUCTION: Read the following statement carefully and mark appropriate column in front of each statement. Mark only one option.

		SA	A	D	SD
1.	Basic Science is fascinating, so it is among my best school subjects.				
2.	Too many things are learnt by cramming in Basic Science, so I hate it				
3.	I like to become a Basic Science teacher in future				
4.	Basic Science concepts are difficult to understand, so I feel bored during Basic Science classes				
5.	I am always happy in Basic Science class because I always participate in class activities				
6.	Basic Science involves a lot of calculation which I cannot cope with				
7.	Basic Science is easy to understand				
8.	I hate Basic Science because we are made to accept and believe what our teacher told us in the class without testing them				
9.	I like Basic Science because all my friends are in Basic Science class				
10.	I prefer other science subjects to Basic Science because Basic				

	Science is too wide and difficult to understand				
11	I enjoy Basic Science class more than other school subjects				
12.	I hate Basic Science				
13.	Basic Science is an important subject for the course I want to read in the University				
14.	Studying Basic Science is a waste of time				
15.	I enjoy Basic Science because I work with my hands to handle and manipulate materials in the class				
16.	I always avoid Basic Science class				
17.	Basic Science activities are interesting to perform				
18.	I hate Basic Science because of the dangerous chemicals in the laboratory				
19.	I have feelings that, I can read Basic Science and understand it				
20.	I hate Basic Science because we learnt it in my school mainly by listening to the teacher and reading his note				

APPENDIX III

STUDENTS' BASIC SCIENCE ACTIVITIES ON PROCESS SKILLS (SBSAPS)

Dear Sir/Ma

Your response to the under listed items are expected to help in carrying out a research in the area of acquisition of Basic Science Practical Skills by the Basic Science students. The information is purely for academic work and your responses will be treated with utmost confidence

SECTION A

Name of school

Sex __________________________ Class _______________

Gender _______________________ School location: Urban ( ) Rural ( )

SECTION B

Instruction: Please use the scale in Appendix IIIA to rate the students' skills acquisition in the following practical skills.

ACTIVITY I

Title: Energy is necessary for work

Materials required: Meter rule, Toy car, Small ball and stone

Procedure: Research Assistant organized the class into groups.

Step 1: Place a ball at a distance slope in front of toy car

Step 2: Gently push the toy car against the small ball

Step 3: Label or mark the starting point of the moving toy car and where it stop.

Step 4: Observe the distance at which the small ball moved.

Step 5: Record your observation

Step 6: Submit your practical notebook for marking

ACTIVITY II

Title: Materials made of petrochemicals

Materials required: Diesel, Gas, Kerosine, Vaseline, Gasoline, Petrol all in container and roughages.

Procedure

Step 1: Name at least three materials at home that are petrochemicals products.

Step 2: Weigh the mass of each petrochemicals in materials above

Step 3: Record the mass of each petrochemicals

Step 4: Cut roughages into smaller pieces

Step 5: Add little petrol and wait until it dissolves.

Step 6: Record your observation

Step 7: Draw Vaseline Jelly petrochemical can and submit your practical notes for marking.

ACTIVITY III

Title: Exploring a habitat (conveniently near the school)

Materials required: insect catcher/ quad rat, peg, twin

Procedure:

Step 1: Research Assistant organized the class into groups

Step 2: Visit the land habitat identified by your teacher

Step 3: Observe the size of the habitat, measure the length and width of the area to be studied with measuring tape and record.

Step 4: Identify plants and animals you see in the area and collect some of the plants with the use of net or quad rat.

Step 5: Note where each plant or animal lives in habitat and record them. Some animals living on top of plants, on the ground or under the ground.

Step 6: Draw and labeled any plant or animal identified

Step 7: Submit your practical notes book for marking

ACTIVITY IV

Title: To demonstrate heat transfer by conduction

Materials required: Bunsen burner/ stove piece of copper wire (about 15cm long)

Procedure:

Step 1: Your teacher organized the class into groups

Step 2: Hold a piece of thick copper wire at one end

Step 3: Put the other end of the copper wire over a Bunsen flame

Step 4: Observe the burning copper wire when touches the flame

Step 5: Illustrate your experiment with the aid of a well labeled diagram

Step 6: Record your observation

Step 7: Submit your practical notebook for marking.

APPENDIX IIIB

STUDENTS' BASIC SCIENCE PROCESS SKILLS RATING SCALE (SBSPSRS)

Section A: Personal Data

1. Name of School:
2. Sex:
3. Class:
4. Gender: Male ( ) Female ( )
5. School Location: Urban ( ) Rural ( )

Section B:

Student's Name	Observation						Recording						Drawing						Labeling						Manipulating Apparatus						Total
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	

Instruction: Please use the following scale to rate the students' skills acquisition through observation.

APPENDIX IV

Instructional Guide on Active Review Strategy

LESSON ONE (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Living things

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

- Mention the different habitats of living things and identify the organisms found in them.
- State the various adaptive features of living things in their habitat.
- Identify characteristics of organisms in the same habitat and what they have in common.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught characteristics of living things.

INSTRUCTIONAL MATERIALS: School garden, charts, preserves fish, lizard, earthworm, birds etc.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 28-33.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. Mention living things known to you.

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to describe habitat and examples.

Step IV: The students point out to the new content (features of the organisms found in different habitat) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

(i) Name three major habitats known to you.
(ii) Gives examples on living things found in the different habitats.

ASSIGNMENT: (i) List types of energy

(ii) Mention different forms of energy

APPENDIX V

LESSON TWO (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Work, Energy and Power.

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

- Describe work, energy and power
- Explain the meanings of potential energy and kinetic energy
- Apply the formula power = $\frac{\text{work}}{\text{Time}}$
- Identify energy transfers that, occur when work is done.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with different activities before

INSTRUCTIONAL MATERIAL: Meterrule, ball, stones, books, wall clock, toy car, and bicycle.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 91-94.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. What is done when a boy carry a bucket of water to bathroom?

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to describe work, energy and power (Apply formula to work, energy and power)

Step IV: The students point out to the new content (uses if chemical, classify chemical based on hazardous nature) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

(i) Describe work, energy and power

(ii) Explain the meaning of potential and kinetic energy

(iii)Calculate the workdone when a person pushes a car from its stationary position to a distance of 50cm applying a force of zero.

(iv)State energy transfers that occur when work is done, give specific examples.

ASSIGNMENT: (i) List types of energy

(ii)Mention forms of energy

APPENDIX VI

LESSON THREE (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Types of Energy (Kinetic energy)

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

- State the assumptions of the kinetic theory.
- Explain the molecular structure of solids, liquids and gases using the kinetic theory.
- Distinguish between boiling and evaporation.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught work, energy and power.

INSTRUCTIONAL MATERIAL: Charts of molecular structure of solid, liquids and gases, beakers, water, ether, source of heat.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 109 – 111.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge.

(i) What is energy?
(ii) State two types of energy?

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials.

Step IV: The students point out to the new contents (kinetic theory, structure of solid, liquid and gases and different between boiling and evaporation) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

i. State the assumption of kinetic theory.
ii. Explain the molecular structure of solids, liquids and gases using kinetic theory.
iii. Distinguish between boiling and evaporation.

ASSIGNMENT:

i. Define thermal energy
ii. Explain conduction, convention and radiation.

APPENDIX VII

LESSON FOUR (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Thermal Energy

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

- Illustrate that, when two bodies are in contact, heat flows from one hot to the cold one.
- Name the methods of heat transfer.
- Describe heat conduction and its applications.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with different types of energy.

INSTRUCTIONAL MATERIAL: Iron rod, beaker, metal spoon, water, hot water, and thermometer.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 112-114.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. e.g what do you observed when you place iron rod on a fire?

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to explain the concept, thermal energy

Step IV: The students point out to the new contents (Heat flows, methods, of heat transfer and heat conduction and its application) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

i. Describe how heat flows from a hot body to a cold one when in contact.

ii. Name two methods of heat transfer.

iii. Explain heat conduction and state two uses.

ASSIGNMENT: Explain conduction, convention and radiation.

APPENDIX VIII

LESSON FIVE (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Convection and Radiation

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

- Describe heat convection
- State application of convection
- Explain heat radiation
- State application of radiation

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught thermal energy and heat before.

INSTRUCTIONAL MATERIAL:

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 112-114.

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. e.g. what do you observed when you walk close to where heat is produce?

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to describe convection and radiation

Step IV: The students point out to the new contents (heat convection, heat radiation etc.) as the research assistant carefully monitors their progress and provides support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

i. Describe convection and list two of its application.

ii. Explain what heat radiation is and give one application of radiation.

ASSIGNMENT: (i) Define chemicals

(iii)Classify chemicals based on their uses and hazardous nature.

APPENDIX IX

LESSON SIX (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Chemicals

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

- Define chemicals
- Classify chemicals based on their intended use and hazardous nature.
- State safety measures when using chemicals

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with different chemicals before but they cannot define, classify and state safety measures when using chemicals.

INSTRUCTIONAL MATERIALS: chemicals bottles (labeled) chemical bottles (non-labeled), kerosene, insecticides, camphor etc.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 85-89.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. e.g. List the composition of petrol.

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to describe chemicals.

Step IV: The students point out to the new contents (uses of chemical, classify chemical based on hazardous nature) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

(i) Define chemicals

(ii) State two classes of chemicals

ASSIGNMENT: Explain crude oil and petrochemicals

APPENDIX X

LESSON SEVEN (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Crude Oil and Petrochemicals.

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

- Explain what Crude Oil and Petrochemicals and petrochemicals means.
- Describe the process of refining crude oil.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with crude oil and petrochemicals before. Like kerosene, grease.

INSTRUCTIONAL MATERIAL: Crude Oil, Engine Oil, Grease, Petrol and Kerosene.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 87_89.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. e.g. what kind of chemicals do we use to drive a car?

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to work on crude oil and petrochemicals

Step IV: The students point out to the new contents (meaning of crude oil and petrochemicals and process of refining crude oil) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

i. Explain the meaning of crude oil and petrochemicals.

ii. Describe the process of refining crude oil.

ASSIGNMENT: State the uses of crude oil and petrochemicals.

APPENDIX XI

LESSON EIGHT (Active Review Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Crude Oil and Petrochemicals.

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

- State the uses of crude oil and petrochemicals.
- State the importance of crude oil to Nigeria.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught the meaning of Crude Oil and Petrochemicals.

INSTRUCTIONAL MATERIAL: Crude Oil, Engine Oil, Grease, Petrol and Kerosene.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 87-89.

PRESENTATION:

Step I: Research assistant ask questions to arouse the student's interest and activate their background knowledge. E.g. what did you put in your stove before hear is produce?

Step II: Students respond to the questions posed by the research assistant based on student's experience

Step III: Research assistant groups the students and present the students instructional materials to explain crude oil and petrochemicals

Step IV: The student's points out to the new contents (uses and importance of crude oil) as the research assistant carefully monitors their progress and provide support, feedback and scores are awarded to each group.

Step V: The students practice the new concepts or skills on their own in the classroom

Step VI: Research assistant gives clarification to each group.

Step VII: Research assistant asks the following questions to evaluate the lesson

i. List three uses of petrochemicals.
ii. Mention four importance of crude oil to Nigeria.

ASSIGNMENT:

List 5 materials at home that are petrochemicals

APPENDIX XII

Teachers' Instructional Guide on Practices- invention Strategy on Basic Science (TIGPISBS)

LESSON ONE (Practice-Invention Strategy)

Class: JSS 2

Duration: 60 minutes

Topic: Living things

Sub Topic: Habitat and Examples.

Instructional Material: Preserved fish, dog, Goat, frog, Lizard, Toad etc.

References: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2. An Integrated Science Course for Junior Secondary Schools, Pp. 28-33.

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

- Mention the different habitats of living things and identify organism find in them.
- State various adaptive features of living things in their habitats.
- Identify characteristics of organisms in the same habitat and what they have in common.

Precious Knowledge: Students had been taught characteristics of living things.

Introduction: The following questions are asked base on student's previous knowledge

- List living organism known to you and mention their habitat.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents. E.g. What is the habitat of the following animals (1) Goat - onland

(2) Tilapia fish - fresh

(3) Toad on tree

(4) Dove -

Step II: Give students opportunities to practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as classwork and move about the classroom

Step VII: The student's work-book are exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XIII

LESSON TWO (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Work, Energy and Power.

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

- Explain the meaning of work, energy and power.
- Explain the meaning of potential and kinetic energy.
- Apply the formula power = $\frac{\text{workdone}}{\text{time}}$
- Identify energy transfers that, occur when work is done.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with work, energy and power.

INSTRUCTIONAL MATERIAL: Ball, Stones, books, wound clock, toy car, bicycle.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 91-94.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as classwork and move about the classroom

Step VII: The student's work-book are exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XIV

LESSON THREE (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Types of Energy (Kinetic Energy)

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

- State the assumptions of the kinetic theory.
- Explain the molecular structure of solids, liquids and gases using the kinetic theory.
- Distinguish between boiling and evaporation using the kinetic theory.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught work, energy and power.

INSTRUCTIONAL MATERIAL: charts of molecular structure of solids, liquids and gases, beakers, water, ether, source of heat.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 109-111.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as classwork and move about the classroom

Step VII: The student's work-book is exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XV

LESSON FOUR (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Thermal Energy

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

- Illustrate that, when two bodies are in contact, heat flows the hot to the cold one.
- Name then methods of heat transfer.
- Describe heat conduction and its applications.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with types of energy before but cannot describe how heat flows.

INSTRUCTIONAL MATERIAL: iron rod, beaker, metal spoon, water, hot water, and thermometer.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 112-114.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as class work and move about the classroom

Step VII: The student's work-book are exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XVI

LESSON FIVE (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: convection and Radiation.

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

- Describe heat convection.
- State application of convection
- Explain heat radiation.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught thermal energy and heat flow process before.

INSTRUCTIONAL MATERIAL: iron rod, beaker, metal spoon, water, hot water, and thermometer.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, an Integrated Science Course for Junior Secondary Schools, Pp. 112-114.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as classwork and move about the classroom

Step VII: The student's work-book are exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XVII

LESSON SIX (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Chemicals

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

- Define Chemicals
- Classify chemicals based on their intended use and hazardous nature.
- State safety measures when using chemicals.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with different chemicals.

INSTRUCTIONAL MATERIAL: chemical bottles (labeled) chemical bottles (non -label), kerosene, insecticides, camphor e.t.c.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 85-89.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as classwork and move about the classroom

Step VII: The student’s work-book are exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XVIII

LESSON SEVEN (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Crude oil and Petrochemicals.

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

- Explain what crude oil and petrochemicals is.
- Describe the process of refining crude oil.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with crude oil and petrochemicals like grease, kerosene before.

INSTRUCTIONAL MATERIAL: grease, petrol and kerosene.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 87-89.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as class work and move about the classroom

Step VII: The student's work-book are exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XIX

LESSON EIGHT (Practice-Invention Strategy)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Crude oil and Petrochemicals.

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

- State the uses of Crude oil and Petrochemicals.
- List the importance of Crude oil and Petrochemicals to Nigeria.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught the meaning of Crude oil and Petrochemicals.

INSTRUCTIONAL MATERIAL: crude oil, engine oil, grease, petrol and kerosene.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 87-89.

PRESENTATION:

Step I: Research assistant provides the students with tasks that required activities in selected basic science contents.

Step II: Give students opportunities practice

Step III: Research assistant periodically introduce the lesson involving a new skills

Step IV: Helps students to re-discover concept and methods through appropriate heuristic approach by providing necessary environment and teaching materials.

Step V: Students looks at alternative approaches made by others in solving the problems

Step VI: Research assistant gives assigns interesting problem as classwork and move about the classroom

Step VII: The student's work-book is exchanged for marking to discover mistakes and to make necessary corrections.

APPENDIX XX

Teachers' Instructional Guide on Modified Conventional Method Strategy on Basic Science (TIGMCMSBS)

LESSON ONE (Conventional method)

Class: JSS 2

Duration: 60 minutes

Topic: Living things

Sub Topic: Habitat and examples

Instructional Material: school garden, video clips, charts, fish, lizards, earthworm, bird's e.t.c.

References: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2. An Integrated Science Course for Junior Secondary Schools, Pp. 28-33.

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

- Define habitat
- Mention the different habitats of living things and identify the organism found in them.
- State various adaptive features of living things in their habitat.
- Identify characteristics of organisms in the same habitat and what they have in common.

Precious Knowledge: Students had been taught characteristics of living things.

Presentation:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students

APPENDIX XXI

LESSON TWO (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Work, Energy and Power.

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

- Explain the meaning of work, energy and power.
- Define potential energy and kinetic energy.
- Apply the formula power = $\frac{\text{work done}}{\text{Time}}$
- Identify energy transfers that, occur when work is done.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught changes in matter.

INSTRUCTIONAL MATERIAL: Poster showing babies, students, teachers and parents.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 91-94.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students

APPENDIX XXII

LESSON THREE (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Types of Energy (Kinetic energy)

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

- State the assumptions of the kinetic theory.
- Explain the molecular structure of solids, liquids and gases using kinetic theory.
- Distinguish between boiling and evaporation using the kinetic theory.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught work, energy and power.

INSTRUCTIONAL MATERIAL: charts of molecular structure of solids, liquids and gases, beaker, water, ether, source of heat.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 109-111.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students.

APPENDIX XXIII

LESSON FOUR (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Thermal Energy

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

1. Illustrate that, when two bodies are in contact, heat flows from the hot to the cold one.
2. Name the method of heat transfer.
3. Describe heat conduction and its application.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with types of energy before but they cannot describe how that, heat flows.

INSTRUCTIONAL MATERIAL: Iron rod, Beaker, metal spoon, water, hot water, and thermometer.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 112 – 114.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students

APPENDIX XXIV

LESSON FIVE (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Convection and Radiation

INSTRUCTIONAL OBJECTIVE: at the end of the lesson, the students should be able to:-

i. Describe heat convection
ii. State application of convection
iii. Explain heat radiation
iv. State application of radiation

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught thermal energy and heat flow process before.

INSTRUCTIONAL MATERIAL iron rod, beaker, metal spoon, water, hot water, and thermometer.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, an Integrated Science Course for Junior Secondary Schools, Pp. 112-114.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students.

APPENDIX XXV

LESSON SIX (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Chemicals

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

- Define chemicals
- Classify chemicals based on their intended use and hazardous nature.
- State safety measures when using chemicals.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been familiar with different chemicals before but they cannot define, classify and state measure when using chemicals.

INSTRUCTIONAL MATERIAL: chemical bottles (labeled) chemical bottles (non-labeled), kerosene, insecticides, camphor e.t.c.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 85-89.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students

APPENDIX XXVI

LESSON SEVEN (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Crude oil and Petrochemicals

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

i. Explain what crude oil and petrochemicals.
ii. Describe the process of refining crude oil.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught convection and radiation in the last lesson.

INSTRUCTIO MATERIAL: Iron rod, Beaker, metal spoon, water, hot water etc.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 112 – 114.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students

APPENDIX XXVII

LESSON EIGHT (Conventional method)

CLASS: JSS II

AVERAGE AGE OF STUDENTS: 12years

DURATION: 60 minutes

TOPIC: Crude oil and petrochemicals (uses and importance)

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

i. State the uses of crude oil and petrochemicals.
ii. List the importance of crude oil to Nigeria.

ENTRY BEHAVIOUR/PREVIOUS KNOWLEDGE: Students have been taught the meaning of crude oil and petrochemicals.

INSTRUCTIONAL MATERIAL: Crude oil, Engine oil, Grease, petrol and kerosene.

REFERENCES: F. O. C. Ndu and E. O. Somoye (2008) Basic Science 2, An Integrated Science Course for Junior Secondary Schools, Pp. 87 – 89.

PRESENTATION:

Step I: Teacher introduces the lesson below by asking the students questions based on previous knowledge

Step II: Teacher discusses the content of the concepts on the board and asks the students to write in their note books

Step III: Teacher gives an overview of the lesson

Step IV: Teacher evaluate the lesson by asking question from the students

Step V: Teacher concludes the lesson by giving homework to the students

APPENDIX XXVIII

EVALUATING SHEET FOR ASSESSING TEACHERS' PERFORMANCE ON THE USE OF PRACTICES- INVENTIONSTRATEGY (PIESAT)

Name of Teacher: ---

School: ---

Date: -----------------

Guidelines Involved	**V. Good 5**	**Good 4**	**Average 3**	**Poor 2**	**V. Poor 1**
Teacher introduction of the lesson whether it is based on students previous Knowledge.					
Teacher's ability to give students the opportunity to answer the questions using their intuition.					
Development of new concept or idea from the given material this will be conclude among each group and at the end of their result finding the class generally listen to each group to present their material.					
Teacher gives homework or assignment					

APPENDIX XXIX

EVALUATING SHEET FOR ASSESSING TEACHERS' PERFORMANCE ON THE USE OF ACTIVE REVIEW STRATEGY (ARSAT)

Name of Teacher: --

School: --

Date: ------------------

Guidelines Involved	**V. Good 5**	**Good 4**	**Average 3**	**Poor 2**	**V. Poor 1**
Ability of the Teacher to give students opportunities to practice in Basic Science					
Ability of Teacher to provide Students with tasks that, require reasoning ,using non-routine problems					
Teachers ability to maintain balance between the time students spend practicing and the time they devote to inventing and discovering new ideas by helping students to re-discover concepts and methods through appropriate heuristic approach by providing the necessary environment and aids.					
Ability of the teacher to check back through the steps which lead to answer if error is found and to looks at alternative approaches					
Teacher clarification of students views on the concept by stimulating students to attempt simpler problems.					
Teacher structures instruction around carefully chosen skills and provides opportunities to share experiences when developing the skill.					
Teacher gives homework or assignment to students based on intelligent question.					

APPENDIX XXX

APPENDIX VIC: EVALUATING SHEET FOR ASSESSING TEACHERS' PERFORMANCE ON THE USE OF CONVENTIONAL STRATEGY (CESAT)

Name of Teacher: --

School: ---

Date: ------------------

Guidelines Involved	**V. Good 5**	**Good 4**	**Average 3**	**Poor 2**	**V. Poor 1**
Teacher's introduction of the lesson.					
Ability of the Teacher to discuss the content of the concepts.					
Ability of the Teacher to allow students to write the note.					
Teacher's ability to give an overview of the lesson.					
Teacher's oral questions in conformity with the concept.					
Teacher conclusion of the lesson.					
Teacher gives homework or assignment.					

APPENDIX XXXI

RESEARCH PICTURES

Students with Research Assistant in Small Group using Active Review Strategy

Students Demonstrating Practice-invention Strategy of Teaching

Students in Conventional Lecture Method Class