EFFECTS OF COGNITIVE APPRENTICESHIP AND CRITICAL EXPLORATION TEACHING STRATEGIES ON BASIC SCIENCE STUDENTS' LEARNING OUTCOMES IN SELECTED SECONDARY SCHOOLS IN OSUN STATE, NIGERIA

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ABSTRACT

Records have shown low students' achievement in basic science; a trend which has been attributed to the use of conventional strategy (CS). This has necessitated the use of other innovative activity-based teaching strategies such as cognitive apprenticeship and critical exploration that could facilitate the teaching and learning of the subject. Previous studies have not considered the extensive use of these two strategies in improving learning outcomes in the subject. This study, therefore, determined the effects of Cognitive Apprenticeship Strategy (CAS) and Critical Exploration Teaching Strategies (CES) on students' learning outcomes in basic science in Osun State. It also examined the moderating effects of gender and parental supportiveness.

The study adopted a pretest-posttest control group, quasi-experimental design with a 3x2x2 factorial matrix. Three Local Government Areas (LGAs) were randomly selected from Osun West senatorial district. Three co-educational schools with basic science teachers and laboratories were purposively selected from each of the LGAs while one arm of basic science Junior Secondary School II class from each of the nine schools was selected. Participants were randomly assigned to CAS (90), CES (90) and control (CS) (90) groups, while treatments lasted 12 weeks. The instruments used were: Basic Science Student Achievement Test (r=0.81), Student Basic Science Attitude (r=0.86), Student Basic Science Process Skills Rating (r=0.83) and Parental supportiveness (r=0.75) scales, Evaluation Sheet for Assessing Research Assistants' Performance, and Teachers Instructional guides on CAS, CES and CS. Seven hypotheses were tested at 0.05 level of significance. Data were subjected to analysis of covariance and Duncan post-hoc test.

There was significant main effect of treatment on students' achievement in basic science ($F_{(2,257)}$=66.56; $\tilde{\eta}^2$=.34). The students in CAS ($\bar{x}$=13.35) performed better than those in CS ($\bar{x}$=7.90) and those in CES ($\bar{x}$=13.23) also performed better than those in CS ($\bar{x}$=7.90). Treatment had significant main effect on students' attitude to basic science ($F_{(2,257)}$=3.59; $\tilde{\eta}^2$=.03). Participants in CAS had the highest adjusted mean score ($\bar{x}$= 37.44) than those in CES ($\bar{x}$= 37.21) and CS ($\bar{x}$= 35.20) groups. Treatment had significant main effect on science process skills ($F_{(2,257)}$ =3.35; $\tilde{\eta}^2$=.03). Participants in CAS ($\bar{x}$=21.28) had better posttest science process skills than those in CES ($\bar{x}$= 19.90) and CS ($\bar{x}$=19.53). Parental supportiveness had no significant main effect on achievement. Gender also had no significant main effect on achievement There was significant two-way interaction effect of treatment and gender on students' attitude to basic science ($F_{(2,257)}$ = 3.49). The best performance came from CAS male students ($\bar{x}$= 37.67) while the least performance came from CS male students ($\bar{x}$= 37.19). There was no significant three-way interaction effect of treatment, gender and parental supportiveness on students' achievement in basic science ($F_{(2,257)}$ = 1.32).

Cognitive apprenticeship and critical exploration teaching strategies improved junior secondary school students' performance in basic science. These two strategies should be adopted for the improvement of students' learning outcomes in basic science; particularly male students with low parental supportiveness.

Keywords: Cognitive apprenticeship strategy, Critical exploration strategy, Learning outcomes in basic science, Junior secondary school students in Osun State.

Word count: 494

CRTIFICATION

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DEDICATION

This work is dedicated to the glory of God the Almighty, and to my late mother, one in a million, Olori Felicia Sikeoye Abike Famodun (1944-2012).

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Table of contents

CHAPTER TWO: REVIEW OF RELATED LITERATURE 22

LIST OF TABLES **Page**

LIST OF FIGURES **Page**

LISTOFAPPENDICES

LIST OF ABBREVIATIONS

JSSCE- Junior Secondary School Certificate Examination

STAN- Science Teachers Association of Nigeria

CAS- Cognitive Apprenticeship Strategy

CS- Conventional Strategy

CES- Critical Exploration Strategy

NERDC- Nigerian Educational Research and Development Council

NISSSP- Nigerian senior Secondary School Project

NISP- Nigerian Integrated Science Project

CERI- Centre for Educational Research and Innovation

APSP- Africa Primary Science Programme

SEPA- Science Education Programmes for Africa

FGN- Federal Government of Nigeria

NTI- National Teachers Institute

NRC- National Research Council

NCE- National Council of Education

UBE- Universal Basic Education

NEEDS- National Economic and Empowerment development Strategies

EE- Environmental Education

DAE- Drug Abuse Education

AAA- American Association for the Advancement of Science

UNESCO- United Nations Economic, Social and Cultural Organisation

UNICEF- United Nations International Children and Emergency Fund

MDGs- Millennium Development Goals

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The focus of science is to gather knowledge about human environment, and the knowledge gathered constitutes the field of study called 'science'. It could be seen as an intellectual and practical activity, or a systematic study of the structure and behaviour of the physical and natural world (environment), through observation and experimentation (National Teachers' Institute, 2013). The relevance of science to national goals, aspirations and economy dictates, to a large extent, the huge commitment and support which most nations make and give to scientific and technological development (Olagunju, Adesoji, Iroegbu and Ige (2003). This is because the index of world leadership is a nation's capacity to make use of newer technologies. Specifically, the Federal Government of Nigeria, in the National Policy on Education (FGN, 2013:Setion 3:7 a-d), stipulates that secondary education shall provide primary school leavers with the opportunity for education of a higher level, irrespective of gender, social status, religious or ethnic background. Besides, it is also expected to provide technical knowledge and vocational skills as well as develop of mental, physical and social abilities and competencies of individuals, as basic requirements for people to live in and contribute to the development of the Nigerian society (FGN, 2013: Section 4:7d-9d). Hence, secondary school Educational activities, therefore, are expected to be centered on the learner for maximum self-development and self-fulfillment.

Notably, at the Basic Education level, emphasis both on pre-vocational and academic activities to provide technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development (FGN, 2013: Section 5: 22 a and h). At this level, students are expected to be taught basic subjects which will enable them to acquire further knowledge about nature and skills to address life challenges. Among the core subjects that the pupils are to be exposed to is Basic Science.

The learning of Basic Science (formerly Integrated Science) was meant to follow basic constructivist principles which basically promote active learning. From this perspective, learning is viewed as a generative process requiring effort in which learners actively construct their own meaning. Basic science as a discipline embodies basic concepts from such other disciplines as Biology, Chemistry and Physics, exclusively with extracts from Health Sciences, Mathematics, Geography, Agriculture and Technology. As such, the subject is a holistic combination of basic concepts of all the sciences in the area of life, energy, and environment. All the areas of specialization are germane in providing learners at the junior secondary school level with functional knowledge and skills required to meet the future aspirations of the society.

The need to achieve the dual aims of teaching and learning the subject has been addressed by quite a number of researchers from different locations all over the universe (Osborn and Wittrock, 2010). Efforts have been geared towards arranging the concepts which the learners need to know spirally in the curriculum. The teaching of the subject can only be result oriented when students are willing, and the teachers are favourably disposed to using appropriate methods and resources in teaching the students. The learning of the subject depends on the way it is presented to the learners and the way the learners actively interact with the learning activities they are expected to participate in, in order to acquire learning experiences (Martins, 2009).

Therefore, a unified approach to teaching Basic Science as an integrated science subject at the Junior secondary level was presented in such a way that students gain the concepts of the fundamental unity of science; the commonality of approach to problems of a scientific nature; an understanding of the role and function of science in everyday life, and the world in which they live (FGN, 2013). Based on the fact that the essence of basic science course is to introduce scientific concept students at the early level of education; the integrating principles are intended to produce a course which is relevant to students' needs and experience; emphasizes the fundamental unity of science; lays adequate foundation for subsequent specialist study; adds a cultural dimensions to scientific education (FGN, 2013).

In order to achieve the wholistic presentation of basic science contents to learners, the thematic approach to content organization was adopted. Consequently, four themes were created to cover knowledge, skills and attitudinal requirements. These are:

You and Environment,

Living and Non-Living Things,

You and Technology, and

You and Energy.

At the upper Basic level however, theme '3', "You and Technology;" was changed to "Science and Development". The topics under each theme were sequenced in a spiral form, beginning with the simple to the complex across the nine (9) years of Basic Education, in order to sustain the interest of learner and promote meaningful learning. In order to achieve the stated goals and objectives, a number of steps have been taken by science educators, governmental and non-governmental organizations, and professional bodies to promote the quality of learning and teaching of basic science in junior secondary schools in Nigeria and other parts of Africa. These include, inauguration of programmes for science development such as Science Education programmes for Africa (SEPA); Africa Primary Science Programmes (APSP); the Nigerian Primary Science Project (NPSP); Nigerian Integrated Science Project(NISP) for Junior

Secondary Schools one to three, and Nigerian Senior Secondary School Project (NSSSP) for Senior Secondary School one to three; others are programmes, projects, workshops, seminars and conferences organized by the Nigerian Educational Research and Development Council (NERDC) in collaboration with the Ministry of Education in each state; production of textbooks, workbooks and teachers' guides as well as empirical studies that could facilitate basic science teaching and learning. Other efforts include teaching basic science in Nigerian Primary and Secondary Schools, Colleges of Education and some Universities, where experts are being produced to man the affairs of integration in science teaching; and provision of resource materials for effective teaching and learning of basic science (Afuwape, 2004).

However, findings show that students' learning outcomes have been very poor, despite all the efforts and innovations at ensuring qualitative teaching and learning of Basic Science at the junior secondary level (Adeyemi, 2006; Ajagun, 2006 and Ozoji, 2008). A cursory look at the performance of students in basic science in Osun state between 2006 and 2013 reveal that percentage of students with distinction and credit passes as follows: 52.34% for 2006; 49.77% for 2007; 51.20% for 2008; 49.31% for 2009; 57.71% for 2010; 61.46% for 2011; 48.82% for 2012 and 56.15% for 2013 (Ministry of Education, Osogbo. Osun state, 2013). This shows that the average good performance for the whole period is 53.3. This is not the best for students who will become future scientists and contribute maximally to the scientific and technological development of the nation.

The general outlook of the results in Integrated Science in Nigeria between 1998 and 2010 and specifically, those of basic science in Osun State between 2006 and 2013 (discussed above) and the comparison between good and poor performance are presented in Tables 1.1, 1.2 and 1.3 respectively.

Table 1.1: JSSCE Integrated Science Result Analysis for Nigeria between 1998 and 2010

	No Registered			No with credits			Differences			% Credit Pass		
Year	M	F	T	M	F	T	M	F	T	M	F	T
1998	6119	4816	10935	3006	2513	5519	3113	2303	5416	49.13	52.18	50.47
1999	6009	5007	11,016	2,614	3136	5750	3395	1871	5266	43.5	62.63	52.2
2000	5847	6872	12719	2411	2984	5395	3436	3888	7324	41.23	43.42	42.41
2001	6133	6851	12984	3207	2,491	5698	2926	4360	7286	52.29	36.35	43.88
2002	6531	8194	6531	14725	4231	2897	7128	3963	3634	7597	51.16	44.35
2003	9053	16916	7863	3764	4139	7903	5289	3724	9013	41.58	52.64	46.72
2004	8292	9321	17613	3746	4379	8125	4546	4942	9492	41.17	46.98	46.13
2005	8647	10715	19362	3128	3673	6801	5519	7042	12561	36.17	34.28	35,12
2006	7966	10947	18913	4067	5784	9851	3899	5163	9062	51.05	52.28	52.08
2007	9068	11546	20614	4158	4871	9029	4910	6675	11585	45.85	42.19	43.8
2010	7109	8694	15803	3291	3348	6639	3818	5346	9164	46.29	38.5	42,01

Source: Federal Ministry of Education, Research Statistics and Planning Section, Abuja (2007).

Key: M=Male, F=Female, T =Total Number of students registered.

Table 1.1 clearly reveals that students' performance in Federal Junior Secondary School Certificate Examination in Integrated Science was very poor within the stated period. The general outlook of the results in Integrated Science/ Basic Science in Osun state between 2006 and 2013 are presented in Tables 1.2 and 1.3.

Table 1.2: JSSCE Integrated Science Result Analysis for Osun State between 2006 and 2013.

S/N	Year of Exam	No. of Candidates Registered	Number with Distinction	Percent. of Distinction	No. of Credit	Percent. of Credit	No. with Passes	Percent. Passes	No. of Failure	Percent. of Failure
1	2006	46,552	2,920	6.27	21,448	46.07	20,238	43.47	1,946	4.18
2	2007	44,729	1,684	3.76	20,582	46.01	20,542	45.92	1,921	4.30
3	2008	41,008	1,063	2.59	19,935	48.61	18,660	45.50	1,350	3.29
4	2009	48,991	1,305	2.66	22,855	46.65	18,870	38.52	5,961	12.16
5	2010	45,768	832	1.82	25,581	55.89	17,467	38.16	1,888	4.13
6	2011	51,640	8,776	16.99	22,965	44.47	17,592	34.07	2,307	4.47
7	2012	44,090	5,060	11.48	16,465	37.34	16,821	38.15	5,744	13.03
8	2013	46,574	5,465	11.73	20,687	44.42	17,568	37.72	2,854	6.13

Source: Ministry of Education, Osogbo, Osun State (2013)

A first look at this result shows that the percentage of failure is low. But ordinary pass in Integrated Science at junior secondary school level is synonymous with failure for students who want to offer Physics, Chemistry, Biology and Mathematics in the senior secondary school. Therefore, when the percentages of passes and failures are added and compared with percentage of distinctions, the result reflects a poor general performance. Poor performance is taken as all performances that fall below expectation, while academic failure refers to all performances below the pass mark (Bakare, 1994).

This, therefore, necessitates another table whereby scores under distinctions and credits are merged and those under passes are also merged with failure to form another column in order to provide a grand platform for comparison. This is shown in Table 1.3.

Table 1.3: Platform of comparison between Good and Poor Performance.

S/N	Year of Exam	No. of candidates registered	No. of Good academic Performance	Percent. of Good academic Performance	No of Poor academic Performance	Percent of Poor academic Performance
1.	2006	46,552	24,368	52.34	22,184	47.65
2	2007	44,729	22,246	49.77	22,463	50.22
3	2008	41,008	20,998	51.20	20,010	48.79
4	2009	48.991	24,160	49.31	24,831	50.68
5	2010	45,768	26,413	57.71	19,355	42.29
6	2011	51,640	31,741	61.46	19,899	38.54
7	2012	44,090	21,525	48.82	22,565	51.18
8	2013	46,574	26,152	56.15	20,422	43.85

Source: Ministry of Education, Osogbo, Osun State (2013)

From Table 1.3, it is evident that it was only in 2011 that students had a percentage score of 61.46, which is considered good academic performance. In all other years, their percentage score was below 60%. The situation of poor performance in schools therefore calls for a concern by all stakeholders, considering the efforts, time and energy expended in ensuring good result in the subject at the junior secondary school level.

Students' poor performance in Basic Science has attracted educators' comments and concerns (Seweje, 2001; Adeyemi, 2006; Duyilemi, 2014), and various reasons have been adduced for this problem. Ajayi (2007) associated this with shortage of qualified instructors, while Erinosho (2004) attributed it to poor understanding of scientific concept by the students.

The Science Teachers' Association of Nigeria (2010) attributed it to lack of commitment among the science teachers, while Duyilemi (2014) attributed it to poor method of teaching. Ogundare (2008) also attributed low academic performance of students in science subjects in Nigerian secondary schools to inadequate provision of materials and instructional resources that could facilitate teaching and learning of science. The poor performance has also been attributed to lack of qualified teachers and inadequate practical equipment (Onyegegbu, 2001); non-utilization of instructional resource materials by teachers (Oriade, 2007; Ehikhamenor, 2003); inability of teachers to provide opportunities for students to apply theoretical knowledge of science concepts in practical situations (Onyegegbu, 2006; Ige, 2003), and use of inadequate teaching strategies for understanding difficult concepts (Okafor and Okeke, 2006). Furthermore, researchers have identified other probable causes of low performance in Basic science. These range from student factors such as their poor attitudes to science (Showers and Shrigley, 2005), lack of interest in science (Adepitan, 2008), lack of role models in the subject (Ivowi & Oludotun, 2001), and poor mathematical background (Ogunleye, 2001). Government factors are in the area of policy making, infrastructural provision and teachers' welfare ((Ogunleye, 2001); while teachers' factors identified are teaching strategies employed (Adepitan, 2008; Kalijah, 2011) and unhealthy teacher-student relationship (Aysan, 2008). In addition, student failure has been found to result from their non- involvement in practical activities and project work that promote the spirit of inquiry, creativity, and the development of necessary skills and competences for functional living (Nwagbo, 2008; Ayogu, 2007). Similarly, the Nigerian Integrated Science Project (NlSP) for JSS l-3 recommends child-centered approach and stresses three basic strategies: (i) use of discovery teaching strategies (ii) the inclusion of problem solving activities and (iii) involvement of students in open-ended laboratory exercises.

Attitude towards science is another reason for poor performance. Attitude towards science denotes interest or feeling towards studying science. Attitude towards science is an important personal factor that influences students' motivation to study different science subjects (Anna Uitto and Pirkko Karna 2013). Research has demonstrated that, ''the attitudes toward science change with exposure to science, but that the direction of change may be related to the quality of that exposure, the learning environment, and teaching method'' (Craker, 2006)

A students' attitude toward science is more likely to influence achievement in science than achievement influencing attitude (Craker, 2006). Futhermore, studies have revealed the influence of methods of instruction on students' attitude towards science (Adesoji, 2008; Gok and Silay, 2008). These studies on attitudes generally explore how attitudes influence success. Characteristic attitudes and dispositions to science include being curious and imaginative, as well as being enthusiastic about asking questions and solving problems. In this regard, Afuwape and Olatoye (2003) recommended effective treatment of students' attitude towards Basic Science, hoping that the resultant positive attitude of students towards Basic Science would in turn improve their achievement. Similarly, Afuwape and Olatoye (2004) advocated enriched mastery and methodology in order to improve students' outcome in Basic Science. Also, Ajala and Kpangban (2000), and Ajayi (2001) submitted that instructional strategies should be varied to improve students' attitude to learning basic science. Factors which affect students' attitude towards science include teacher's instructional strategies, conducive learning environment, and non- innovative methods.

Basic science process-skills are usually taught as part and parcel of Basic Science curriculum. They are activity-based skills which can be acquired through training and direct experience. The acquisition of these skills by students is influenced by the cognitive knowledge-base of the students. The skills are the foundation of problem solving in science and scientific method. These skills according to Wetzel (2010), are the methods used by students to conduct investigations and understand how humans know about the World in which they live, whereby they go beyond the textbook and supplementary core-content within textbooks with hands-on, minds-on activities. It also means using your subject content as a means for exposing students to the real processes of science. Science process skills are based on scientific inquiry. Njoku (2004) further explained that the skills are cognitive and psychomotor skills which scientists use in problem identification, objective inquiry, data collection and analysis. These skills are retained after the cognitive knowledge of science has been forgotten. Furthermore, these skills involve making explicit references to science and allowing students time to reflect on how they participated in the process. It also helps ensure students make the connection between science processes involved within an investigation and science content (Karen, 2009).

There seems to be a general consensus of opinion among science educators concerning the influence of teaching methods or instructional strategies adopted by the teacher and other variables on students' achievement and attitude to science (Gbolagade, 2009). He emphasized the importance of appropriate teaching strategies in the development of skills required for making science content relevant to the growth and development of both the individual and the society. Students must be exposed to situations which demand the knowledge and skills they are required to acquire and use.

In spite of all the efforts towards improving students' performance, using some teaching strategies which include, demonstration, discussion, project, field trip, group discussion and lecture methods, the performance of students is still very low. Of all these, lecture method is the most popular, commonest and mostly used in Nigerian classrooms (Duyilemi, 2005). Ogunsola-

Bamidele (2012) remarked that lecture method is the most abused of all teaching methods and the least effective in many respect. This implies that the aims and objectives of teaching Basic Science cannot be attained with lecture method; hence, there is the need for more involving methods of instruction. That is, if Basic Science would be taught to achieve its stated objectives, an activity and student -oriented approach would be used in line with the role of a teacher, which has gradually shifted from traditional disseminator to that of mentoring or tutoring. Here, the teacher assist students with sources of information and provides them with guidance, as students need to be given opportunity to be actively involved in the learning process (Duyilemi, 2005). Teaching is not only standing in front of a class talking, the best teacher contemplates the manner in which they will present the topic and have a wide variety of instruction models at their disposal (Orlich, Harder, Callahn, Travisan, Brown, 2010). It is therefore imperative strategies that could appeal to and arouse learners' interest and at the same time help to achieve the objectives of Basic Science.

The persistent low performance in the subject has therefore created the need for further search for alternative strategies for teaching Basic Science. In Nigeria, attempts have been made to investigate the usability of cognitive apprenticeship and critical exploration as teaching strategies. For instance, Agommuoh and Ifeanacho (2013) in their investigation of secondary school students' Assessment of Innovative Teaching Strategies in Enhancing Achievement in Physics and Mathematics in Umuahia, Abia State of Nigeria, found that inquiry method, discovery learning, discussion, role play, simulation, games, team teaching, brainstorming, and other similar strategies which include cognitive apprenticeship and critical exploration were agreed to be teaching strategies that can enhance achievement in Physics and Mathematics. They recommended that Physics and Mathematics teachers should be encouraged to use these teaching strategies when teaching Physics and Mathematics. Furthermore, the necessity for the use of cognitive apprenticeship and critical exploration teaching strategies in Nigeria was advocated by Madu (2004), who vehemently opposed the lecture-based instruction, which he referred to as teacher- centered and full of passive acquisition of knowledge by students, who do not have conceptual understanding but memorize the learning content. He therefore advocated the use of innovative teaching strategies in the teaching of science subjects by the science teachers, so as to enable students to learn and acquire positive attitudes and values, process skills, and problem-solving skills. In the light of this, it becomes necessary to examine the effects of cognitive apprenticeship and critical exploration -teaching strategies on students' learning outcomes in Basic science, in nine selected junior secondary schools in Osun State, Nigeria.

Cognitive apprenticeship is an instructional model derived from the metaphor of the apprentice working under the master craftsperson in traditional societies, and from the way people seem to learn in everyday informal environments (Lave, 2002). This method rests on a somewhat romantic conception of the "ideal" apprenticeship as a method of becoming a master in a complex domain (Brown, Collins and Duguid, 2003). Cognitive apprenticeship is especially appealing to designers of web-based learning environment, who are embracing a more constructivist approach to learning and instruction. Cognitive apprenticeship is a process by which learners learn from a more experienced person by way of cognitive and metacognitive skills and processes. It is an apprenticeship process that utilizes cognitive and metacognitive skills and processes to guide learning (Ogbonna, 2007; Carter, Ferzi and Wiebe, 2007; Martins, 2009}.

Critical exploration is a teaching approach adapted by a learning theorist, Eleanor Duckworth (2001 and 2006) from Jean Piaget's (developmental psychologist) clinical method. It is a method whereby discussion centres on a specific intellectual challenge that has been represented in concrete form; most often, a reliable material and proven ground, against which students can develop and evaluate their own ideas. Duckworth (2006) proposed that the two components of critical exploration are curriculum development and pedagogy. In this method, teachers find ways to encourage their students to explore the subject-matter and express their thought on the material. Teachers critically explore students' learning through project in poetry, sciences, mathematics, history, spelling, or any other part of the curriculum. As students struggle through a problem, the teacher puts them at ease, invites them to talk about and keep thinking about their ideas, and reacts to the substance of their answer without judging them. In these, the teacher refrains from signaling to students what she wants them to say, because doing so will sacrifice the opportunity to know what the students actually think. Rather than being expected to provide a certain answer, the students reveal their own understanding through their responses. This does not mean that the teacher's own curricular goals are pushed aside. On the contrary, a teacher's knowledge in the subject matter and skill as an educator would be simultaneously put to work as she deepens students' understanding and helps them to develop their own thought further.

The study further examined the influence of gender and parental supportiveness on achievement, attitude and science process-skills. The effect of gender in science-related subjects is a major issue of concern among educators. This may be as a result of conflicting results obtained from such gender-related studies. For example, some researchers have shown that boys perform better than their female counterparts in science subjects (Raimi, 2003). But Ogunkola (2000) found that there was no significant main effect of gender on students' attitude and achievement in Biology. In the same light, Ebere (2006) reported in his study "breaking gender barrier on achievement in Science Teaching Method (STME), using hands-on, mind-on science'', that students (boys and girls) who were exposed to science process-based learning activity, oriented learning and manipulation of materials, yielded a more effective learning irrespective of gender, than other students. From this, there is need to examine the effects of two selected strategies (Cognitive Apprenticeship and Critical Exploration) on students learning outcomes in Basic Science by gender.

According to Abakaliki (2004), gender stereotype is responsible for the low representation of women in science, which no doubt hinders the performance of the girl-child. Ogunleye (2002), Ogunneye (2003), Ezirim (2006) Animasahun, (2007) and Ogundiwin (2014) observed that gender has significant influence on achievement in Physics and Biology; For instance, teachers set higher expectations and boys are always leaders in science related activities, which could make females feel inferior and less determined to achieve better. However, Agommuoh and Nzewi (2003) and Babajide (2010) found that gender has no significant influence on achievement in science.

However, using gender as moderating variable, Ayanda (2006) observed that within the limits of experimental accuracy, gender did not significantly influence the level of science achievement. The influence of gender on achievement is therefore still a controversial one among science researchers. It is therefore imperative that more studies investigate the role of gender in students' achievement in science. The inconsistency has therefore made the researcher to examine the effect of cognitive apprenticeship and critical exploration strategies on students' learning outcomes in basic science, using gender as a moderating variable.

In addition, parental support is another variable that affects students' achievement in Basic Science. As a matter of fact, support given by parents in their children's education has been the subject of research for several decades, and the topic continues to be of interest (Carter and Wojtkiewiez, 2000; US Department of Education, 2000; Centre for Educational Research and Innovation (CERI), 2014). Therefore, increasing parental support in children's learning has become an important issue in many school reform efforts (CERI, 2014). There is overwhelming evidence that parental support in children's education is linked to children's school success (Nord and West, 2001; US Department of Education, 2000). Shiu (2002) investigated parental support in Taipei and found significant relationship between parental support in their children's education and their academic achievement. A rich and supportive home learning environment (high SES) helps children succeed in school (Jordan, Snow and Porche, 2000). Parental support in children's education in the middle and high school years, and intervention of parents, produce a positive result in terms of academic success. Students with supportive parents exhibit higher rates of self-reliance, identity formation school performance and positive career-planning aspirations, as well as lower rates of depression and delinquency (Myers, 2008).

Though there have been several studies on the general use of cognitive apprenticeship and critical exploration in highly industrialized countries where these variables have been tested and proven highly effective (Georgia and Canada) there is dearth of such studies in developing countries, particularly in the teaching of Basic in Nigeria. Hence, Collins et-al (2006) and Duckworth (2010) have therefore suggested the use of cognitive apprenticeship and critical exploration in African countries for the teaching and learning of science.

1.2 Statement of the Problem

Effective instructional strategies have been identified as the solution to poor performance of students in Basic Science. That is why much awareness is raised on the adoption of these strategies by teachers. However, despite the level of awareness propagation among teachers teaching Basic Science at the junior secondary school level, students' academic performance and attitude to Basic Science and their skills remain not so encouraging. These students show negative attitude to science and their persistent, poor achievement in Basic Science is an evidence to support this.

Students that are exposed to instructions about living and non-living things still exhibit poor achievement in, negative attitude to and ineffective skills in Basic science, and are unable to tackle simple problems (Adesoji, 2008; Wetzel, 2010; Duyilemi, 2014). This poor performance has been attributed to several factors such as: the use of lecture method, lack of parental support for students' education, misconceptions of concepts and gender stereotype all of which have been identified as the most important.

Researchers (Madu, 2004; Ogundare, 2008; Ogundiwin, 2014) have suggested various teaching methods such as the use of Video Compact Disc, audiocassette, guided discovery, values clarification, outdoor activities, and enter -educate amongst others, which have not yielded sufficient positive results as evidenced in the performance of students in Basic Science in external examinations. Researchers (Ogbonna, 2013; Agommuoh &Ifeanacho, 2013) have also suggested the use of meta-cognitive teaching strategies such as cognitive apprenticeship and critical exploration. However, studies that devised an intervention education programme to explore the possibility of using cognitive apprenticeship and critical exploration strategies for teaching Basic Science in Nigeria are scarce, although the strategies have been used in teaching subjects like Physics, Social Studies and Mathematics in other countries with significant positive effects observed. However, to the best of the researcher's knowledge, there has been no particular study in Nigeria which has utilized the combination of cognitive apprenticeship and critical exploration teaching strategies to enhance students' learning outcomes in Basic Science.

Therefore, this study investigated the effects of cognitive apprenticeship and critical exploration strategies on secondary school students' achievement in, attitude to and adoption of science process skills in Basic Science in Osun state. The study further examined the influence of gender and parental support on students' learning outcomes in Basic Science.

1.3 Hypotheses

Based on the stated problem, the following hypotheses are tested at 0.05 Alpha Level.

HO_1: There is no significant main effect of treatment on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic Science.

HO_2: There is no significant main effect of parental supportiveness on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic Science.

HO_3: There is no significant main effect of gender on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic Science.

HO_4: There is no significant interaction effect of treatment and parental supportiveness on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic Science.

HO_5: There is no significant interaction effect of treatment and gender on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic Science.

HO_6: There is no significant interaction effect of gender and parental supportiveness on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic science.

HO_7: There is no significant interaction effect of treatment on parental supportiveness and gender on students'

(a) Achievement in Basic Science

(b) Attitude to Basic Science

(c) Science process skills in Basic Science.

1.4 Scope of the Study

This study focuses on effects of cognitive apprenticeship and critical exploration teaching strategies on basic science students' learning outcomes in selected secondary schools in Osun state, Nigeria. The study is delimited to only Junior Secondary Two (JSII) students in 9 (Intact Classes) selected from three Local Government areas of Osun state, namely: Iwo, Ayedire and Ola-Oluwa. Living and non-living things' concepts in 9-year Basic Education curriculum of Basic science for junior secondary school II themes are used for the study. Living things: are sub-divided into habitat, Uniqueness of man; changes in living things are recognized as temporary and permanent changes; changes in non-living things is at the stages of development, and changes in matter are solid, liquid and gas.

1.5 Significance of the Study

This study will be of immense benefit to all stakeholders in educational sector. The purpose of the study is to bring about increase in performance of students, positive attitude and development of science process skills, towards basic science which so far have not been really achieved. This study is therefore considered significant because it might bring about the desired positive change in learning Basic Science. Hence, students will be the first beneficiaries of this study, for it would lead to increase in their performance, bring about a positive attitude and science process skills towards Basic science.

The findings of this study would also help teachers to use strategies that promote learning, thus making them actively involved in improving their classroom instructional practices. The findings of the study would also be beneficial to the educational administrators, especially, the Ministry of Education, Osun state because the recommendations could be used in training staff or personnel for the realization of educational goals in the state. Curriculum planners would benefit greatly from this study because it would enable them to draw concepts that would assist students in improving their achievement in, positive attitude to, and development of science process skills towards Basic Science.

The study would also enable parents to provide necessary materials for learning and financial as well as moral support for their children. Parents would see reasons to play positive and supportive roles to their children educational career.

The study would form empirical basis for subsequent research on students' achievement, attitude to and understanding of science process skills in Basic Science.

1.6 Operational Definition of Terms

Basic Science: Science subject offered at the Junior Secondary School level of Education in Nigeria.

Cognitive Apprenticeship teaching strategy: An apprenticeship process that utilizes cognitive and meta- cognitive skills and process to guide learning.

Critical Exploration teaching strategy: An experience in teaching and learning which a teacher conducts so as to engage learners in a subject matter that is real and may be physically present in the classroom.

Conventional teaching 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.

Parental Support: This is support given to students by the parents or guardians. This includes provision of materials necessary for learning, financial and moral support.

Students' Achievement: This is the extent to which a student has learned knowledge, skills etc. after an educational program. In this study, students' achievement refers to the scores obtained by students in an examination. This is measured using BSSAT.

Students' Attitude: This is the disposition of students towards Basic Science. Positive attitude enhances performance while negative attitude paves way for poor performance. This is measured using SBSAS.

Science process skills: These are mental tools, psychomotor and affective domains which practitioners of science employ in discovering and acquiring scientific knowledge. This is measured using Basic science process skills rating- scales (BSPSRS).

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The Review of Literature is in the following order:

2.1 Theoretical Framework

2.1.1 Constructivist Theory: Lev Vygotsky (1978) and Piaget (1969) theory of constructivism

2.1.2 Cognitive Constructivism in relation to the Cognitive Apprenticeship and Critical Exploration

2.1.3Bandura (1977) social learning theory

2.1.4 Collins Brown- Model of Cognitive Apprenticeship

2.2 Conceptual review of literature

2.2.1 The Nature of Basic Science

2.2.2 Skills Associated with Basic and Integrated Science

2.2.3 Students' Achievement in Science

2.2.4 Students' Attitude to Science

2.2.5 Students' Science Process Skills

2.2.6 Features of Cognitive Apprenticeship

2.2.7 Features of Critical Exploration in the Classroom

2.3 Empirical Review

2.3.1 Cognitive Apprenticeship Strategy and Students' Learning Outcomes in Basic Science

2.3.2 Critical Exploration Strategy and Students' Learning Outcomes in Basic Science

2.3.3 Conventional Lecture Strategy and Students' Learning Outcomes in Basic Science

2.3.4 Parental support and Students' Learning Outcomes in Basic Science

2.3.5 Gender and Students' Learning Outcomes in Basic Science

2.4 Appraisal of the Literature Reviewed

2.1 Theoretical Framework

This study is based on the idea of constructivism.

2.1.1 Constructivist Theory

Constructivism is basically a psychological theory of knowledge which holds that humans construct knowledge and meaning from their experiences. This school of thought is traced to the work of Russian Psychologist, Lev Vygotsky (1896-1934), who believed that learning is a process of novice introduction to ideas and critical exploration. It was adapted by learning theorist, especially in the works of the developmental psychologist, Jean Piaget's clinical method. who proposed the learning theory of constructivism in which children construct knowledge through their own experiences and interactions, and thus make meaning of the world around them (Slavin, 2003).

Constructivists suggest that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively. Vygotsky's (1978) social learning has antecedents in the work of Lave and Wenger (situated learning) with other researchers (Brown, et al. 1989). They developed situated learning and emphasized the idea of cognitive apprenticeship.

Cognitive apprenticeship supports learning in a domain by enabling the students to acquire, develop and use cognitive tools in authentic domain activity. Learning, both outside and inside schools, advances through collaborative social interaction and social construction of knowledge. Constructivism is a set of beliefs about knowledge that begins with the assumption that reality exists but cannot be known as a set of truth (Tobin &Tippins, 1993). Constructivism is not accepting what you are told but your prior knowledge about what you are taught and your perception about it.

Vygotsky (1978) on the other hand advocated a more social constructivism, in which he proposed that cognitive development is influenced heavily by other people and external factor (Vygotsky, 1978). He believed that students should utilize the input of others to build or construct their own learning through collaborative experiences (Martins, 2009), and that while teachers could facilitate the learning, it primarily stems from peers, family and friends, as well as from other cultural sources. Vygotsky also believed that children acquire signs when they learn, which they internalize and which enable them to be able to think independently, which is also known as 'self-regulation' (Daniels, 2001; Moll, 1990). Vygotskyian theory also incorporates cooperative learning, where children learn from each other in their Proximal Development Zone (PDZ) and are more responsible for their own learning (Slavin, 2003; Vygotsky, 1978). Constructivist teaching incorporates cooperative learning and is sometimes referred to as top-down (Slavin, 2003), where students begin with a complicated problem and solve it using basic skill and some teacher guidance.

Jean Piaget's theory of child development made a distinction between assimilation and accommodation, as mechanisms of learning affords the child "teachable moments''. Piaget's theory of cognitive development proposes that humans cannot be given information which they immediately understand and use. Instead, humans must construct their own knowledge. They build their knowledge through experiences, which enable them to create schemas mental models in their heads. These schemas are changed, enlarged, and made more sophisticated through two complimentary processes: assimilation and accommodation. One important generalization of Piagetian theory is the role of the teacher. In a Piagetian classroom, an efficient teacher provides a rich environment for the spontaneous exploration of the child. A classroom filled with interesting things such as: Basic Science kits, microscope, hand lens, models etc. to explore encourages students to become active constructors of their own knowledge (their own schemas) through experiences that encourage assimilation and accommodation. In a Piagetian classroom, students must be given opportunities to construct knowledge through their own experiences. They cannot be ‘told ’by the teacher as there is less emphasis on directly teaching specific skills and more emphasis on learning in a meaningful context.

Cornelius-White (2007) found that students using more learner-centered methods often performed at a higher level than teacher-centered methods, and they succeed in using a constructivist approach in Mathematics and Science. Even as far back as 1969, Hurd has advocated that Science should be taught in the way that Science as a discipline is practiced, and should therefore be investigative. One of the advantages of hands-on activities, according to Martins (2000), is that the teacher can observe how children are working within a controlled environment to evaluate their progress. The children’s performance will demonstrate their proficiency in the skills employed in the process.

This theory of constructivism is further demonstrated in the following diagrams:

Figure 2.1a: Vygotsky’s Constructivist Approach (Adopted, May 10, 2014)

Figure 2.1a shows that when learners receive a little guidance from teachers on what to do, they begin to make efforts on gradual scaffolding basis and eventually attain the zone of proximal development,, whereby they are able to construct their ideas and knowledge through their own experiences and interactions and thus make meaning of the world around them.

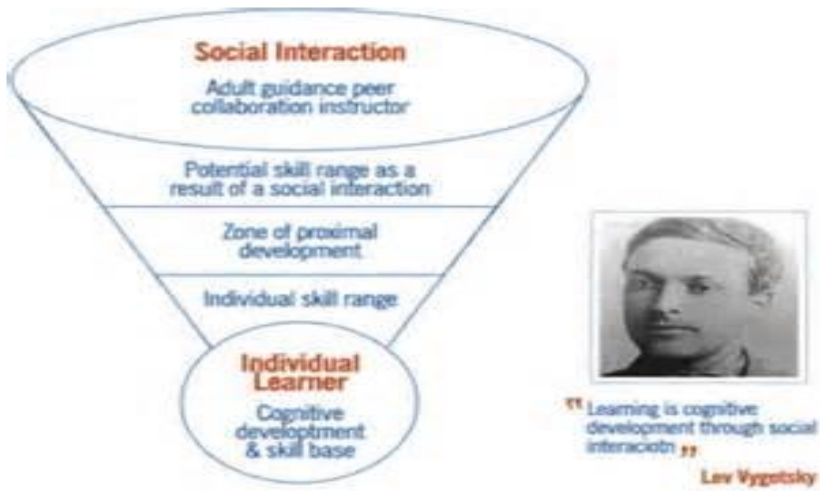

Figure 2.1b: Vygotsky's Emphasis on Social Interaction (Adopted, May 10, 2014)

Figure 2.1b shows that an individual learner as an independent person has personal cognitive development and skill- base which is however limited and may not exceed a particular individual skill range , which is pegged by the zone of proximal development. However, when the individual interacts with others and work as a team, he develops better and acquires more experiences and better skills based on the opportunity of social interaction. This opportunity promotes a joint effort and peer collaboration, which is more beneficial to the individuals and the society at large.

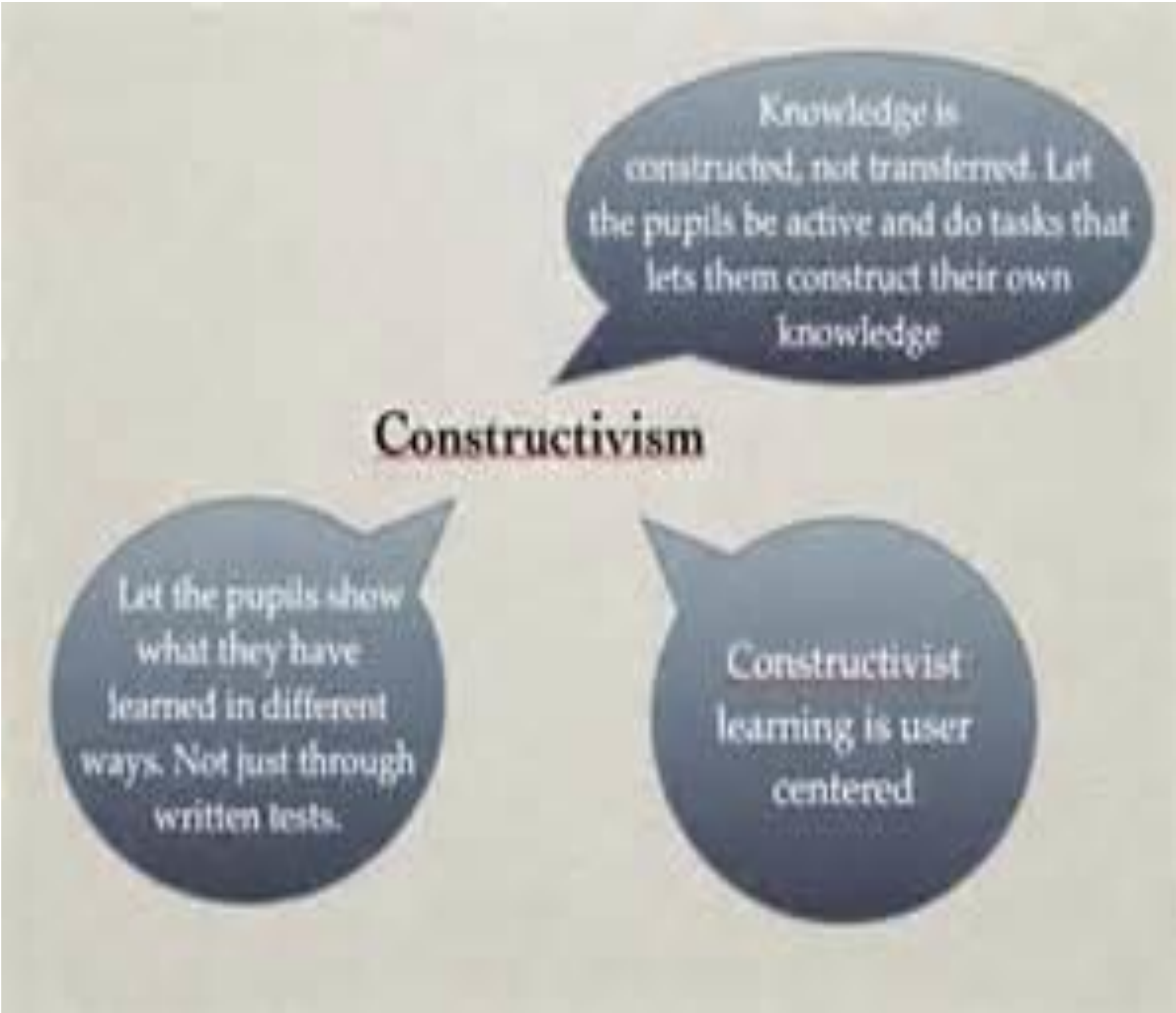

Figure 2.1c:Vygotsky'sInstruction to Teachers on the use of Constructivism Approach (Adopted, May 10, 2014)

To explain Figure 2.1c, starting from the lower right and rotating to the left, teachers are implored to make the delivery of academic content learner-centered, whereby the teacher gives a little guidance and allow the learners to interact among themselves to construct their own ideas of the subject matter. Learners should be allowed to participate actively and perform tasks that let them construct their own knowledge. Finally, the learners should be allowed to show what they have learned in different ways and not just through written tests only. This is to give room for adequate participation and demonstration of innate skills by the learners, whereby some can excel in drawing, projects, observation and so on rather than restriction to written tests only.

2.1.2 Cognitive Constructivism in relation to the Cognitive Apprenticeship and Critical Exploration.

Cognitive Constructivism is applicable to the Cognitive apprenticeship and Critical Exploration strategies. Cognitive Constructivism according to Fosnot (1996), 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, adapt and be flexible is highly paramount. The implication of cognitive constructivism, according to Kato and Kamii (2001), is that the child becomes very autonomous and independent, refusing to be governed by reward and punishment.

Cognitive Apprenticeship and Critical Exploration developed from this theory. Confucius' pedagogical methods also supported this view in which a 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 Cognitive Apprenticeship and Critical Exploration can be traced to the early philosophies of Plato. Plato believed that we learn about the world in two different ways. We get useful information through our senses, like sight and touch, but we reach the level of truth by using a higher thinking ability, which he called reason. Plato said that our senses give us imperfect knowledge, because they relate specific objects. But our reason produces truth, or perfect knowledge, because it relates ideas. Both Plato and Aristotle believed that as humans develop, there are qualitative changes in their ability to think logically about experiences. The importance of critical thinking was also evident in the beginning of the modern era of education in the writings of Dewey (1909/1997). He described the ability to think critically as a way to find meaning in the world in which we live, but the processes by which learning occur, (cognitive adaptation and social mediation) are believed to be continuous or remain the same throughout life. 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 (Piaget & Inhelder, 1969; Vygotsky,1978). An emphasis is now being placed on the ability to understand and use information, not just merely to possess it, but to improve their achievements, attitude and practices towards environmental education (Igboko & Ibeneme, 2006). Almost unanimously, educators believe the development of critical thinking ability should be a primary goal of education (Pithers & Soden, 2000).

Questions lead to understanding, but many students typically have no questions. They might sit in silence with their minds inactive as well. Sometimes the questions students have tend to be shallow and nebulous, which might demonstrate that they are not thinking through the content they are expected to be learning. If educators want students to think, they must then stimulate and cultivate the habit of thinking with questions in students (Paul, 2006). By engaging students in critical exploration 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 cognitive apprenticeship in which materials and objects from the children's environment enable them to recognize, verify and store experiences for later use is encouraged. While the importance of acquisition and recall of basic knowledge remains important, the development of Cognitive Apprenticeship and Critical Exploration have emerged as equally important The strategies also find balance in facilitating the acquisition of basic knowledge in order to develop and nurture critical thinking in education, which is important in the acquisition of great achievement including right attitude and science process skills towards Basic Science..

2.1.3 Bandura (1977) Social Learning Theory

The social learning theory of Bandura emphasizes the importance of observing and modeling the behaviours, attitudes, and emotional reactions of others. Bandura (1977): (p22) states: 'Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own action to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action.''(P22). Social learning theory explains human behaviour in terms of continuous reciprocal interaction between cognitive, behavioural, and environmental influences. The component processes underlying observational learning are: (1) Attention, including modeled events (distinctiveness, affective valence, complexity, prevalence, functional value) and observer characteristics (sensory capacities, arousal level, perceptual set, past reinforcement). The second is Retention, including symbolic coding, cognitive organization, symbolic rehearsal, motor rehearsal); (3) Motor Reproduction, including physical capabilities, self-observation of reproduction, accuracy of feedback, and (4) Motivation, including external, vicarious and self reinforcement, because it encompasses attention, memory and motivation. Social learning theory spans both cognitive and behavioural frameworks. Bandura's theory improves upon the strictly behavioural interpretation of modeling provided by Miller and Dollard (1941). His work is related to the theories of Vygotsky and Lavy which also emphasize the central role of social learning.

Social learning theory has been applied extensively to the understanding of aggression (Bandura, 1973) and psychological disorders, particularly in the context of behaviour modification (Bandura, 1969). It is also the theoretical foundation for the technique of behaviour modeling which is widely used in training programs. Bandura has focused his work on the concept of self-efficacy in a variety of contexts (e.g., Bandura, 1977). The most common (and pervasive) examples of social learning situations are television commercials. Commercials suggest that drinking a certain beverage or using a particular hair shampoo will make people or users popular and win the admiration of attractive people. Depending upon the component processes involved (such as attention and motivation), we may model the behaviour shown in the commercial and buy the product advertised.

In explaining this theory further, the Northwestern psychologist, Donald Campbell in Liehert and Sprafking (1988), used concrete examples of making a choice between gun and butter in a war situation or peaceful atmosphere, and postulated that if someone has taken an introductory course in economics, he is already familiar with the policy planner's dilemma of deciding whether to allocate limited resources for guns or for butter. The problem is usually posed to illustrate the impersonal market forces of supply and demand, profit and loss. Yet, planners are people, and most individuals come to the war-or-peace decision points of life having already developed preferred responses. Donald Campbell calls these tendencies "acquired behavioural dispositions," and he suggested six ways that we learn to choose one option over another.

1. ***Trial-and-error experience*** is a hands-on exploration that might lead to tasting the butter and squeezing the trigger, or perhaps the other way around.

2. ***Perception of the object*** is a firsthand chance to look, admire, but not to touch a pistol and a pound of butter at close range.

3. ***Observation of another's response to the*** *object* is hearing a contented sigh when someone points the gun or spreads the butter on toast. It is also seeing critical frowns on faces of people who bypass the items in a store.

4. ***Modeling*** is watching someone fire the gun or melt the butter to put it on popcorn.

5. ***Exhortation*** is the National Rifle Association's plea to protect the right to bear arms or Willard Scott's commercial message urging us to use real butter.

6. ***Instruction about the object*** is a verbal description of the gun's effective range or of the number of calories in a pat of butter (Cambell, in Liehert and Sprafking, 1988).

Campbell claims that direct trial-and-error experience creates a deep and long-lasting acquired behavioural disposition, while perception has somewhat less effect, observation of response even less, and modeling less still. Exhortation is one of the most used but least effective means to influence attitudes or actions.

Stanford psychologist, Albert Bandura, agrees that conversation is not an effective way of altering human behaviour, but he thinks that classical learning theory's preoccupation with trial-and-error learning is shortsighted. For instance, he believed that coping with the demands of everyday life would be exceedingly trying if one could arrive at solutions to problems only by actually performing possible options and suffering the consequences. His social learning theory concentrates on the power of example.

Bandura's major premise is that we can learn by observing others. He considers vicarious experience to be the typical way that human beings change. He uses the term *modeling* to describe. Campbell's two midrange processes of response acquisition (observation of another's response and modeling), and he claims that modeling can have as much impact as direct experience.

Social learning theory is a general theory of human behaviour, but Bandura and people concerned with mass communication have used it specifically to explain media effects. Bandura warned that children and adults acquire attitudes, emotional responses, and new styles of conduct through filmed and televised modeling. He cautioned that TV might create a violent reality that was worth fearing (Cambell, in Liehert and Sprafking, 1988).

Bandura's warning struck a responsive chord in parents and educators who feared that escalating violence on TV would transform children into bullies. Although he does not think this will happen without the tacit approval of those who supervise the children, Bandura regards anxiety over televised violence as legitimate. Social learning theory postulates three necessary stages in the causal link between television violence and actual physical harm to another, namely: attention, retention, and motivation.

Attention: This refers to advertisers' strategy to create a scenario that would draw the attention of viewers to the message being communicated to the audience. According to Bandura, televised violence will grab audience's attention because it is simple, distinctive, prevalent, useful, and depicted positively.

Retention: Bandura observes that it is fortunate and preferable that people learn from vicarious observation, since mistakes would prove costly and fatal. For instance, an individual is able to discover that seeing someone holding a knife and pointing it straight to another person could be harmful. It is hoped that the individual will never have an occasion to put his knowledge into practice. However, it is certainly unlikely that the individual sometimes mimic the action he has learned. In contrast to classical learning theory, Bandura believes one can learn novel behaviour without any practice or direct reinforcement for its consequences. The action will lie dormant, available for future use, as long as we remember it. Memory is a cognitive function, so Bandura's theory moves beyond mere behaviourism. Like most other communication theorists, he believes that the ability to use symbols distinguishes humans from the limited stimulus-response world of animals. Humans do not just respond to stimuli, they interpret them, and store events in two ways -- through visual images and verbal codes. The more an individual exaercises the image, the stronger the memory will be in the future.

Motivation: According to Bandura, under the third stage, we observe many forms of behaviour in others that we never perform ourselves. Without sufficient motivation, an individual may never imitate the violence he sees on TV. Bandura uses the term motivation to refer to the rewards and punishments individual imagines will accompany his behaviour, because it is widely believed that behaviour is governed by its consequences. Rewards and punishments often come in part from external sources such as parents, friends, and teachers. Bandura observes that the effects of TV violence will be greatly diminished if a young person's parents punish or approve of aggression. Television models do more than teach novel styles of conduct. When people on television are punished for being violent, that punishment reinforces society's sanctions against acting above or outside the law. Bandura concludes that reinforcement does not affect the learning of novel responses but determines whether or not observationally acquired competencies will be put into use (Cambell, in Liehert and Sprafking, 1988).

From Bandura's theory, one can deduce the following principles:

1. The highest level of observational learning is achieved by first organizing and rehearsing the modeled behavior symbolically and then enacting it overtly, coding modeled behavior into words, labels or images results in better retention than simply observing.

2. Individuals are more likely to adopt a modeled behavior if it results in outcomes they value.

3. Individuals are more like to adopt a modeled behavior if the model is similar to the observer and has admired status and the behavior has functional value.

2.1.4 Collins-Brown Model of Cognitive Apprenticeship

The Collins-Brown model of Cognitive apprenticeship incorporates the following instructional strategies or components:

1. Content: The goal is to teach tacit, heuristic knowledge as well as textbook knowledge. Collins et-al. (2006) refers to four kinds of knowledge:

--Domain knowledge is the conceptual, factual, and procedural knowledge typically found in textbooks and other instructional materials. This knowledge is important, but it is often insufficient to enable students to approach solve problems independently.

--Heuristic strategies are "tricks of the trade" or "rules of thumb" that help people narrow solution paths while solving a problem. Experts usually pick up heuristic knowledge indirectly through repeated problem-solving practice; slower learners usually fail to acquire this subtle knowledge and never develop competence. There is evidence to believe, however, that at least some heuristic knowledge can be made explicit and represented in a teachable form (Chi, Glaser, and Farr, 1988).

--Control strategies are required for students to monitor and regulate their problem-solving activity. Control strategies have monitoring, diagnostic, and remedial components; this kind of knowledge is often termed meta-cognition (Flavell, 1979).

--Learning strategies are strategies for learning: they may be domain, heuristic, or control strategies. Inquiry teaching to some extent directly models experts learning strategies (Collins and Stevens, 1991).

2. Situated learning: The goal is to teach knowledge and skills in contexts that reflect the way the knowledge will be useful in real life. Brown, Collins, and Duguid (2003) argue for placing all instruction within "authentic" contexts that mirror real-life problem-solving situations. Collins (2008) is less forceful, moving away learning could encompass settings ranging from running a bank or shopping in a grocery store to inventing new theorems or finding new proofs. That is, situated learning can incorporate situations from everyday life to the most theoretical endeavours (Collins, 2008).

Collins cites several benefits for placing instruction within problem-solving contexts:

--Learners learn to apply their knowledge under appropriate conditions.

--Problems-solving situations foster invention and creativity.

--Learners come to see the implications of new knowledge. A common problem inherent in classroom learning is the question of relevance: "How does this relate to my life and goals?" When knowledge is acquired in the context of solving a meaningful problem, the question of relevance is at least partly answered.

--Knowledge is stored in ways that make it accessible when solving problems. People tend to retrieve knowledge more easily when they return to the setting of its acquisition. Knowledge learned while solving problems gets encoded in a way that can be accessed again in similar problem-solving situations.

3. Modeling and explaining: These show how processes unfold and tell reasons why it happens that way. Collins (2008) cites two kinds of modeling: modeling of processes observed in the world and modeling of expert performance, including covert cognitive processes. Computers can be sued to aid in the modeling of these processes. Collins stresses the importance of integrating both the demonstration and the explanations as students observe details of the modeled performance. Computers are particularly good at modeling covert processes that otherwise would be difficult to observe. Collins suggests that truly modeling competent performance, including the false starts, dead ends, and backup strategies, can help learners more quickly in adopting the tacit forms of knowledge alluded to above in the section on content. Teachers in this way are seen as "intelligent novices" (Bransford et-al., 1990). By seeing both process modeling and accompanying explanations, students can develop "conditionalized" knowledge, that is, knowledge about when and where knowledge should be used to solve a variety of problems.

4. Coaching: Under this section, teachers observe students as they try to complete tasks and provide hints and helps when needed. Intelligent tutoring systems sometimes embody sophisticated coaching systems that model the learner's progress and provide hints and support as practice activities increase in difficulty. The same principles of coaching can be implemented in a variety of settings. Bransford and Vye (1990) identify several characteristics of effective coaches:

--Coaches need to monitor learners' performance to prevent their getting too far off base, but leaving enough room to allow for a real sense of exploration and problem solving.

--Coaches help learners to reflect on their performance and compare it to others.'

--Coaches use problem-solving exercises to assess learners' knowledge states. Misconceptions and buggy strategies can be identified in the context of solving problems.

--Coaches use problem-solving exercises to create the "teachable moment".

5. Articulation: Have students think about their actions and give reasons for their decisions and strategies, thus making their tacit knowledge more explicit. Think-aloud protocols are one example of articulation. Collins (2008) cites the benefits of added insight and the ability to compare knowledge across contexts. If learners' tacit knowledge is brought to light, that knowledge can be used to solve others' problems.

6. Reflection: Have students look back over their efforts to complete a task and analyze their own performance. Reflection is like articulation, except it is pointed backwards to past tasks. Analyzing past performance efforts can also influence strategic goal-setting and intentional learning (Bereiter and Scardamalia, 2003). Collins and Brown (2006) suggest four kinds or levels of reflection:

--Imitation occurs when a batting coach demonstrates a proper swing, contrasting it with your swing;

--Replay occurs when the coach videotapes your swing and plays it back, critiquing and comparing it to the swing of an expert;

--Abstracted replay might occur by tracing an expert's movements of key body parts such as elbows, wrists, lips, and knees and comparing those movements to your movements.

--Spatial reification would take the tracings of body parts and plot them moving through space.

The later forms of reflection seem to rely on technologies—video or computer—for feasible implementation.

7. Exploration: Encourage students to try out different strategies and hypotheses and observe their effects. Collins (2008) claims that through exploration, students learn how to set achievable goals and to manage the pursuit of those goals. They learn to set and try out hypotheses, and to seek knowledge independently. Real-world exploration is always an attractive option; however, constraints of cost, time, exploration; hypermedia structures also allow exploration of information.

8. Sequence: Present instruction in an order: from simple to complex, with increasing diversity; put global before local skills.

--Increasing complexity. Collins et-al (2006), point to two methods for helping learners to deal with increasing complexity. First, instruction should include steps to control the complexity of assigned tasks. They cite Laves' study of tailoring apprenticeships: apprentices first learn to sew drawers, which have straight lines, few pieces of material, and no special features like zippers or pockets. They progress to more complex garments over a period of time. The second method for controlling complexity is through scaffolding. Here, the cases or content remains complex, but the instructor provides the needed scaffolding for initial performances and gradually fades that support.

--Increasing diversity refers to the variety in examples and practice contexts.

--Global before local skills refers to helping learners to acquire a mental model of the problem space at very early stages of learning. Even though learners are not engaged in full problem solving, through modeling and helping on parts of the task (scaffolding), they can understand the goals of the activity and the way various strategies relate to the problem's solution. Once they have a clear "conceptual map" of the activity, they can proceed to developing specific skills.

There are two other major differences between cognitive apprenticeship and traditional apprenticeship. First, because traditional apprenticeship is set in the workplace, the tasks arise not from pedagogical concerns, but from the demands of the workplace. In cognitive apprenticeship, tasks are sequenced to reflect the change demands of learning. Second, whereas traditional apprenticeship emphasizes teaching skills in the context of their use, cognitive apprenticeship emphasizes generalizing knowledge, so that it can be used in many different settings.

2.2 Conceptual Review of Literature

2.2.1 The Nature of Basic Science

Science has two major components: science content and process. The content is the knowledge people accumulate about their environment, while the process deals with ways in which scientists go about gathering knowledge about the environment. The process of science, sometimes called science process skills, are mental tools which practitioners of sciences employ in discovering and acquiring scientific knowledge (Millennium Development Goals, 2012).

Basic science is the major science subject offered in the Junior Secondary school; others include Agricultural Science, Introductory Technology, and Home Economics and so on. Basic science helps students to develop their physical skills such as the proper handling of objects and equipment such as microscope; measuring solid, liquid and gases such as mass, volume of water in litre and gases in kilogram. It also helps students to develop their natural curiosity through opportunities to carry out scientific investigations like observation of objects and equipment, classifying objects into living and non-living things, into solid, liquid and gas, into plants and animals, into metals and non-metals, and also through experimentation (Millennium Development Goals, 2012).

Science also helps students to explain events in nature, enabling them to identify those beliefs that are superstitions. For example, scientists cannot come up and say a mango fruit that drops from a tree will move upwards rather than downwards. That would not be consistent with the law of gravity. Science helps students to think and reason in a logical manner-- that is inductive reasoning. It helps students in learning how to solve simple problems they encounter on daily basis. It enables students to develop their social skills, for example, establishing friendship while working co-operatively in groups. It helps to prepare students for future careers in medicine, pharmacy, engineering and so on. It helps students to understand, use and control their environment. It helps build a solid foundation for production and employment. It brings about improvement in our economy and also makes living more meaningful with the application of scientific knowledge (Millennium Development Goals, 2012).

The inclusion of Basic Science as a core subject in the junior secondary school curriculum calls for a need to teach it effectively. Among the variables that educational psychologists have found to be important in classroom teaching include the percentage of time teachers allocate to instruction, the amount of content they cover, the percentage of time that students are engaged in learning, the congruence between what is taught and what is tested, and the ability of the teacher to give clear directions, provide feedback, hold students accountable for their behavior, and create a warm, democratic atmosphere for learning. It is expected that teaching of Basic Science should result in the acquisition of basic science knowledge, skills and attitudes necessary to solve everyday problems. Regrettably, the annual performance of students in the subject showed a decline in cognitive achievement (MDGs, 2007).

In science, student's achievement is the extent to which a student has learned knowledge, skills etc. after an educational programme. There are five significant categories of achievement in primary science namely: physical skills (for example, the use of tools), social skills (for example, ability to cooperate with others), attitude development (for example, persistence to solve a problem), concept clicking/conceptual development (for example, understanding that some changes are irreversible), process skills (for example, ability to offer explanations) (MDGs, 2007).

Science process skills, otherwise interpreted as the processes of science, are mental tools which practitioners of science employ in discovering and acquiring scientific knowledge. The use of these process skills over a period of time leads to accumulation of scientific knowledge in form of scientific laws, principles and theories, all of which together constitute the products of sciences sometimes called the content of sciences (MDGs, 2007). These science process skills are:

1. **Observation:** To observe means to look at things carefully and closely so that we can understand their characteristics, features and differences. We observe things very well so we can solve some scientific problems about those things. These things are observed through our sense organs which include the eye, skin, ear, nose and tongue.
2. **Recording:** We record things so that other people can have access to our findings. This is one of the things scientists do so that a scientist in America can do exactly the same experiment a scientist in Nigeria did to see if he will get the same result. Therefore, recording helps us to remember what we have observed in our activities or experiments, since we cannot remember everything that happened during observations.

3, **Classifying:** Things are classified into living or non-living things, according to their state, i.e. whether solid, liquid or gas; also according to shape, weight, sound, taste, size, roughness and behaviour, while we normally taste things e.g. food to see whether they are sour, bitter or sweet. Classification is known as sorting things according to properties. It helps us to make quick decision (Adewale, Adenuga, Igwe, Iroegbu & Nwachukwu, 2009).

4. **Manipulating**: Conceptions of contemporary best practice of teaching and studying emphasize that students should be involved in the study process through manipulation of equipment and objects, and through participation in any scientific activity.

5. **Measuring:** These means converting unknown quantities into known quantities, such as standard of unit of measuring. This information is referred to as quantitative data. Measurements are to be recorded in an orderly and systematic fashion with labeled units of measurement. Others include: communicating, experimenting, hypothesizing, analyzing, inference making, inductive-reasoning, predicting, constructing and generalizing.

The workability of the Science Process skills in relation to Science content is hereby illustrated in Figure 2:

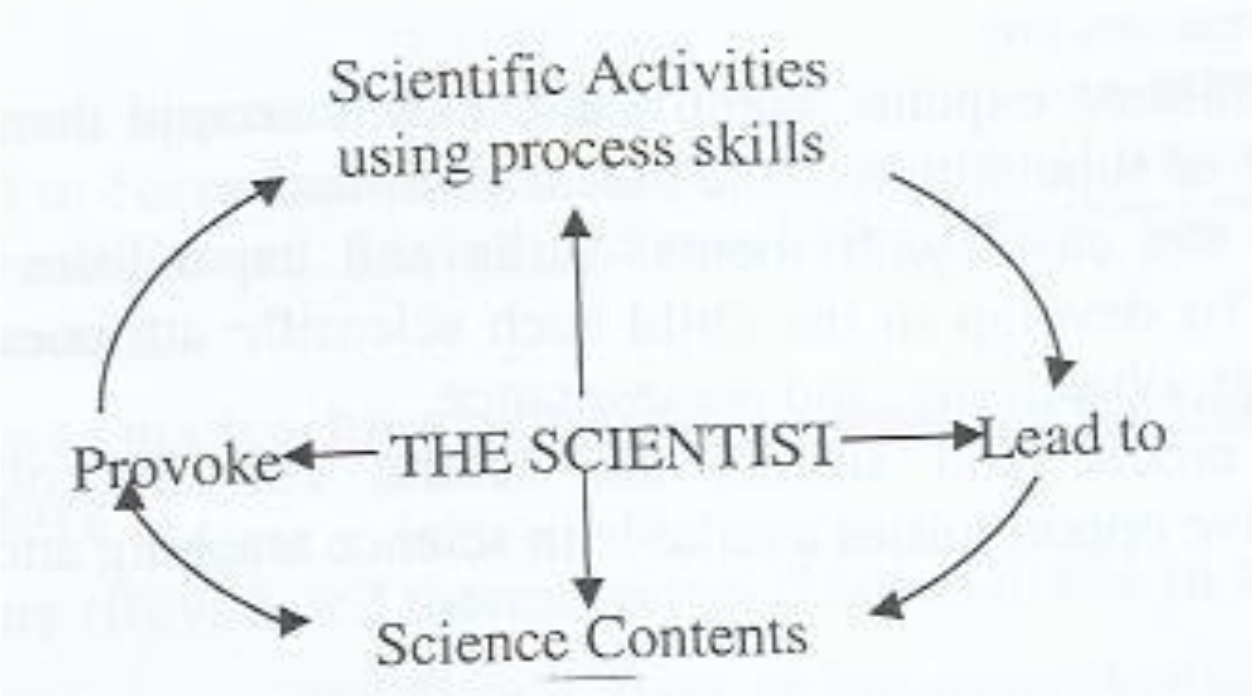

Figure 2.2: Interaction between Science Process Skills and Science Content with the Scientist at the centre of the science activities (National Teachers Institute (NTI), 2013).

In using science process skills, the scientist has to be honest and open-minded about the information obtained. These are just two of the attitudes displayed by scientists when doing science. Others include: patience, persistence, and perseverance, reference for life and humility, curiosity, carefulness, precision, and objectivity. These are referred to as scientific attitudes. It should be noted that scientific knowledge is not a dogma; meaning that it is tentative. What we know today may change if superior evidence is produced that invalidates the supportive theories. Also, the supportive theories must be testable. Thus, superstition and magic are not science since they are not testable (MGDs, 2009).

National standard and goals for reforming science education have placed a demand for more academic rigour in learning and teaching complex subject matter (National Research Council, 2000; American Association for the Advancement of Science, 2003). Embedded in the science education community's reform efforts is a belief that rigorous standards backed by quality curricula and effective teaching – often identified as a form of inquiry – will translate into a robust learning and high levels of achievement for all students. Due to the reform efforts, Nigeria recently had a metamorphosis of the integrated science curriculum at the Universal Basic Education (UBE) level into Unifying Basic science (NERDC, 2007). Integrated science metamorphosed to Basic Science. Science has been considered as a process of inquiry, which is, a procedure for answering questions, solving problems and developing more effective procedures for answering questions and solving problems. It has been argued that common sense inquiring is quantitatively oriented. For instance, Dewey (1983) observed that the problem of the domain of common sense to that of science has notoriously taken the form of opposition of the qualitative to the non-qualitative, largely but not exclusively the qualitative. It is generally recognized that through the use of science (in contrast with common sense), we are more likely to obtain the correct answers to questions and better solutions to problems. This is not to assert that better results are always obtained by science, but that such results are more likely to be obtained by its use.

The preliminary efforts towards basic science began with Science Teachers Association of Nigeria (STAN) 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 integration of those disciplines. The result is contained in the STAN's Newsletter No 1 on an Integrated Science course, which consists of guidelines for including such a course for the junior forms of secondary schools. The UNESCO-UNICEF (2007) and Afuwape (2003) observed that integration is the opposite of fragmentation, and that fragmentation signifies the traditional school subject with partition. The system of traditional subject curriculum is compartmentalization of knowledge. The type of curriculum is deficient because it has much connection with life as a whole and it is highly specialized. The concept of integration is concerned with natural enquiry of the children. Hence, Basic science is a unifying curriculum that provides the whole science as one.

Seweje (2001) noted that the concept of Basic Science as an approach to the teaching of science aimed at enabling students to give concept of the fundamental unity of science, the commonality of approach to problems of scientific nature and also gain an understanding of the role and function of science in everyday life. Similarly, Afuwape (2004) reported that Integrated science is an approach of the teaching of science in which concept and principles are presented so as to express the fundamental unity of scientific thought and avoid un-due stress on the distinctions between various scientific fields.

The National Research Council (NRC, 2007) asserted that a systematic study of the universe in the form of Integrated Science cannot but involve the active participation of learner if he is to acquire necessary skills that will make him function in the scientifically and technologically oriented world. STAN Newsletter (2010) recommended basic strategies to be employed for the effective teaching of Integrated Science as:

(a) Use of discovery teaching strategies.

(b) Problem-solving activities.

(c) The involvement of student in open-ended activities.

Science has played significant role in the development of nations. Scholars have identified it as a potential instrument for solving socio-economic problems such as unemployment, hunger, poverty, population explosion and environmental degradation, which are problems confronting developing countries like Nigeria (Adesoji, 2003; Afolabi & Audu, 2007). Donkor (2006) and

Seweje (2001) defined science as the organized study of natural phenomena presumed to have been a main pursuit since the first attempt to harness the forces of nature. They stressed further that science is usually regarded as the "know why". The type of science where emphasis is placed on the fundamental unity of science is referred to as integrated science. This is different from the old fashion of separating science where emphasis is placed on division into Physics, Chemistry and Biology.

Integrated Science is not new in many parts of the world. It is relatively new in some developing countries where General or Rural Sciences have not been emphasized over the years. For example, General Science had been introduced to Nigerian Schools since 1876, whereas integrated Science became popular only between 1970 and 1979 (Duyilemi, 2005; Afuwape, 2003). This period was characterized by activities generated in many parts of the world to develop new and suitable science curricular for the primary and Junior Secondary schools.

Nature study and hygiene, which were the vogue in primary and teacher training institutions, have also metamorphosed into integrated science. This is because the contents of such old subjects disciplines were not enough to make the products (learners) cope effectively with environmental problems (Duyilemi, 2000).

The first International Conference on Integrated Science Teaching took place in Varina, Bulgaria in 1968. The first publication of the first Integrated Science Project (NISP) was in 1970. It spelt out the objectives of Integrated Science and since then, this aspect of science has been better imbibed by relevant cadres of the educational systems.

The Nigerian Integrated Science Project (2010) specified the following principles of integrated science, among others, as a course which:

(a) is relevant to students' need and experience,

(b) stresses the fundamental unity of science,

(c) lays adequate foundation for subsequent specialist study, and

(d) adds cultural dimension to science education.

Following the decision of the Federal Government to introduce the 9-year Basic Education programme and the need to attain the Millennium Development Goals (MDGS) by 2015 and by extension, the need to implement the National Economic and empowerment Development strategies (NEEDS), which can be summarized as value re-orientation, poverty eradication, job creation, wealth, generation and education to empower the people, it becomes imperative that the existing curricula for primary and JSS be reviewed, re-structured and re-aligned to fit into a 9-year Basic Education programme. The National Council on Education (NCE) at its meeting in Ibadan in December 2005, directed the NERDC to carry out this assignment.

This 9-year Basic Science and Technology curriculum is the product of a realignment and restructuring of the revised curricula for Primary Science and Junior Secondary School Integrated Science. In selecting the contents, three major issues shaping the development of nations worldwide, and influencing the world of knowledge today were identified. These are globalization, information/communication technology and entrepreneurship education. The desire of Nigeria to be identified with contemporary development worldwide called for the infusion of relevant contents of four non-school curriculum innovations in the area of:

(i) Environmental Education (EE)

(ii) Drug Abuse Education (DAE)

(iii)Population and Family Life Education (POP/FLE).

(iv)Sexually Transmitted Infection (STI) including HIV/AIDS

Infusion of content occurred in every class from basic one to nine. Besides, some introductory technology topics have been introduced at the lower and middle levels, while leaving the upper level purely with science topics. The overall objectives of this curriculum are to enable the learners to:

(a) Develop interest in science and technology.

(b) Acquire basic knowledge and skills in science and technology.

(c) Apply their scientific and technological knowledge and skills to meet societal needs.

(d) Take advantage of the numerous career opportunities offered by science and technology.

(e) Become prepared for further studies in science and technology.

The thematic approach to content organization was adopted in order to achieve a holistic presentation of science and technology contents to learners. Four themes were used to cover knowledge, skills and attitudinal requirements. These are:

1. You and environment
2. Living and Non-living things
3. You and Technology
4. You and Energy

The use of guided inquiry method of teaching and learning is implied in the activities that promote learning by doing and skill development (Nigerian Educational Research and development Council, 2007).

2.2.2 Skills Associated with Basic and Integrated Science

According to Campbell (2008), two aspects of science process skills have been identified which can be taught and effectively assessed. These are the Basic Science processes and the integrated Science processes. The Basic Science skills which were also attested by Wetzel (2008) include the following skills:

1. *Observing:* Using the five senses to gather information about an object or event. It is a description of what was actually perceived. This information is referred to as qualitative data.
2. *Measuring:* Expressing the amount of an object or substance in qualitative terms, such as metres, litres, grams and Newtons.
3. *Inferring:* Formulating assumptions or possible explanations based upon observations. Giving an explanation for a particular object or event.
4. *Classifying:* Grouping or relating or ordering objects or events into categories based upon characteristics or defined criteria.
5. *Predicting:* Forecasting or guessing the most likely outcome of a future event based upon a pattern of evidence or past observation or the extension of data.
6. *Communicating:* Using morals, symbols, or graphics to describe an object, action or event.
7. *Space time relations:* Visualizing and manipulating objects and events, dealing with shapes, time, distance, and speed.
8. *Using numbers:* Using qualitative relationships, e.g. scientific notation, error, significant numbers, precision, ratios and proportion, which simply means the ability to

do something well or the competence to perform a task. It is an action or movement performed semi-automatically as a result of repeated practice. Skills are therefore best acquired in the course of activities, and mastered with a varying degree of precision depending on the practice done.

Consequently, the skills associated with Integrated Science include:

(i) *Formulating hypotheses:* Stating a tentative generalization of observations or inferences that may be used to explain a relatively larger number of events, but which is subject to immediate or eventual testing by one or more experiments.

(ii) *Identifying Variables:* Stating the changeable factors that can affect an experiment. It is important to change only the variable being tested and keep the rest constant. The one being manipulated is the independent variable, the one being measured to determine its response is the dependent variable, and all variables that do not change and may be potential independent variables are constants.

(iii) *Defining Variables Operationally:* Explaining how to measure a variable is an experiment.

(iv) *Describing relationships between variables:* Explaining relationships between variables. Variables are an experiment, such as between the independent and dependent variables, plus the standard of comparison.

(v) *Controlling variables:* Manipulating and controlling properties that are related to situations or events for the purpose of determining causation.

(vi) *Designing investigations:* Designing an experiment by identifying materials and describing appropriate steps in a procedure to test a hypothesis.

(vii) Acquiring Data: Collecting qualitative and quantitative data as observations and measurements.

(viii) Interpreting data: Arriving at explanations, inferences, or hypothesis from data that have been graphed or placed in a table, frequently involving the mean, mode, median, range, frequency distribution, t-test, and chi-square test.

(ix) Organizing data in tables and graphs: Making data tables and graphs for data collected.

(x) Analyzing investigations and their data: Interpreting data statistically, identifying human mistakes and experimental errors, evaluating the hypothesis, formulating conclusions, and recommending further testing where necessary.

(xi)Understanding cause and effect relationships: What caused what to happen and why?

(xii)Formulating models: recognizing patterns in data and making comparisons to familiar objects or ideas.

xiii)Experimenting: Testing a hypothesis through the manipulation and control of independent variable, interpreting and presenting results in the form of a report that others can follow to replicate the experiment.

Integrated Science process skills comprise five component skills, such as making operational definitions, formulating questions and hypothesis, experimenting, interpreting data and formulating models. Recently, Pemida and James (2001) also identified eleven major process skills which include observing, classifying, inferring, predicting, measuring, communicating, interpreting data, making operational definitions, formulating hypothesis and question, experimenting and formulating models. They advocated the inclusion of these process skills in the teaching of Science Education of the American Association for the Advancement of Science (AAAS). They further stressed the need for the teaching and acquisition of these skills by stating that what is taught to learners should resemble what scientists do and what they carry out in their scientific activities.

In spite of the relevance of the teaching of all these skills, researchers wonder if science teaching has ever focused on the development of the skills, hence the need for science educators to evolve a strategy that will place emphasis on the teaching of these skills.

2.2.3 Students' Achievement in Science

The performance of students in science generally is a major concern to science educators as students' performance in science subjects is low in both national and state examinations. A number of factors can be identified as the causes of poor performance of students in sciences. These include the science curricula, teachers' methods of teaching, parents, government, lack of science facilities and others (Ahiakwo, 2003).

Survey from schools revealed that inadequate instructional materials, laboratory facilities in the schools also negatively affect the effective learning of Science in the schools. Students' perform poorly in sciences globally because they are not involved in the teaching and learning activities right from the beginning of any new concept to be taught (Okafor & Okeke, 2006). Also, other factors are lack of qualified teachers as well as experiences in teaching, and unavailability and/or insufficiency of materials in the laboratories (Ajayi, 2007).

Researchers like Danmole and Adeoye (2004) as well as Alebiosu and Bamiro (2007) have identified reasons for poor attitude, low enrolment and underachievement in the sciences to include ill-equipped laboratories, teacher and gender factors and insufficient funding. Various studies have shown that teachers of integrated science are not qualified and this in turn affects achievement (Odetoyinbo, 2004).

2.2.4 Students' Attitude to Science

Efforts by scientists and scholars within and outside Nigeria to establish a relationship between attitude towards science and achievement in science dated back to the early eighties. Attitude is a state of readiness, a tendency to act or react in a certain manner when confronted with certain stimuli. It has direction, hence can be either favourable or unfavourable towards an object. Kobella (2000) noted that attitude can be taught and changed but it has a capacity of being stable depending on the dimension of its objects.

Attitude towards science denotes interest or feeling towards studying science. Attitude in science means scientific approach assumed by an individual for solving problems, assessing ideas and making decisions (Animasahun, 2009). Attitude denotes the sum total of a man's inclinations, feelings, prejudices, or biases, preconceived notions, ideas, fears, threats, and conviction about any topic or subject. The perceived importance of Mathematics is one of the essential attitudes towards Mathematics, Basic Science included. It has been observed that the attitude of students can be influenced by the attitude of the teacher and teachers' method of instruction (Adesoji, 2008). The teacher's method of teaching Mathematics and his or her personality greatly account for students' positive or negative attitude towards Mathematics (Yaya, 2009). Thus, the attitude of a learner towards Science and Mathematics would determine the extent of the learners' attraction to repulsion of Science and Mathematics (Ogukola, 2002). Therefore, if a person is not favourably disposed to Mathematics or any other subjects, his or her attitude toward the subject may be negative. Thus, positive attitude will lead to persistence and better achievement. Scientific attitude embraces all scientific processes of gathering information with no subjectivity, skepticism or prejudice for the advancement of science. These processes can be objectively and confidently carried out by skillful individuals.

Characteristic attitudes and dispositions to science include being curious and imaginative, as well as being enthusiastic about asking questions and solving problems. Another desirable scientific attitude is respect for the methods and values of science. These scientific methods and values include seeking to answer questions, using some kind of evidence, recognizing the importance of rechecking data, and understanding that scientific knowledge and theories change overtime as more information is gathered. However, negative attitude could be identified by students' non-challant behaviour, playing truancy specifically during science classes, poor reaction to assignments, poor response to class questions, and displaying phobia for difficult terms used in Basic Science.

Literature containing a number of research reports on achievement goal recognition has been advanced in various science curricula worldwide. Prominent in these reports is the concept of attitudinal goal. The term attitude in science education is attractive to teachers and learners in 2 ways: To develop positive attitude towards science and possess objective attitude in science.

Review of relevant literature on the relationship between students' attitude and performance in science reveal that research studies in the two areas were few. This view was supported by Ogunleye (2001). Some researchers showed that parental support could affect students' attitude. Labude (2000) found out that parents' attitude towards physics was significantly correlated with children's attitude and achievement in physics, while Animasahun (2009) found significant differences in the attitude of students in all the students' home background levels. The finding of Onabanjo (2000) was similar to this. He indicated that parental support had effect on students' attitude to mathematics.

2.2.5 Students' Science Process Skills

Science Process Skills (SPS) are cognitive and psychomotor skills which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication. The underlying skills and premises which govern the scientific method are referred to as science process skills. Science process skills are also used to guide students' learning. These skills focus on thinking patterns that scientists use to construct knowledge, represent ideas, and communicate information. Science process skills help students to pose questions, state problems, make observations, classify data, construct inferences, form hypotheses, communicate findings, and conduct experiments. The acquisition and frequent use of these skills can better equip students to solve problems, learn on their own, and appreciate science.

Basic science process skills are usually taught as part and parcel of Basic Science curriculum. They are activity-based skills which can be acquired through training and direct experience. The acquisition of science process skills by students is influenced by the cognitive knowledge base of the students. The science process skills are the foundation of problem solving in science and scientific method. They are 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 sense of 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 & Sanli, 2011). They are inseparable in practice from conceptual understanding that is involved in learning and in applying science. 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, investigation and in 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 live, whereby we go beyond the textbook and supplementary core-content within textbooks with hands-on, minds-on activities. It also means using subject content as a means for exposing students to the real processes of science. Science process skills are based on scientific inquiry. 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 teaching 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 (Wetzel, 2008). They are also acquired during practical teaching of science in the laboratory (Oginni, 2009).

Njoku (2002) further explained that science process skills are cognitive and psychomotor skills which scientists use in problem identification, objective inquiry, data collection and analysis. These skills are retained after the cognitive knowledge of science has been forgotten. 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 students make the connection between science process involved within an investigation and science content (Karen, 2009).

Science process skills are special skills that simplify learning science, make students active, develop students' sense of responsibility in their own learning, increase the permanency of learning, as well as help them in learning research methods (Karamustafaoslu, 2011). They are the thinking skills that we use to get information, think on the problems and formulate the results. Scientists use them in their studies. These skills are appropriate for all fields of science, and they reflect on the correct behaviorus of scientists while they are solving a problem and planning an experiment. They constitute the essence of thoughts and research within science. It is more important for students to learn how to apply science than learning reality, concepts, generalizations, theories and laws in science lessons. Therefore, it is necessary for them to imbibe up the habit of using science process skills.

These skills, according to Karamustafaoslu (2011), are considered to be efficient in learning and teaching, engaging a significant place in various countries' teaching programmes such as 'Science- A Process Approach' (SAPA), developed by the American Association for the Advancement of Science between 1963 and 1974, and high school science curricula. For in the nature of many children is already the curiosity for searching and this curiosity leads them to search. That is to say, the skill 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 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 in learning by doing according to Minner, Levy and centuary (2010), students use almost all of their senses and learning becomes more permanent and hands-on activities get them 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 lives.

2.2.6 Features of Cognitive Apprenticeship

Cognitive apprenticeship is much like a trade apprenticeship in which learning occurs as expert and a novice interact socially while focusing on completing a task: the focus, as implied in the name, is on developing cognitive skills through participating in authentic learning experiences. Collins et-al (2006) succinctly defined it as learning through-guided-experience on cognitive and meta-cognitive, rather than physical skills and processes.

Cognitive apprenticeship as a strategy for learning involves the concept of situatedness and legitimate peripheral participation, both described by Lave and Wenger (2001). Situated learning occurs through active participation in an authentic setting, founded on the belief that these engagements foster relevant transferable learning much more than traditional information dissemination methods of learning. However, it is more than just learning by doing: situated learning requires a deeper embedding within an authentic context. Human actions of any nature are socially situated, and are affected by cultural, historical and institutional factors (Wertsch, 2000).

This situation is a key component of learning environment and thus needs to be considered in a cognitive apprenticeship. Learning in a cognitive apprenticeship occurs through legitimate peripheral participation, a process in which new comers enter on the periphery and gradually move towards full participation. It is not a technique or strategy, as it tends to happen quite naturally on its own. Legitimate peripheral participation is perhaps the easiest to understand through a workplace examples of traditional apprenticeship.

Lave and Wenger (2001) present the example of legitimate peripheral participation as apprentices learn the trade of becoming a tailor. Consider, for instance, the tailors' apprentices whose involvement will start with both initial preparations for the tailors' daily labour and finishing details on completed garments. The apprentices progressively move backwards through the production process to cutting jobs.

Cognitive apprenticeship usually commences with modeling guided by a teacher, experts or peers. The teacher gradually decreases the support provided to the students through scaffolding and coaching methods and increases student's autonomy through exploration. In the process of learning, students must revisit what they have done and discuss their ideas with teachers and other students. Students finally discuss, demonstrate, present and exchange their individual or group products and look back to analyze their own or others' performance and articulate through articulation and reflection methods (Collins, 1991).

2.2.7 Features of Critical Exploration in the Classroom

Critical exploration are experiences in teaching and learning which a teacher conducts so as to engage learners in a subject matter that is real and may be physically present in a classroom. With its fullness of detail, the reality of such a subject accommodates plenty of leeway across which learners may exercise curiosity, actions, observations, conjectures and thought. Theirs are the eyes noticing something about that subject they had never seen before; theirs is the mind perturbed enough by it to ask a question, or want to try something out, or express spontaneous reactions; theirs are hands constructing something or modifying an apparatus or wielding a paint brush. By their own agency on and with the subject, learners develop in their awareness and understanding of it, and in their capacity for action (Duckworth, 2006).

But the name, 'critical exploration', and the methodology it represents were introduced to class practice by Eleanor Duckworth from the research methodology that Jean Piaget (1926/1960) and Inhelder (1974) evolved while investigating how students come to new understanding, and capacities in relation to the world.

Inhelder first applied the name, ‘critical exploration’, to Piaget’s clinical interviewing which included observing children as well as interviewing and interacting with a child who is experimenting and investigating a problem set by the researcher. Inhelder introduced this method to pedagogical contexts (Inhelder, Sinclair & Bovert, 1974, p. 18-20). Duckworth (2005b, p. 258-259) describes critical exploration as having two facets: curriculum development and pedagogy. Curriculum development means: the teacher is planning how to engage students’ minds in exploring the subject matter. Pedagogy constitutes the practice by which teachers invite students to express their thoughts:

Critical exploration as a research method requires just as much resourcefulness in finding appropriate materials, questions, and activities as any good curriculum development do. Whether it be poems, mathematical situations, historical documents, liquids, or music, our offerings must provide some accessible entry points, must present the subject matter from different angles, elicit different responses from different learners, open a variety of paths for exploration, engender conflicts, and provide surprises; we must encourage learners to open out beyond themselves, and help them realize that there are other points of view yet to be uncovered- that have not yet exhausted the thoughts they might have about this matter (Duckworth, 2006).

During critical exploration, exploring goes on in two modes; in one mode, the child explores the subject matter, and in the other mode, the researcher-teacher explores the child’s thinking. Hence, for the teacher, critical exploration finds itself at the nexus of research and teaching where teacher and learner support each other (Shorr, 2007).

Critical exploration, then as a research method, has two aspects: - developing a good project for the child to work on; and succeeding in inviting the child to talk about her ideas: putting her at ease, being receptive to all answers; being neutral to the substance of the answer while being encouraged about the fact, the thinking and talking; getting the child to keep thinking about the fact of the problem, beyond the first thought that comes to her; getting her to take her thinking seriously (Duckworth, 2005b).

Consequently, Duckworth (2009: 1) suggested that a classroom teacher can take on the role of a researcher, ‘‘observing what students have learned, while guiding students' explorations towards a deeper understanding of the subject’’. The teacher explores too, by interacting with students' learning. It is the teacher's work to present engaging problems, and attend to students' ways of figuring them out; helping them to notice what is interesting. For example, the teacher listens to students as they explain their ideas and asks them questions that seek to take their thinking further (Duckworth, 2006:173-174).

2.3 Empirical Review

2.3.1 Cognitive Apprenticeship Strategy and Students' Learning Outcomes

Cognitive apprenticeship encourages authentic activity and assessment. The most important emphasis of the learning environment in cognitive apprenticeship is situated learning and the culture of expert practice. Learners are engaged in learning activities that are similar to the practices of real-world experts. Practices of cognitive apprenticeship are motivating and engaging for learners (Brown et-al, 1989)

Cognitive apprenticeship provides students with authentic tasks; it encourages them to think like and to be treated as experts. When students are actively engaged in authentic tasks and make discoveries on their own, they are motivated and they experience a sense of ownership of their knowledge and tasks. Cognitive apprenticeship may encourage greater levels of retention and transfer (Agommuoh & Ifeanacho, 2013)

Learning with the cognitive apprenticeship framework is situated in a context similar to that which experts actually practice. Situated, contextualized learning enables students to retain their knowledge until they encounter similar situations in the future. Cognitive apprenticeship may facilitate higher order reasoning. In cognitive apprenticeship practices, students work with teachers and experts who use higher-level thinking processes; they are exposed to these processes through cognitive modeling. After receiving initial stages of support from teacher and experts, students actually explore new ideas and make discoveries using advanced reasoning processes (Cornelius-White, 2007).

Diverse simple cases of cognitive apprenticeship turn up whenever teachers report on ways that they have found, through classroom experience, to creatively build the intellectual skills of their students. For example, Carter, Ferzi and Wiebe (2007) interviewed 10 randomly selected students taking a course at North Carolina State University that "introduced life science majors to biology". The students reported that modeling, coaching, and repeated practice with realistic life reports (rather than with school-oriented) "book reviews, summaries and essays" helped them to understand Biology better.

In Nigeria, attempts have been made to investigate the usability of cognitive apprenticeship and critical exploration as forms of innovative activity-based teaching strategies. For instance, Agommuoh and Ifeanacho (2013) in their investigation of secondary school students' assessment of innovative activity-based teaching strategies in enhancing achievement in Physics and Mathematics in Umuahia, Abia State of Nigeria, found that inquiry method, discovery learning, discussion, role play, simulation, games, team teaching, brainstorming and other similar strategies, which include cognitive apprenticeship and critical exploration, were agreed to be innovative activity-based teaching strategies that can enhance achievement in

Physics and Mathematics. They recommended that Physics and Mathematics teachers should be encouraged to use these innovative activity-based teaching strategies in the teaching of Physics and Mathematics. Also, Ogbonna (2007) in his study on comparative effectiveness of two constructivist instructional models on students' academic achievement and retention in junior secondary school Mathematics, advocated active participation of the students in the classroom, whereby the focus should be for the teacher to use learner- centred innovative pedagogical strategies in the teaching and learning of science. He said such innovative activity-based strategies include peer tutoring, simulation, team teaching, brainstorming, cognitive apprenticeship, discovery learning, critical exploration, inquiry and role play strategies.

Buttressing the Ministry of Education Malaysia (2002), Ogbonna recommended that students need knowledge, problem solving skills, creative and critical thinking for proper adjustment into a fast scientifically developing society like Nigeria. Furthermore, the necessity for the use of cognitive apprenticeship and critical exploration teaching strategies in Nigeria was advocated by Madu (2004), who vehemently opposed the lecture-based instruction which he referred to as teacher centred and full of passive acquisition of knowledge by students who do not have conceptual understanding but memorize the content. He therefore advocated for the use of innovative activity-based teaching strategies in the teaching of science subject by the science teachers, so as to enable students to learn and acquire positive attitudes and values, process skills, and problem-solving skills.

The study of Akinbobola and Ado (2007) on hands –on, minds-on strategies for teaching is also important. Guided- discovery approach holds that these innovative strategies, which include brainstorming, role play, cognitive apprenticeship and critical exploration, help learners to acquire appropriate skills, abilities and competencies as equipment for the individuals to solve problems and contribute to the development and growth of the society. The above submission was further strengthened by Akinbobola (2008) in his study on facilitating Nigerian Physics students' attitude towards the concept of heat energy. Also, Okoza and Aluede (2013) in their study of understanding metacognitive awareness among teachers in the school system: issues and benefits frowned at the paucity in the knowledge and application of metacognitive teaching strategies in Nigerian classroom by the teachers, especially in Edo state. They therefore suggested that children should be encouraged to explore their world, discover knowledge, reflect and think critically as the components of cognitive apprenticeship and critical exploration teaching strategies. They specifically recommended that specific metacognitive strategies should be utilized in the classroom, and that teachers should undergo deliberate school training programmes on metacognitive instructional strategies to facilitate the teaching of science.

2.3.2 Critical Exploration Strategy and Students' Learning Outcomes

Duckworth (2006) was convinced that people must construct their own knowledge and must assimilate new experiences in ways that make sense to them. She went further to explain that simply telling students what they should know leaves them cold. She submitted that critical exploration stresses the following aspects of learning and teaching: -students bring their prior expectations, interest and knowledge to the learning experience; the students' experience and insights are of high value as the development of their personal intelligence emerges through actions and the wonderful ideas. To reach deep understanding, students need to start from their own sets of ideas, be engaged in the subject matter and make a connection between the actual problem or subject matter and what they already understand.

Consequently, the students do the talking as they explain the sense they are making, and the teacher listens. However, this requires a learning culture that accommodates students in feeling free and safe to say what their emerging ideas are, and how what they say is valued (Duckworth 2005). By opening up to children the many fascinating aspects of the ordinary world and by enabling them to feel that their ideas are worthwhile having and following through their tendency to have wonderful ideas they can be affected in significant ways'' (Duckworth, 2006, p. 12)

Students need something complex that challenges them to explore: students need to engage with the phenomena of study, not schematic substitutes. It is in struggling with complex problems that every learner undergoes the processes of constructing their own knowledge. As learners experience internal cognitive conflicts in what they believe about the subject matter, their minds become more deeply engaged with the problem at hand. Learners' efforts in figuring out questions and puzzles are more productive than knowing the right answers because higher order thinking processes are involved. Therefore, teachers of critical exploration value the diverse efforts that students make during their explorations even where these efforts do not arrive at expected answers. In facilitating this investigative work, the questions that are asked over and over again by students and teachers alike are, for example: "What do you notice?''. 'What do you mean?'' How are you thinking about it? "Why do you think that?'' "Is that the same as what (someone else) thought they saw? 'How did you figure that? How did you do that? How did that fit with what she just said? Could you give an example?" Hence, most importantly: It is the students who sense and understand by trying out their ideas, explaining them to others, and seeing how this holds up in other people's and their own eyes and in the light of the phenomenon itself (Duckworth, 2002).

A teacher is a facilitator with a researcher mind-set: The teacher creates situations and selects environmental resources that get students excited and engaged in learning that is meaningful to them. The teacher is sensitive to the thoughts and feelings of learners, puts students at ease, engages learners, invites them to talk about their ideas, waits for learners to think and listens, and then reacts to the substance of their answer without judging them. The teacher takes a neutral researcher's stance. Instead of lecturing, the teacher creates a situation that helps learners to confront their thinking processes, where they are responsible for their own learning (Duckworth, 2005).

The teachers' role then, is to ask questions like, "When you say x, what do you mean by it?'' How would that work if added to this situation? "Am I right in understanding your idea, if I say it is this way?'' Instead of signaling to the students what he might expect them to say, the teacher provides opportunities for learners to reveal their own understanding. This is because the learners have become visible through the responses they make including actions, drawings, gestures, constructions, dialogues and sound, for example. Guiding questions for the teacher himself might be as follows: 'What lies behind this response? How may the other children be responding to it? What question shall I ask next, or what experience to offer next, or where to direct their attention next? (Duckworth,2005b, p.261). The students' work is to make sense of the phenomena of study. The teachers' work is to ensure safe and supportive conditions in the classroom so that the students can take intellectual risks and their work investigatively.

2.3.3 Conventional Lecture Strategy and Students' Learning Outcomes

The oldest method of teaching used in most Nigerian schools is a traditional talk-chalk strategy. The teacher "gives out" the facts to the students and the students in turn listen and digest the knowledge (Osokoya, 2002). 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, making students passive listeners and preventing them from active thinking and learning, consequently making students to perceive science subjects as difficult, and having negative attitude toward science. They further argued that it has always resulted in under-achievement of students.

However, Ajayi (2001) in his study highlighted that instructional strategies should be varied as no particular instructional strategy is perfect for the teaching and learning of all concepts. He further maintained that the use of conventional, lecture instructional strategy enhances better learning outcomes in terms of achievement, positive attitude, formation and skills in teaching and learning process of some subjects or concepts, as it saves time and cost, and 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 a useful and powerful instructional strategy.

2.3.4. Parental Support and Students' Learning Outcomes

Numerous studies have shown that family, home environment and parental aspiration have great influence on students' achievement (Martins, 2000; Ezeasor, 2003). Parental support includes provision of materials necessary for learning, and financial and moral supports. Parents are supposed to play supportive role to their children in terms of everyday care and education.

Actually, they are expected to show deep interest in what their children do in school and how well they do it. Also they are expected to provide enabling environment at home in order to increase students' academic achievement. According to Jeynes (2001), parental support is the key to improving academic achievement of children. Also parental support, according to Jeynes (2003) determines how well children do in school. He concluded that parental support has a significant positive effect on children across races, although it is greater for some group than others.

Researchers have been increasingly concerned about the degree to which parents are involved (or uninvolved) in their children's education as it pertains to the children's achievement (Jeynes, 2003). Literature also indicates that the place of parental support in academic achievement holds, no matter the level of parental education or the level of socio-economic background or the racial heritage of the children being studied (Shaver &Walls, 2008).

According to Animasahun and Animasahun (2011), home environment has a greater effect on students' performance than the school environment. Onabanjo (2000), in her study involving 300 secondary II students from six co-educational secondary schools in Odogbolu and Ijebu-Ode Local Government Areas of Ogun State, found no significant main effect of parental support on students' achievement in mathematics. She, however, found a significant main effect of parent support on students' attitude towards mathematics.

Animasahun (2009) corroborates the findings of Onabanjo (2000). He found no significant main effect of students' home background on students' performance in social studies. Animasahun (2009) in his studies also found significant difference in the attitude of students in all the student home background level (highly favourable, moderately favourable and unfavourable). Students from high favourable home background are significantly better than students from moderately favourable home background and unfavorable home background. Surprisingly the unfavourable home background students have slightly better attitude in social studies than those from moderately favourable home background. This also agrees with Onabanjo's (2007) findings.

From the literature reviewed, it could be seen that home environment has many variables that may or may not affect students' achievement, which researchers can investigate. This study, however, investigated the effect of parental support on achievement, attitude and science process skills. This study is necessary due to the inconclusiveness of earlier studies, more so as it pertains to Basic Science.

2.3.5 Gender and Students' Learning Outcomes

Generally, studies on gender differences in science achievement, interest and participation are enormous in science education literature (Abiona, 2008; Ogunkola and Fayombo, 2009; Okoye, 2010). In spite of many of such studies, more investigations are still being undertaken in this area. This is so because, a definite and stable picture of gender differences in science achievement in Basic Science and Technology inclusive, is yet to emerge. Rather, what is evident is that, there are three conflict pictures in respect of gender differences in science achievement. Stephen and Sandra (2006) described gender as the social and historical constructions of masculine and feminine roles, behaviour and attributes. Studies have shown significant difference in favour of boys (Abiona, 2008; Ojo, 2009) sometimes in favour of girls (Olatundun, 2008) and sometimes the studies have shown no significant difference between boys and girls in relation to their achievement and attitude in different science subjects (Okoye, 2010). Ogunkola and Fayombo (2009) in their study found that there was no statistical difference in secondary school students' achievement based on their gender. Some studies however, were of the opinion that gender is of no significant effect on learning outcomes (Ige, 2013; Gbadamosi, 2012; Kehinde-Awoyele, 2012).

Odebode (2001), reporting on gender roles, noted that girls performed better in verbal tests and obtain higher grades than boys, while boys were better in mathematics and in 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). Also, Olagunju (2001) emphasized the need for proper sensitization of science teachers to gender issues in science classroom.

Furthermore, previous studies as indicated below show that gender plays a role in student science learning:

(i) The popularity of certain science topics varies with age and gender. Girls generally prefer biological topics (Baram-Tsabari, et al, 2006).

(ii) Girls have access to science books at school and teachers have strategies to encourage girls to read them. Parents encourage reading at home but are generally less directive than teachers as to what the girls read, and tend to underestimate their daughters' science-related interests (Ford, Brickhouse, Lotteroperdue & Kittleson, 2006).

(iii) There continues to be significant gender differences in science experiences, attitudes and perceptions of science courses and careers (Jones, Howe and Rua, 2000).

(iv) Globally, girls surpass boys in reading and boys surpass girls in mathematics and science, but the gap between boys and girls in scientific subjects, has lessened overtime. Girls can surpass boys in certain mathematical and scientific disciplines when questions are open-ended and collaborative in nature (Blondin & Lafontaine, 2005).

(v) Scientific activities designed from a “feminist and socio-constructivist perspective” are much more appealing to girls and motivate girls to continue in the sciences (Lirette-Pitre & Mujawamariya, 2005).

From these studies of children’s learning there are some implications for science programmes:

(i) Although the progression implied in science programmes in a linear and staircase-like uniform changes, children’s learning does not evolve in this manner (Liu & Lesniak, 2006).

(ii) Due to time constraints, students are at most “exposed” to programme concepts but do not have time to develop an understanding of the concepts (Liu & Lesmak, 2006).

(iii) Programme developers should embed well-planned analogies in the test (Chiu &Lin, 2005).

Male performed better than female counterparts in terms of process skills (Jones, Howe and Rua, 2000). The difference in skills acquisition is most pronounced in manipulation of apparatus. Conversely, Wetzel (2008) observed that girls performed better than boys in understanding of science process skills. With this striking revelation, the present study further investigated the influence of gender on students’ acquisition of science process skills.

2.4 Appraisal of the Literature Reviewed

Literature had been reviewed on cognitive apprenticeship which provides students with authentic tasks; it encourages them to think alike and to be treated as experts. When students are actively engaged in authentic tasks and they make discoveries on their own, they are motivated and they experience a sense of ownership of their knowledge and tasks. Cognitive apprenticeship may encourage greater levels of retention and transfer. Learning with the cognitive apprenticeship framework is situated in a context similar to that which experts actually practice. Situated, contextualized learning enables students to retain their knowledge until they encounter similar situations in the future, while cognitive apprenticeship may facilitate higher order reasoning. However, these authors fail to integrate their theories in cultural specific situations whereby what is applicable to a particular culture may not be practicable in another. Possibly, this might be the reason for the dearth of these practices in Nigeria. The present study has therefore taken up the challenge to integrate this practice into effective teaching of Basic Science in Nigeria .

Reviewed literature on critical exploration revealed that people must construct their own knowledge and must assimilate new experiences in ways that make sense to them. It was further explained that simply telling students what they should know leaves them cold. Critical exploration is built on the believe that students bring their prior expectations, interest and knowledge to the learning experience; their experience and insights are of high value as the development of their personal intelligence emerges through actions and the wonderful ideas. To reach deep understanding, students need to start from their own sets of ideas, be engaged in the subject matter and make a connection from the actual problem or subject matter to what they already understand. However, the reviewed literature was silent on individual differences which if not properly considered, could jeopardize the effectiveness of the strategy. The present study plans to take note of this in the execution of the strategy.

This review of literature also indicated that gender differences in science achievement, interest and participation are enormous in science education literature. In spite of many of such studies, more investigations are still being undertaken in this area. This is so because, a definite and stable picture of gender differences in science achievement, attitude and science process skills in Basic science, is yet to emerge. Rather, what is evident is that, there are three conflict pictures in respect of gender differences in science achievement. For instance, some schools of thought have the belief that gender difference has to do with differences in cognitive abilities

From the review of literature on parental support, parents are expected to play supportive role to their children in terms of everyday care and education. Actually, they are supposed to show deep interest in what their children do in school and how well they do it. Also, they are expected to provide enabling environment at home in order to increase students' academic achievement. Based on literature, parental support is the key to improving academic achievement of children. It also determines how well children do in school. It was concluded that parental support has a significant positive effect on children across races, although it is greater for some groups than others. The present study intends to further investigate the influence of gender on students' acquisition of science process skills.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

The study adopted a pretest-posttest control group quasi- experimental research design. The design is symbolically represented as:

0_1 X_1 04 E1

0_2 X_2 0_5 E2

0_3 X_3 0_6 C

Where 0_1, 0_2, 0_3 represent the pre-tests observations for the experimental group 1, 2 and control group respectively.Where04, 05, 06 represent the post-tests observations for the experimental group 1, 2 and control group respectively.

X_1 = Treatment 1 involving Cognitive Apprenticeship Strategy (CAS) E1

X_2 = Treatment 2 involving Critical Exploration Strategy (CES) E2

X_3 = Control group – Conventional / Traditional Strategy (CS). C

The design employed a 3x2x2 factorial matrix for the purpose of the analysis of the research data. The matrix is presented in table 3.1.

Table 3.1: 3x2x2 Factorial Matrix of the variables of the study.

TREATMENT	GENDER	PARENTAL SUPPORT	
		HIGH	LOW
Cognitive Apprenticeship Strategy	Male		
	Female		
Critical Exploration Strategy	Male		
	Female		
Conventional / Traditional Strategy	Male		
	Female		

3.2 Variables of the Study

The variables in this study are indicated below:

a) Independent variable**:** The independent variable was the mode of instructional strategy which varies at three levels:

(i) Cognitive Apprenticeship Strategy (CAS)

(ii) Critical Exploration Strategy (CES)

(iii) Conventional Strategy (CS)

b) *Moderator variables:* The moderator variables are:

(i) Gender (male and female)

(ii) Parental support (high, low)

c) *Dependent variables:* The dependent variables are:

(i) Achievement in Basic Science

(ii) Attitude to Basic Science

(iii) Process skills in Basic Science

3.3 Participants Selection

Three out of ten Local Government Areas (LGAs) were randomly selected from Osun West senatorial district from which nine (9) co-educational schools with their intact class were selected for the study. Each local government area had both treatment and control group that is, three (3) schools having two treatment and one control groups. Iwo local government has eleven (11) public secondary schools out of which three (3) were randomly selected for the study. Also, Ayedire local government has nine (9) public secondary schools out of which three (3) were randomly selected; likewise, Olaoluwa local government has seven (7) public secondary schools out of which three (3) were randomly selected for the study. In all these schools, only the junior sections were selected, using simple random sampling technique.

The choice of JSS 11 Basic Science students was made because they have been exposed to introductory aspect of Basic Science in primary school and junior secondary school one (JSS1). Also, the students were more receptive to the study as they were not under the pressure of preparing for external examinations. The teaching of the concept was appropriate to the scheme of work at this stage of their spiral curriculum, according to the new Basic science and Technology curriculum (Federal Ministry of Education, 2009):

- Living things: Habitat, Uniqueness of man
- Changes in Matter: Temporary and permanent changes
- Changes in living things: Stages of Development
- Changes in non-living things: Solid, Liquid and Gas.

The selected concepts were found to be difficult topics in the curriculum which are frequently examined in junior secondary school examination.

3.4 Research Instruments

Eight instruments were used for generating data in this study. They include:

(a) Basic Science Students' Achievement Test (BSSAT)

(b) Students Basic Science Attitude Scale (SBSAS)

(c) Students' Basic Science Process Skills (SBSPS)

(d) Parental Support Scale (PSS)

(e) Teachers' Instructional Guide on Cognitive Apprenticeship Strategy (TIGCAS)

(f) Teachers' Instructional Guide on Critical Exploration Strategy (TIGCES).

(g) Teachers' Instructional Guide on Conventional Strategy (TIGCS)

(h) Evaluation sheet for Research Assistant Performance during Training (ESARAP).

All the instruments were developed and validated by the researcher in collaboration with the supervisor. The details of each of the above are further explained:

3.4.1Basic Science Students' Achievement Test (BSSAT)

This instrument, developed by the researcher in collaboration with the supervisor tested the JSS II students' intellectual achievement in living things, changes in matter, changes in living things and changes in non- living things. The test contains twenty five multiple choice objectives test items. It has two sections with Section (A) containing demographic information such as

Name of School, Students Name, Class, Gender, Age, Local Government Area and Highest Qualification of Parents, while section B contains the test items constructed as presented in Table 3.2. The options for the questions range from A to D. One mark was awarded for each correct option and zero for wrong option. This means that the total marks obtainable is 25. The test items were generated to cover cognitive domains of knowledge, Understanding and thinking, in accordance with Okpala, Onocha and Oyedeji (1998). The table of specification is contained in Table 3.2.

Table 3.2: Table of Specification for Basic Science Students' Achievement Test (BSSAT)

Topic	Knowledge	Understanding	Thinking	Total
Living things	(2) 1,5	(1) 4	(3) 2,3,10	6
Changes in living things	(3) 6,8,12	(3) 7,9,13	(2) 11,14	8
Changes in non-living things	(2) 15,18	(2) 16,21	(3) 17,19,20	7
Changes in matter	(1)24	(2)25,23	(1) 22	4
Total	8	8	9	25

3.4.1.1 Validity and Reliability of Basic Science Students' Achievement Test

The validity and reliability coefficient of the (BSSAT) were determined using coefficient of the initial draft of forty multiple choice items and were given to some lecturers in the Science Unit of the Department of Teacher Education, Faculty of Education, University of Ibadan,

Ibadan; some Ph.D students in the field of Basic Science and two lecturers who are experts in the field of Science Education. This was done to ascertain the face, content and construct validity of the instrument. The forty (40) multiple choice items were reduced to thirty (30) items while twenty five (25) items survived final scrutiny. It was later trial-tested in a representative secondary school that was not selected for the main study in which the items fell within the discriminating indices of 0.4 to 0.6.

The data collected were analyzed using Kuder-Richardson formula 20 (KR20). The reliability coefficient of 0.81 and an average item difficulty index of 0.49 were obtained.

3.4.2 Students' Basic Science Attitude Scale (SBSAS)

The instrument was developed and validated by the researcher. It was divided into two (2) sections. Section A was on demographic variables; it sought information on the name of the school, name of student, class of student, gender and age of student and the local government area, and time allowed for the test. Section B was on students' attitude toward Basic Science.

It comprised 25 items based on 4 point likert type scale. The scoring of SBSAS was as follows: Strongly Agree (SA) - 4 marks, Agree (A) - 3 marks, Disagree (DA) – 2 marks, Strongly Disagree (SD) – 1 mark. The aforementioned goes for positively worded statement while the reverse was used for negatively worded statements such as: Strongly Disagree (SD)- 4 marks, Disagree (DA) – 3 marks, Agree (A) – 2 marks, Strongly Agree (SA) – 1mark.

3.4.2.1 Validity of Students' Basic Science Attitude Scale

The face and content validity of the instrument was ensured through experts (two) in the field of Science in the Department of Teacher Education, Faculty of Education, University of Ibadan, Ibadan. The instrument was also examined by the researcher's supervisor in order to determine whether the items would measure the intended contents. Their suggestions were incorporated into the final draft. The Cronbach Alpha formula procedure was applied by the researcher to find the reliability co-efficient. In order to do this, some students who were out of the study area in the same local government area were involved to determine the reliability co-efficient of the instrument. The reliability Cronbach Alpha Co-efficient of 0.86 was obtained and it is the instrument that the researcher used for this study.

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

This instrument, developed and validated by the researcher, is made up of twenty five items on a 5-point rating scale to measure students' science process skills. The twenty five items were distributed among the five basic science process skills which are observing, classifying, measuring, recording and manipulating. The rating scales used are: Very Good = 5, Good = 4, Very Fair = 3, Fair =2 and Poor = 1. The table of classification for this is represented in Table 3.3.

Table 3.3: Classification of Students' Basic Science Process Skills Rating Scales (SBSPSRS)

Topic	Observation	Classification	Recording	Manipulation	Total
Living things	(2) 18,21	(3) 8,11,19	(1) 9,	(1)16	7
Changes in living things	(3) 1,14,22	(1) 2,	(1) 20	(1)12	6
Changes in non-living things	(2) 6,23	(1) 3	(1)10	(1)13	5
Changes in matter	(3)4,7,24	(1)15	(1) 5.	(2)17,25	7
Total	10	6	4	5	25

3.4.3.1 The Validation and Reliability of Students Basic Science Process Skills

To validate this, the instrument was distributed to experts for review. Their opinions and advice were used to either discard or rework the items. The instrument was used by three basic science teachers to observe. The Cronbach Alpha reliability index obtained was 0.83.

3.4.4 Parental Support Scale for Education

This scale is a self–developed instrument specifically designed to elicit information on adolescent perceived knowledge of parental supportiveness. The instrument consists of 10 items structured in a 5-point likert format, with responses ranging from 5 (strongly agree) to 1 (strongly disagree).

It sought information on the name of the school, name of student, class of student, gender and age of student and the local government area, and time allowed for the test.

The scoring of PSS was as follows: Strongly Agree (SA) - 5 marks, Agree (A) - 4 marks, Undecided – 3marks, Disagree (DA) – 2 marks, Strongly Disagree (SD) – 1 mark. The above goes for positively worded statements while the reverse was used for negatively worded statements such as: Strongly Disagree (SD)- 5 marks, Disagree (DA) – 4 marks, Undecided 3marks, Agree (A) – 2 marks, Strongly Agree (SA) – 1mark.

3.4.4.1 The Validation and Reliability of Parental Support Scale

The reliability of the scale was determined with a two week pre-test procedure. The scale has Cronbach Alpha of 0.75 from a two week test re-test reliability method. Minimum score obtainable is 10, while the maximum score is 50. To determine High and Low Parental support therefore, the maximum score is taken to percentage level which is 50 x 2= 100. Therefore, a score of 60% and above is taken to be High Parental support score, while scores falling below 60% are considered as Low Parental support scores.

3.4.5 Teachers' Instructional Guide (TIG)

These are teaching guides prepared by the researcher for the research assistants (teachers) on the three strategies (Cognitive Apprenticeship, Critical Exploration and Conventional strategy). These were used during the training period for the experimental and control groups. The detail is shown in Appendices V, VI and VII on pages 179-197.

3.4.5.1 Teachers' Instructional Guide on Cognitive Apprenticeship Strategy (TIGCAS)

The training had the following steps on Cognitive apprenticeship:

Step I: Research assistant introduces the topic of the content to the students.

Step II: Research assistant performs task so students can observe.

Step III: Students performs task in the presence of research assistant.

Step IV: Students are supported by the research assistant when in dilemma.

Step V: Students are to verbalize their knowledge and thinking with the help of research assistant.

Step VI: Students are to compare their performance with others.

Step VII: Research assistant and students solve the difficult task that students cannot do

Step VIII: Research assistant gives assignment to students.

To validate this, the instrument was distributed to experts for review. Their opinions and advice were relied upon to either discard or rework the items. The instrument was used by three independent raters to observe and rate the teachers during the activity session. The inter-rater reliability was then estimated using Scott's (π); the inter-rater reliability index obtained was 0.78.

3.4.5.2 Teachers' Instructional Guide on Critical Exploration Strategy (TIGCES)

This is a model that directed the teachers in creating learning experiences in which students were allowed some measures of interactions with materials rather than with their colleagues, while the competitive mind was retained. It was not group based but individualistic in activities such that someone emerges as the best. The researcher prepared the guide for teachers that were involved in the study, who had been randomly asked to use the method. This gave them direction on the role and activities students should individually and independently pursue.

Critical exploration strategy training includes:

Step I: The topic of the content is introduced to the students by the research assistant.

Step II: Students raise questions based on their curiosity on the concept.

Step III: Students are encouraged by the research assistant to explore on their thought towards the concept.

Step IV: Students perform tasks relating to the solutions towards the questions raised through feedback from their thought processes.

Step V: Research assistant ask students to summarize the feedback from questioning and thought processes in their notebooks.

Step VI: Students express the answers using their simple sentences.

Step VII: Research assistant gives assignment to students.

To validate this, the instrument was distributed to experts for review. Their opinions and advice were relied on to either discard or rework the items. The instrument was used by three independent raters to observe and rate the teachers during the activity session. The inter-rater reliability was then estimated using Scott's (π); the inter-rater reliability index obtained was 0.76. The research assistants in control groups were only exposed to conventional method:

3.4.5.3 Teachers Instructional Guide on Conventional Strategy (TIGCS)

The researcher prepared the guide for teachers that were involved in the study who were randomly asked to use the method. This gave them direction on the role and activities students should individually and independently pursue.

Step I: The research assistant introduces the lesson by asking questions based on their previous knowledge.

Step II: Research assistant presents instructional materials and discusses the content of the lesson to students.

Step III: Research assistant summarizes the concept to the students.

Step IV: Research assistant instructs students to write the summary on the board in their note books.

Step V: Research assistant evaluate the lesson by asking students some questions.

Step VI: Research assistant gives assignment to the students

To validate this, the instrument was distributed to experts for review. Their opinions and advice were taken to either discard or rework the items. The instrument was used by three independent raters to observe and rate the teachers during the activity session. The inter-rater reliability was then estimated using Scott's (π); and the inter-rater reliability index obtained was 0.74.

3.4.6 Evaluation Sheet for Assessing Research Assistants' Performance on the use of the Strategies (ESARAP)

This is the guideline for evaluating performance of the trained teachers on the effective use of the instructional strategies. During the training of the participating teachers for one week, the researcher requested the teachers to demonstrate their lessons, which were assessed by the researcher using the evaluation sheet for assessing research assistants' performance (ESARAP), to ensure that teachers strictly comply with the guide.

The strategies are:

1. Cognitive Apprenticeship
2. Critical Exploration
3. Conventional Strategies.

The rating scale had two sections:

Section A: This consists of the personal data of the trained teachers containing Name, School, Number of periods, Class taught, and Date and Summary of the concept discussed in the class.

Section B: This consists of items to be evaluated. The items are placed on a 5-point Likert type rating scale ranging from Very Good (5), Good (4), Average (3), Poor (2) and Very poor (1).

3.4.6.1 Validation of ESARAP

The instruments were trial–tested on certain Basic Science teachers different from those used for the study to ensure its reliability. For the purpose of validation, experts' attention was drawn to ascertain the appropriateness of the concept and methods to the target population. The observations and comments of these experts were taken into consideration before the final draft was prepared.

3.5. Research Procedure for the Study

The following time schedule was adopted.

- One (1) week was used for training of research assistants (Teachers)
- One (1) week for scrutiny of research assistants to ensure that they are ready to do what they are supposed to do.
- One (1) week for pre-test
- Eight (8) weeks for treatment using the trained research assistants on the listed strategies. These took place simultaneously in all the schools selected.
- One (1) week for post-test
- This makes a total of twelve (12) weeks.

3.5.1 Training of Research Assistants

Training was done step by step through the explanation on the teaching guides. (Cognitive apprenticeship, critical exploration and conventional strategies) The first week was used for the training of the research assistants. To ensure that the teachers acquire competencies in their randomly assigned strategies, the training took place in the respective classes of the research assistants involved. The researcher was the one that trained the research assistants in their schools and classes. The training had the following steps on cognitive apprenticeship:

Step I: The topic of the content is introduced to the students by the research assistant.

Step II: Research assistant performs the task so students can observe.

Step III: Students perform the task in the presence of research assistant.

Step IV: Students are supported by the research assistant when in dilemma.

Step V: Students are to verbalize their knowledge and thinking with the help of research assistant.

Step VI: Students are to compare their performance with others.

Step VII: Research assistant and students are to solve the difficult tasks that students cannot do.

Step VIII: Research assistant gives assignment to students.

The training on critical exploration strategy steps includes the following:

Step I: The topic of the content is introduced to the students by the research assistant.

Step II: Students raise questions based on their curiosity on the concept.

Step III: Students are encouraged by the research assistant to explore on their thought towards the concepts.

Step IV: Students perform task relating to the solution towards the questions raised through feedback from their thought processes.

Step V: Research assistant ask students to summarize the feedback from questioning and thought processes in their notebooks.

Step VI: Students express the answers using their simple sentences.

Step VII: Research assistant gives assignment to students.

The training on conventional strategy steps includes the following:

Step I: Research assistant introduces the lesson by asking students questions based on their previous knowledge.

Step II: Research assistant presents instructional materials and discusses the content of the lesson to the students.

Step III: Research assistant summarizes the concept to the students.

Step IV: Research assistant instructs students to write the summary on the board in their note books.

Step V: Research assistant evaluates the lesson by asking students some questions.

Step VI: Research assistant gives assignment to students.

3.5.2 Administration of pre-test.

All the 270 students (JSSII) in all the nine schools selected for the experimental and control groups were given pre-test on all the evaluative instruments. The pre-test lasted for one week as follows: Students Basic Science Attitude Scale (SBSAS) followed by Basic Science Students' Achievement Test (BSSAT), and Students Basic Science Process Skills Rating Scale (SBSPSRS) in that order.

3.5.3 Treatment Procedure

The treatment was carried out on the experimental and control groups. During this period, students were taught various aspects of the living things, changes in living things, changes in matter, changes in non-living things by the necessary assistants using

- Cognitive Apprenticeship
- Critical Exploration
- Conventional Strategy

This stage lasted eight weeks. At the end of the treatments, one week was used for post-test scores.

3.5.4 Administration of Posttest

All the JSS II students in the nine sampled schools for the experimental and control groups were given Posttests on all the evaluative instruments. The Posttests were as follows:

Students Basic Science Attitude Scale (SBSAS) followed by (Basic Science Students Achievement Test (BSSAT) Students Basic Science Process Skills Rating Scale (SBSPSRS) and Parental support scale (PSS) were administered.

3.6 Procedure for Data Collection

The researcher, having sought the principal's permission in the selected schools, trained the research assistants. All the JSSII students in each of the nine schools who participated in the study were pre-tested with the use of the instruments. With the help of the research assistants, Students' Basic Science Attitude Test (SBSAT) was administered first, followed by Basic Science Students' Achievement Test (BSSAT), students' Basic Science Skills Rating Scale (SBSSRS), Parental Support Scale (PSS), Teachers' Instructional Guide on Cognitive Apprenticeship Strategy (TIGCAS), Teachers Instructional Guide on Critical Exploration Strategy (TIGCES),and Teachers Instructional Guide on Conventional Strategy (TIGCS). Each of the three groups was therefore exposed to the treatment selected for them. The post-test contained the same items used as pre-test and were administered on all the groups at the end of the treatment sessions. Procedurally, one week was used to train the research assistants, a week for pre-test administration, eight weeks for treatment implementation and a week for post-test administration, making a total of twelve weeks.

3.7 Procedure for Data Analysis

The data was analyzed using descriptive statistics (Mean and Standard Deviation) and inferential statistics such as Analysis of Covariance (ANCOVA), using pretest scores as covariates. Also, the Estimated Marginal Mean (EMM) aspect of the ANCOVA was employed to determine the magnitude of the performance of the various groups. In the case of significant main effects, the Duncan analysis was used to determine the sources of such significant differences. For significant interaction effects, graphs were used to show the nature of interaction. All the hypotheses were tested at .05 level of significant.

CHAPTER FOUR

INTERPRETATION OF RESULTS

4.0 Introduction

The focus of this study was to investigate the effects of Cognitive Apprenticeship and Critical Exploration Teaching Strategies on students' learning outcomes in selected secondary schools in Osun state. This chapter presents the results of the findings and discussion of the data gathered during the course of the study.

4.1 Descriptive statistics.

4.1.1 Descriptive statistics associated with Treatment

Table 4.1: Summary of Descriptive Statistics Associated with Treatment

	Achievement Scores			**Attitude Scores**			**Science process skills**		
	CAS	**CES**	**CS**	**CAS**	**CES**	**CS**	**CAS**	**CES**	**CS**
No of cases	90	90	90	90	90	90	90	90	90
Pre-test mean	12.68	12.58	7.11	37.31	37.09	35.11	20.35	18.98	19.40
Pre-test S.D	0.65	0.65	0.59	0.63	0.83	0.91	0.52	0.51	0.42
Posttest mean	13.35	13.23	7.40	37.44	37.21	35.20	21.28	19.90	19.53
Posttest S.D	0.34	0.35	0.40	0.07	0.07	0.09	0.47	0.49	0.58
Mean Gain	0.67	0.65	0.29	0.13	0.12	0.09	0.93	0.92	0.13

.   **CAS- Cognitive Apprenticeship Strategy**

. **CES- Critical Exploration Strategy**

.**CS- Conventional Strategy**

.**S.D- Standard Deviation**

Table 4.1 displays the descriptive Statistics of the students' achievement, attitude and science process skills scores. The Posttest scores improved for Cognitive apprenticeship in achievement, attitude and science process skills scores 0.67, 0.13 and 0.93 respectively. Critical exploration Posttest scores showed improvement with 0.65, 0.12 and 0.92 respectively. In case of Conventional strategy, the Posttest scores do not improve in achievement, attitude and science process skills.

The mean gain in descending order is: Cognitive apprenticeship had higher mean gain than Critical exploration, while Critical exploration had higher mean gain than Conventional strategy. Figures 3.1, 3.2 and 3.3 displayed the bar chart showing the magnitude of descriptive statistics of the students' achievement, attitude and science process skills scores associated with treatment as presented earlier in Table 4.1.

This is further represented in Figure 4.1.

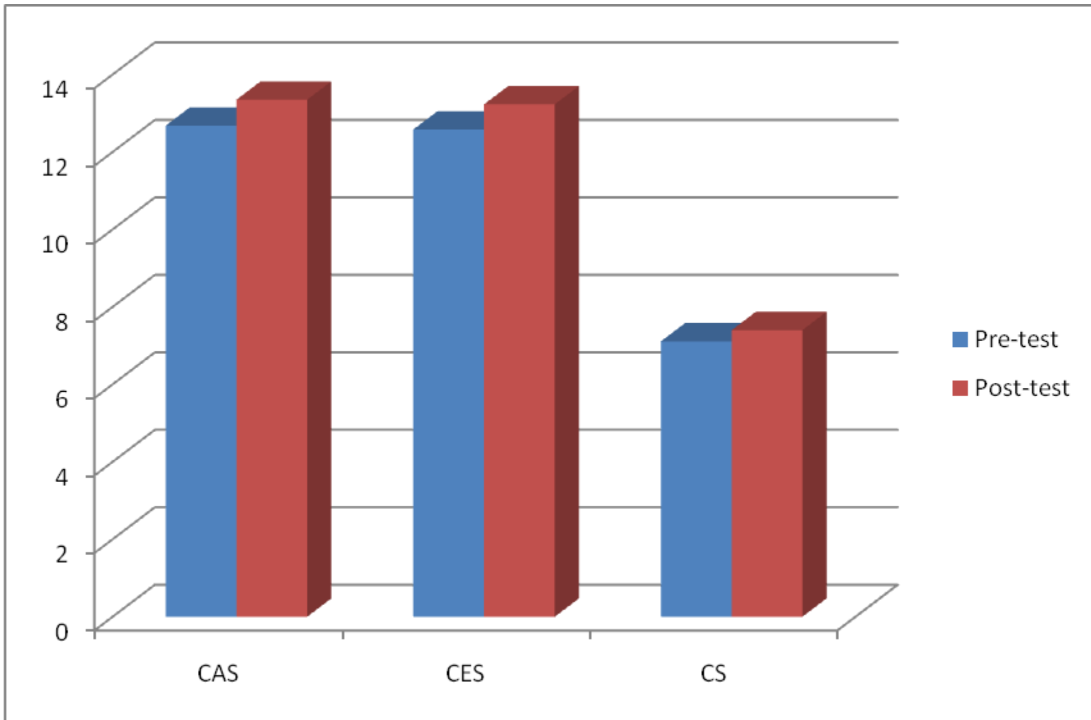

Figure 4.1: Bar chart showing descriptive statistics associated with treatment on achievement mean scores.

. CAS- Cognitive apprenticeship strategy

. CES-Critical exploration strategy

. CS-Conventional strategy

Figure 4.1 reveals the bar chart showing descriptive statistics associated with treatment on achievement mean scores. The posttest scores improved for Cognitive apprenticeship in achievement scores by 0.67 (pretest mean= 12.68, posttest mean= 13.35), Critical exploration strategy scores show improvement with 0.68 (pretest mean=12.58, posttest mean=13.23). In the case of Conventional strategy, the posttest scores do not improve in achievement (Pretest mean=7.11, Posttest scores=7.40).

The mean gain in descending order was; Cognitive apprenticeship had higher mean gain than Critical exploration strategy, while Critical exploration strategy had higher mean gain than Conventional strategy.

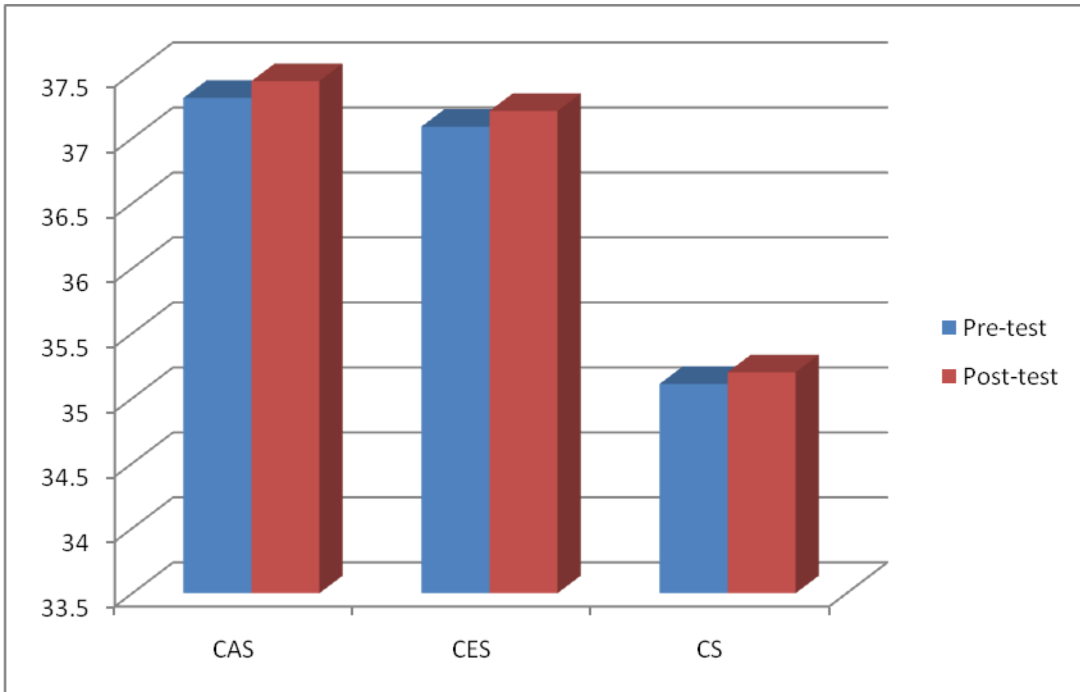

Figure 4.2: Bar chart showing Descriptive Statistics Associated with Treatment on attitude mean scores.

- CAS-Cognitive apprenticeship strategy
- CES-Critical exploration strategy
- CS-Conventional strategy

Figure 4.2 reveals the bar chart showing descriptive statistics associated with treatment and attitude mean scores. The posttest scores improved for Cognitive apprenticeship strategy in attitude scores by 0.13 (Pretest mean=37.31, Posttest mean=37.44). Critical exploration posttest scores shows improvement with 0.12 (Pretest mean=37.09, Posttest mean=37.21). In the case of Conventional strategy, the posttest scores do not improve in attitude scores. (Pretest mean=35.11, Posttest mean= 35.20). The mean gain in descending order was: Cognitive apprenticeship strategy had higher mean gain than critical exploration, while Critical exploration had higher mean gain than Conventional strategy.

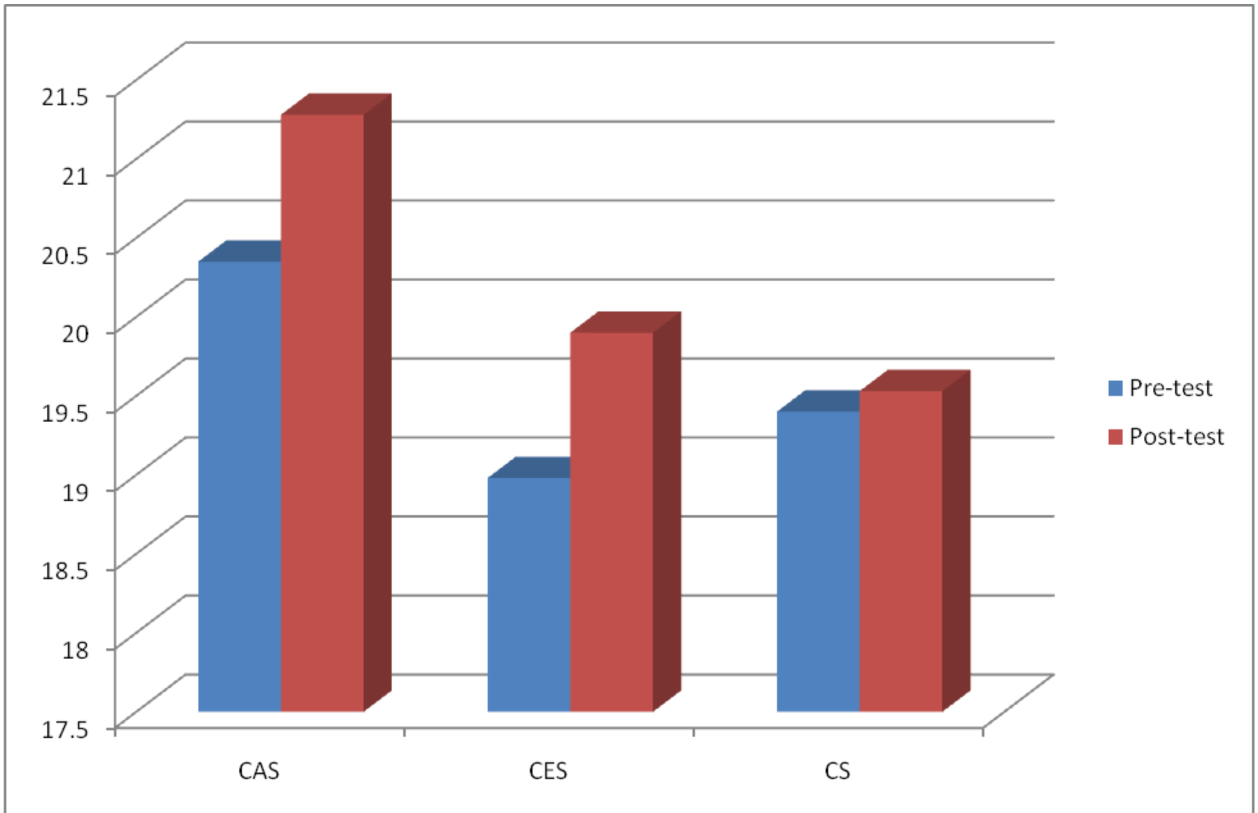

Figure 4.3: Bar chart showing descriptive statistics associated with treatment and science process skills scores.

.CAS- Cognitive apprenticeship strategy

.CES-Critical exploration strategy

.CS-Conventional strategy

Figure 4.3 reveals the bar chart showing descriptive statistics associated with treatment and science process skills mean scores. The Post test scores improve for Cognitive apprenticeship in science process skills scores by 0.93 (Pretest mean=20.35, Posttest mean=21.28) and Critical exploration strategy post test scores show improvement with 0.92 (Pretest mean=18.93, Posttest mean=19.90). In the case of Conventional strategy, the posttest scores do not improve in science process skills. (Pretest mean=19.40, Posttest mean=19.35). The mean gain in descending order was: Cognitive apprenticeship strategy had the highest mean gain followed by Critical exploration, while Conventional strategy had the least mean gain.

4.1.2. Descriptive Statistics Associated with Gender

Table 4.2: Summary of Descriptive Statistics Associated with Gender

	Achievement Scores		Attitude Scores		Science process skills	
	MALE	**FEMALE**	**MALE**	**FEMALE**	**MALE**	**FEMALE**
No of cases	**133**	**137**	**133**	**137**	**133**	**137**
Pre-test mean	**10.59**	**11.24**	**37.48**	**37.09**	**19.06**	**20.49**
Pre-test S.D	**0.61**	**0.29**	**0.44**	**0.43**	**0.53**	**0.42**
Posttest mean	**11.17**	**11.82**	**37.36**	**37.22**	**19.86**	**20.59**
Posttest S.D	**0.51**	**0.29**	**0.06**	**0.06**	**0.58**	**0.42**
Mean Gain	**0.58**	**0.56**	**-0.12**	**0.13**	**0.80**	**0.10**

Table 4.2 displays the descriptive statistics of the students' achievement, attitude and science process skills' scores. The mean gain in descending order was: female students had higher mean gain than male students.

Figures 4.1, 4.2 and 4.3 display the bar charts showing the magnitude of descriptive statistics of the students' achievement, attitudes' and science process skills 'scores associated with gender as presented in Table 4.2

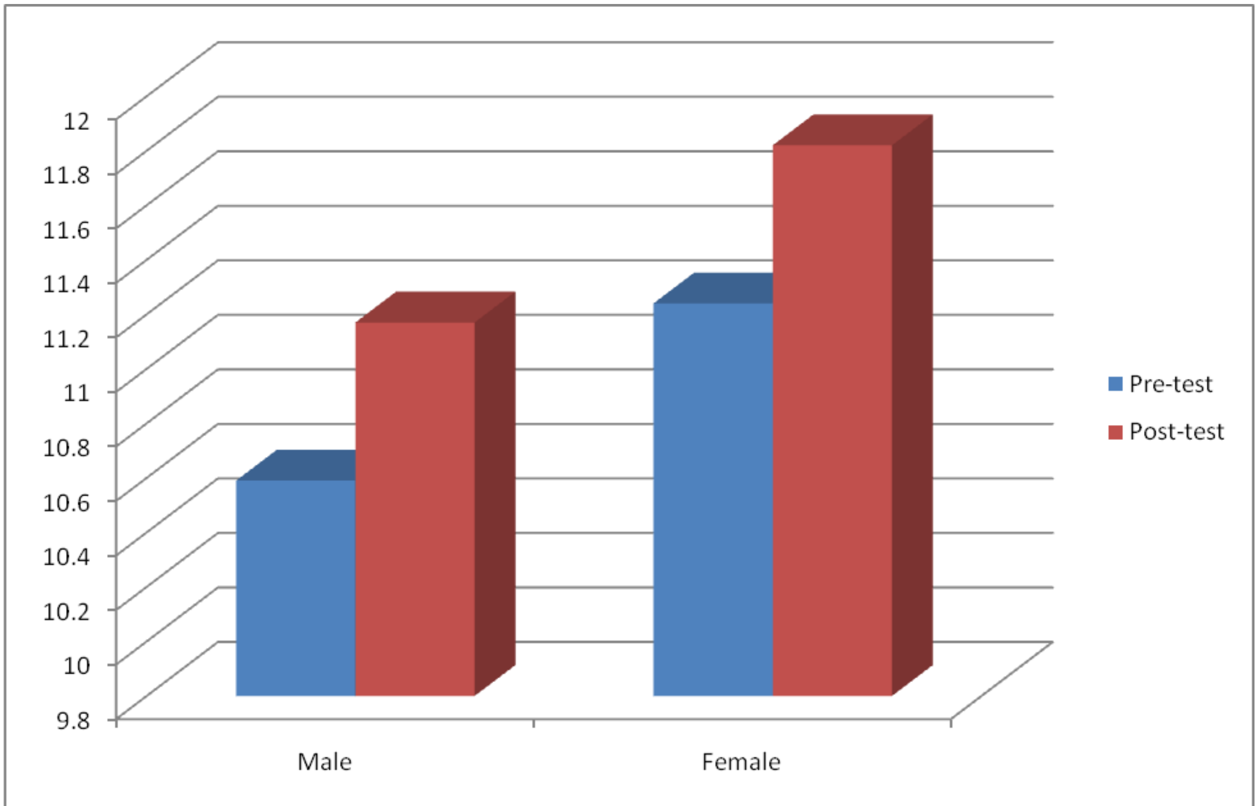

Fig 4.4: Bar chart showing descriptive statistics associated with achievement according to gender

Figure 4.4 is the bar chart showing descriptive statistics associated with achievement according to gender. There were improvement in male and female posttest achievement scores 0.58 (Pre-test mean=10.59, Post-test mean=11.17) and 0.56. (Pre-test mean=11.24, Post-test mean=11.82) respectively.

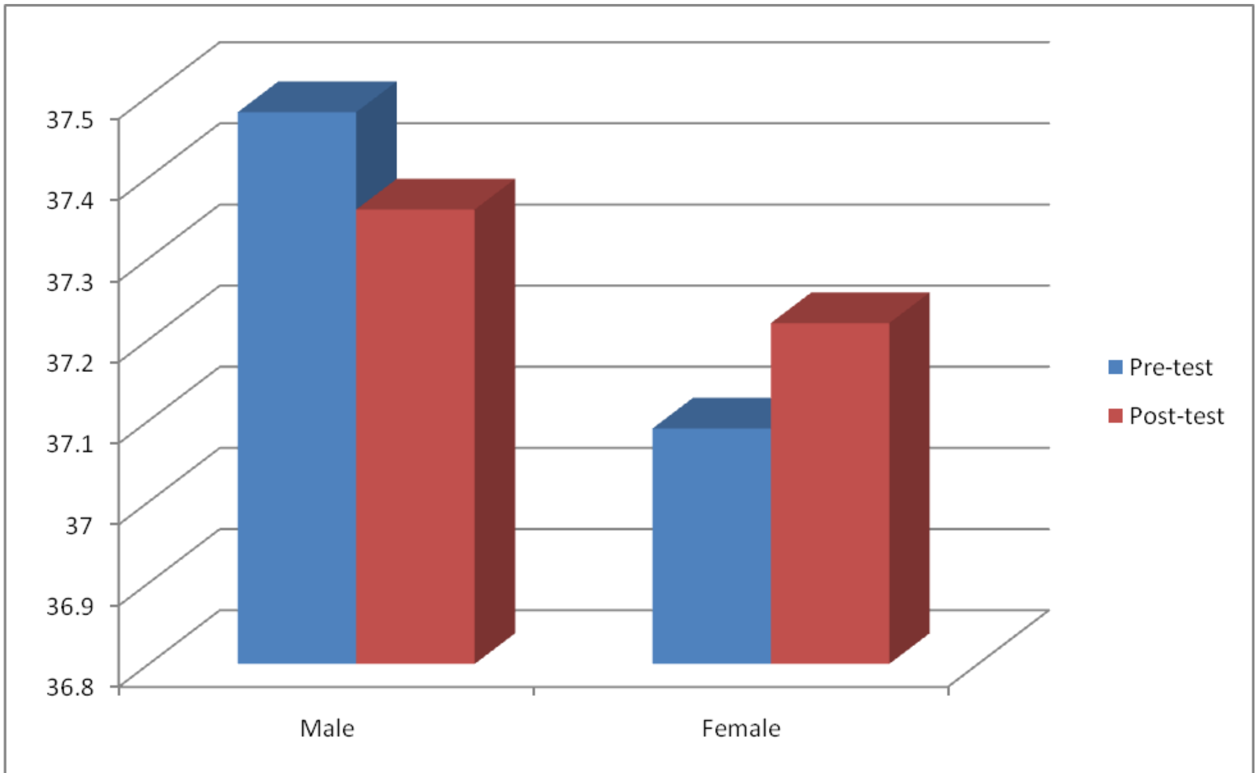

Figure 4.5: Bar chart showing descriptive statistics associated with attitude according to gender

There was no improvement in male posttest attitudinal scores -0.12 (Pretest mean =37.48, posttest mean=37.36), but there was improvement in female post-test attitudinal scores 0.13 (pre-test mean=37.09, post-test=37.22)

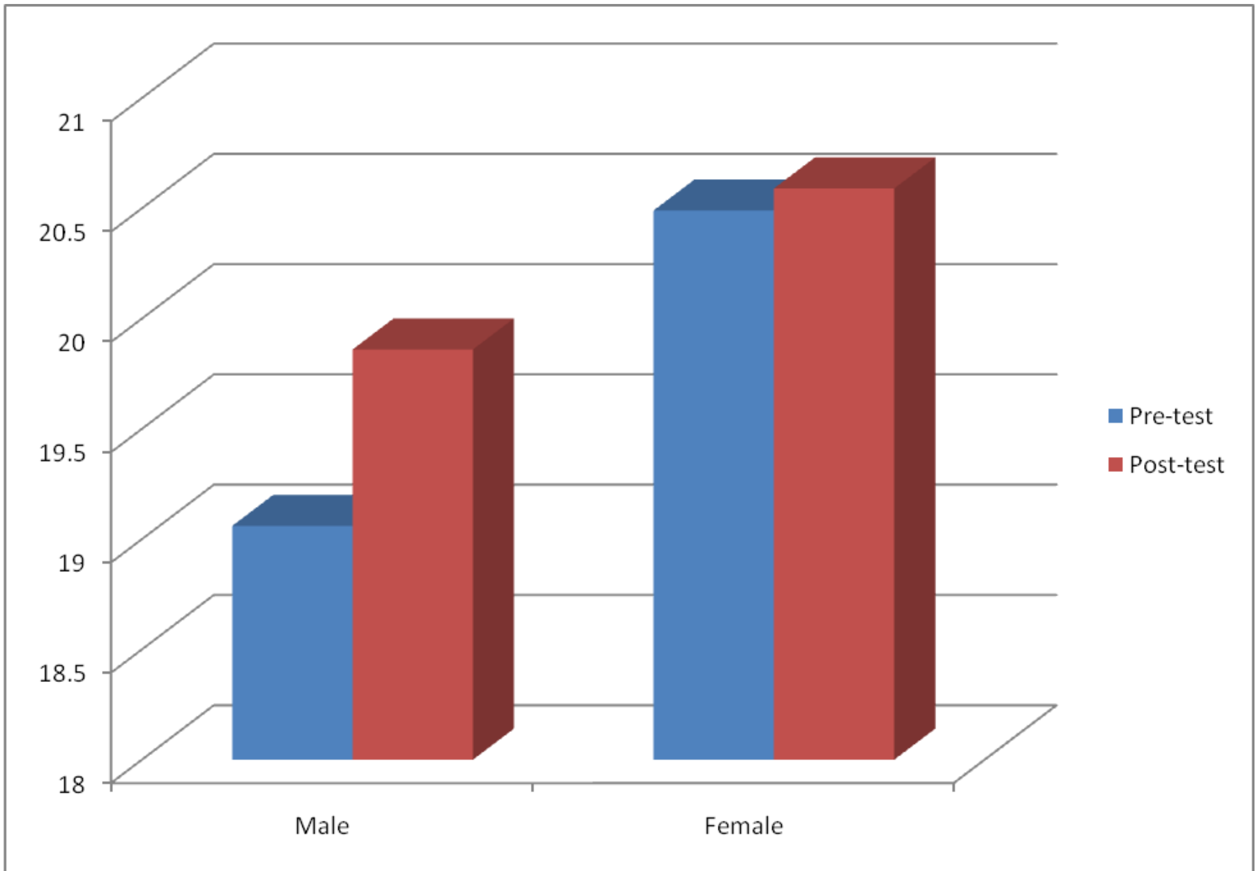

Figure 4.6: Bar chart showing descriptive statistics associated with science process skills according to gender

Figure 4.6: is the Bar chart showing statistics associated with science process skills according to gender. There were improvements in male and female science process skills' scores, 0.80. (Pre-test mean=19.06, Post-test mean=19.86) and 0.83 (Pre-test mean=19.76, Post-test mean=20.59) respectively. There was no gain in mean scores of female students, while there was an improvement in mean scores of male students.

4.1.3 Descriptive Statistics Associated with Parental Support

Table 4.3: Summary of Descriptive Statistics Associated with Parental Support

	Achievement Scores		Attitude Scores		Science Process Skills	
	Low	**High**	**Low**	**High**	**Low**	**High**
No of Cases	**45**	**225**	**45**	**225**	**45**	**225**
Pre-test Mean	**10.71**	**11.20**	**37.18**	**37.16**	**18.82**	**20.11**
Pre-test S.D	**0.52**	**0.38**	**0.21**	**0.33**	**0.36**	**0.61**
Posttest Mean	**11.46**	**11.52**	**37.34**	**37.23**	**19.90**	**20.58**
Posttest S.D	**0.38**	**0.17**	**0.08**	**0.04**	**0.55**	**0.24**
Mean Gain	**0.75**	**0.32**	**0.16**	**0.07**	**1.08**	**0.47**

Table 4.3 displays the descriptive statistics of the students' achievement, attitude and science process skills 'scores associated with parental support. There were improvements in the mean achievement scores of both low (0.75) and high (0.32) students, but the low students show greater improvement in mean attitudinal scores (0.07), while there was no improvement in the mean attitudinal scores of high students (0.16). The mean scores of high students show greater improvement (0.47) than that of low students (1.08). Figures 5.1, 5.2 and 5.3 displayed the bar chart showing the magnitude of descriptive statistics of the students' achievement, attitude and science process skills' scores associated with parental support as presented in Table 4.3.

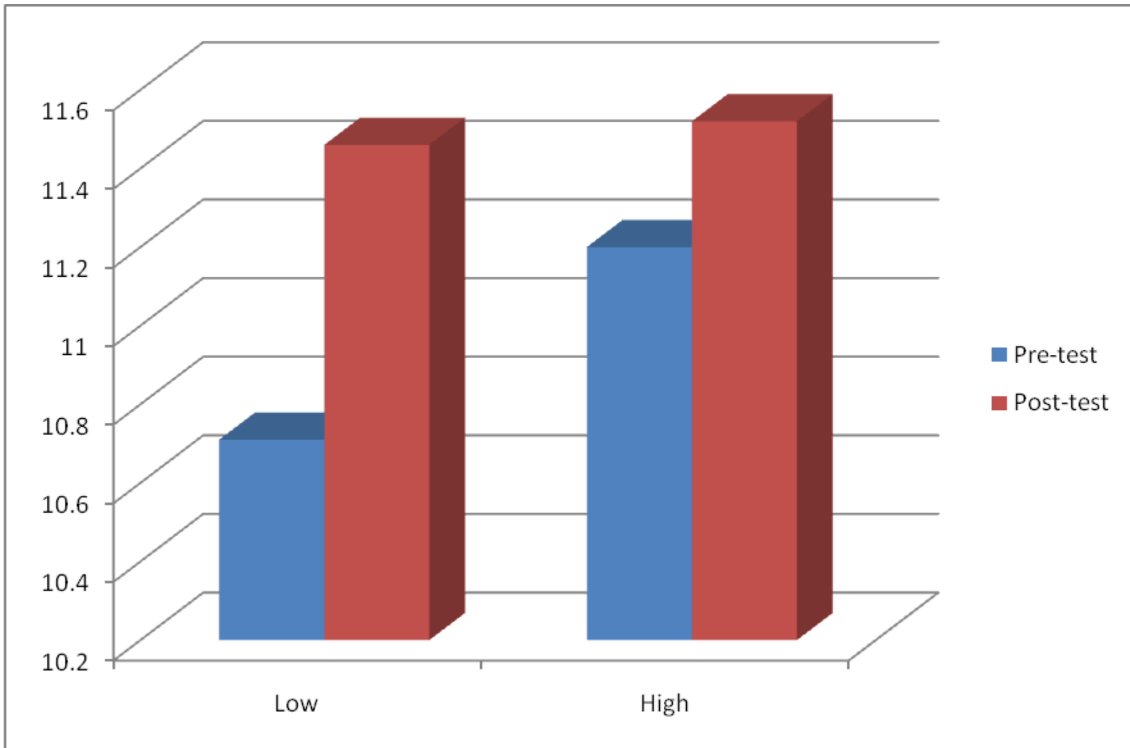

Figure 4.7: Bar chart showing descriptive statistics of achievement associated with Parental Support.

Figure 4.7 is the Bar chart showing descriptive statistics of achievement associated with parental support. There were improvements in the mean scores of low students by 0.75 (Pre-test mean=10.71, Post-test mean=11.46) and high students by 0.32 (Pre-test mean=11.20, Post-test mean=11.52).

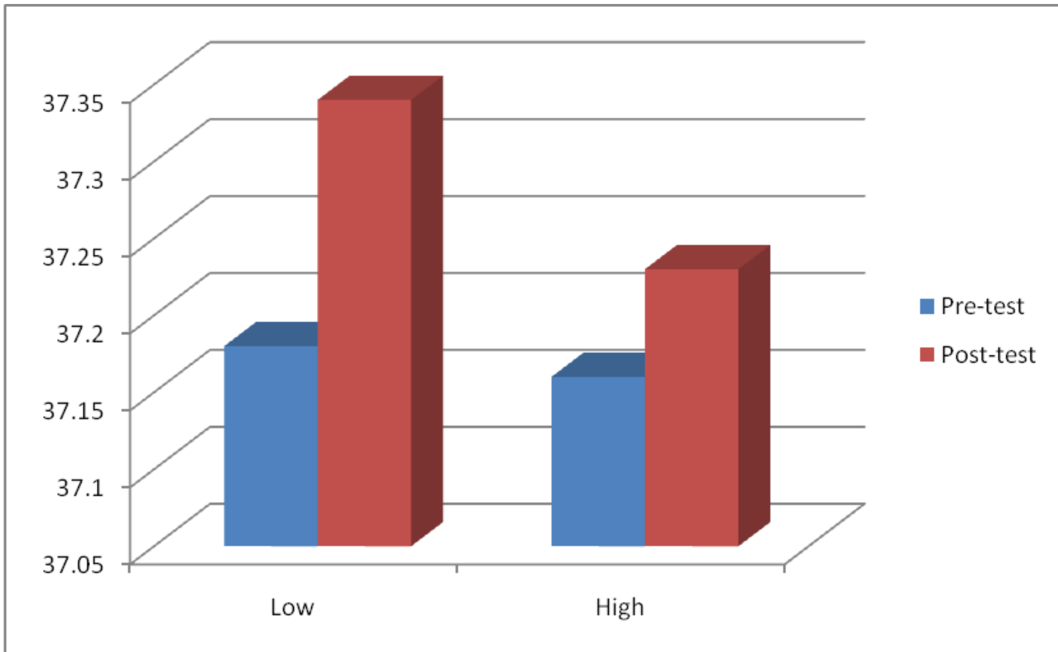

Figure 4.8: Bar chart showing descriptive statistics of attitude with Parental Support

Figure 4.8 is the Bar chart showing descriptive statistics of attitude associated with parental support. The low students show greater improvements in mean attitudinal scores by 0.16 (Pre-test mean=37.18, Post-test mean= 37.34) and high mean attitudinal scores 0.07 (pre-test mean=37.16, Post-test mean=37.23)

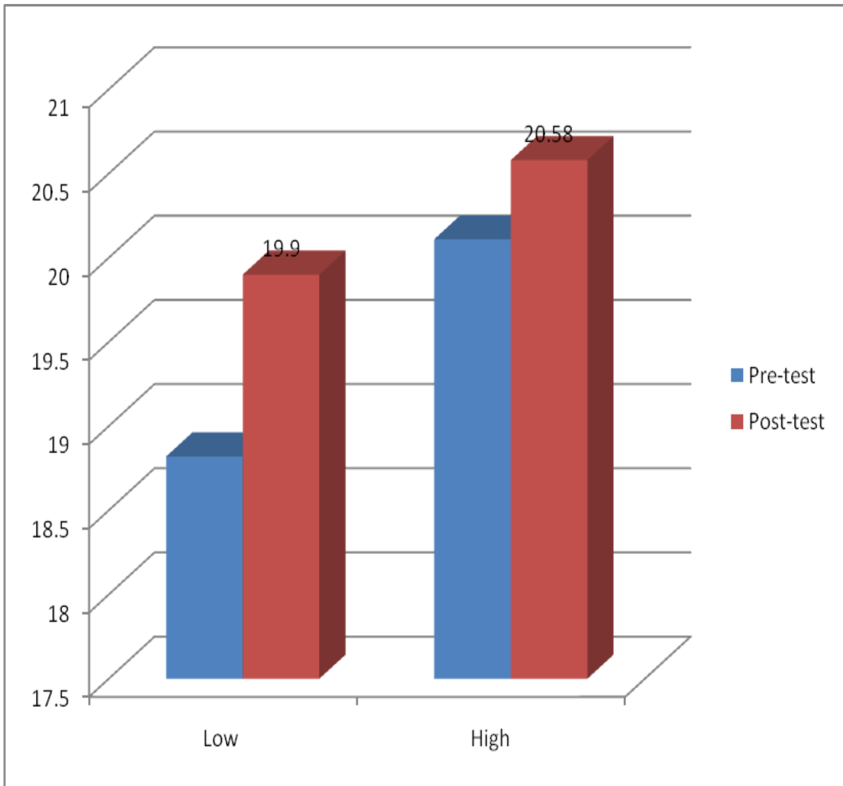

Figure 4.9: Bar chart showing descriptive statistics of science process skills associated with Parental Support.

Figure 4.9 revealed bar chart showing descriptive statistics associated with parental support. The mean science process skills 'scores of students with low parental support students show greater improvement by 1.08(Pretest mean=18.82, Post-test mean=19.90) than that of students with high parental support by 0.47 (Pre-test mean=20.11, Post-test mean=20.58).

4.2. Testing of Hypotheses

Main Impact of Treatment

4.2. 1a Ho1a: There is no significant main effect of treatment on students' achievement in Basic Science.

Table 4.4 represents the summary of ANCOVA results on subjects' posttest achievement scores

Table 4.4: 3 x 2x 2 ANCOVA Showing the Summary of Post-Test Achievement in Basic Science among Students by Treatment, Gender and Parental support.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2243.596[a]	12	186.966	30.453	.000	.587
Intercept	1818.503	1	1818.503	296.194	.000	.535
Pre-test	270.049	1	270.049	43.985	.000	.146
Treatment	817.266	2	408.633	66.557	.000	.341
Gender	15.214	1	15.214	2.478	.117	.010
Parental support	.139	1	.139	.023	.881	.000
treatment * gender	.689	2	.345	.056	.945	.000
treatment* parentalsup	5.127	2	2.563	.418	.659	.003
gender * parentasupp	.024	1	.024	.004	.950	.000
treatment*gender*paretalsupp	16.221	2	8.111	1.321	.269	.010
Error	1577.870	257	6.140			
Total	39460.000	270				
Corrected Total	3821.467	269				

R. Squared=.587 (Adjusted R. Squared=)*Significant at p< 0.05

Table 4.1 shows a significant main effect of treatment on achievement in Basic Science among the students (F $_{(2,257)}$ = 66.557; P<0.05, $\tilde{\eta}^2$ = 0.341). The effect size of 34.1%.was recorded. Hence, the hypothesis was rejected statistically. To determine the actual source of the observed significant differences, Estimated Marginal Means (EMM) analysis was carried out on the mean scores of the groups. This is presented in Table 4.2.

Table 4.5: Estimated Marginal Means (EMM) analysis

According to Treatment and control Group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Conventional Strategy	7.900[a]	.401	7.110	8.690
Cognitive Apprenticeship Strategy	13.350[a]	.343	12.675	14.024
Critical Exploration Strategy	13.225[a]	.346	12.545	13.906

Table 4.2 shows that the mean score of participants exposed to cognitive apprenticeship strategy is higher than those of the critical exploration strategy and the conventional strategy group. Also, the mean score of participants exposed to critical exploration strategy is higher than that of the conventional strategy group. This is shown in Figure 4.10.

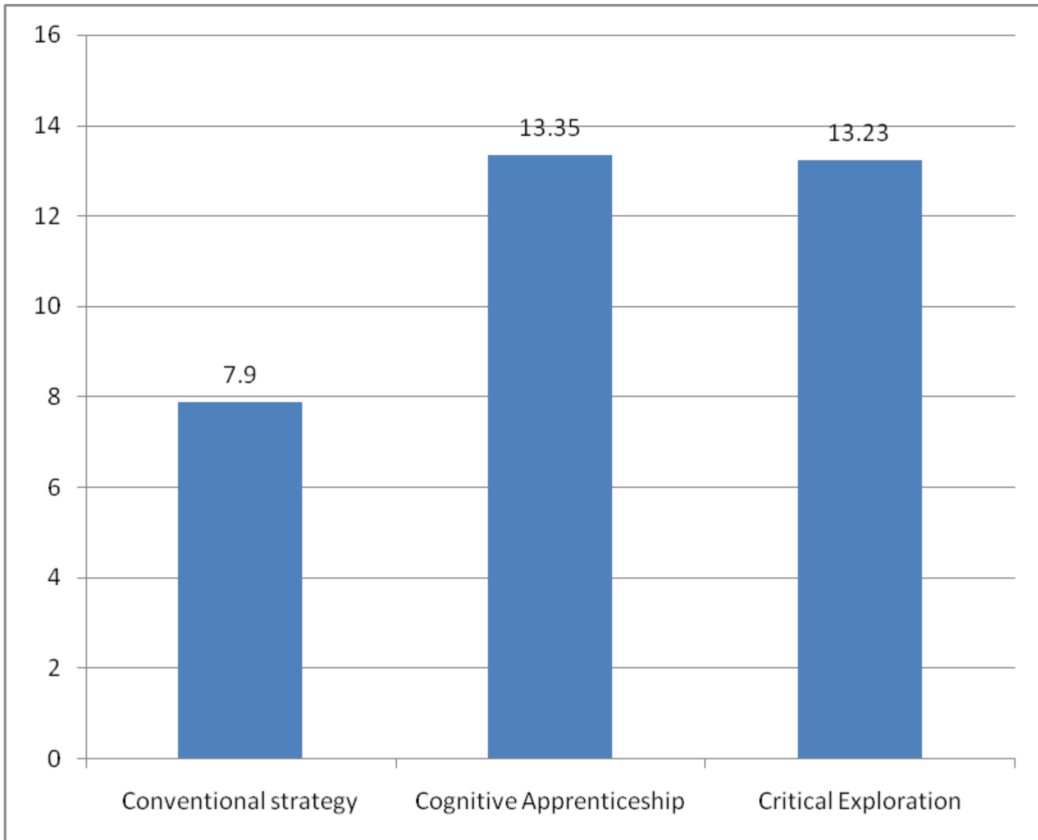

Figure 4.10: Bar Chart showing Estimated Marginal Mean according to Treatment and control.

Figure 4.10 shows that the mean score of participants exposed to cognitive apprenticeship strategy was 13.35, those of the critical exploration strategy was 13.23, and the conventional strategy group had the mean score of 7.90. Also, the mean score of participants exposed to cognitive apprenticeship strategy was higher than those of the critical exploration and conventional strategy groups. The Duncan post hoc analysis was conducted on the posttest mean and the result is presented in Table 4.6.

Table 4.6: Duncan Post Hoc Analysis According to Treatment Group

Treatment	N	Mean	Treatment		
			1. Cognitive Apprenticeship Strategy	2. Critical Exploration Strategy	3 Conventional Strategy
1. Cognitive Apprenticeship Strategy	90	13.350		*	*
2. Critical Exploration Strategy	90	13.225	*		*
3. Conventional Strategy	90	7.900	*	*	

*Pairs of group significantly different at P<.05.

The mean score of participants exposed to cognitive apprenticeship strategy is significantly higher than those of the critical exploration strategy and the conventional strategy groups. Also, the mean score of participants exposed to critical exploration strategy is significantly higher than that of the conventional strategy group Therefore, the researcher concluded that cognitive apprenticeship strategy is the best among the three strategies used in enhancing achievement in Basic Science.

4.2. 1b Ho1b: There is no significant main effect of treatment on students' Attitude to Basic science

Table 4.7: 3x2x2 ANCOVA Showing the Summary of Post-Test Attitude to Basic Science among Students by Treatment, Gender and Parental Support.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5879.050[a]	12	489.921	1765.322	.000	.988
Intercept	19415.670	1	19415.670	69960.108	.000	.996
Pre-attitude	5617.240	1	5617.240	20240.493	.000	.987
Treatment	1.995	2	.997	3.594	.029	.027
Gender	.701	1	.701	2.525	.113	.010
Parental supportiveness	.487	1	.487	1.756	.186	.007
treatment * gender	1.939	2	.970	3.494	.032	.026
treatment * parentalsupp	.692	2	.346	1.247	.289	.010
gender * parentalsupp	.448	1	.448	1.615	.205	.006
treatment*gender*parentalsupp	.706	2	.353	1.272	.282	.010
Error	71.324	257	.278			
Total	380555.000	270				
Corrected Total	5950.374	269				

R Squared= .988 (Adjusted R Squared=) * Significant at P<0.05

Table 4.7 shows a significant main effect of treatment on attitude to Basic Science among the students ($F(_{2,257})$ = 3.594; P<0.05, $\tilde{\eta}^2$ = 0.027). The effect size is 2.7%.This means that there is difference in the means of treatments in attitude to Basic Science. Hence Ho1b was rejected. To determine the source of the observed significant differences as indicated in the ANCOVA, The

Estimated Marginal Mean was carried out on the mean scores of the groups, this is presented in Table 4.8.

Table 4.8: Estimated Marginal Mean of Post-test Attitude scores According to Treatment and control Group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Conventional Strategy	35.201[a]	.085	35.033	35.369
Cognitive Apprenticeship Strategy	37.444[a]	.070	37.307	37.582
Critical Exploration Strategy	37.209[a]	.073	37.065	37.352

Table 4.8 shows that the mean score of participants exposed to Cognitive Apprenticeship Strategy had the highest adjusted mean Attitude scores ($\bar{x}$=37.444), followed by Critical Exploration Strategy treatment Group ($\bar{x}$=37.205), while students in Conventional group had the least adjusted mean Attitude scores ($\bar{x}$==35.201).This is displayed in Figure 4.11:

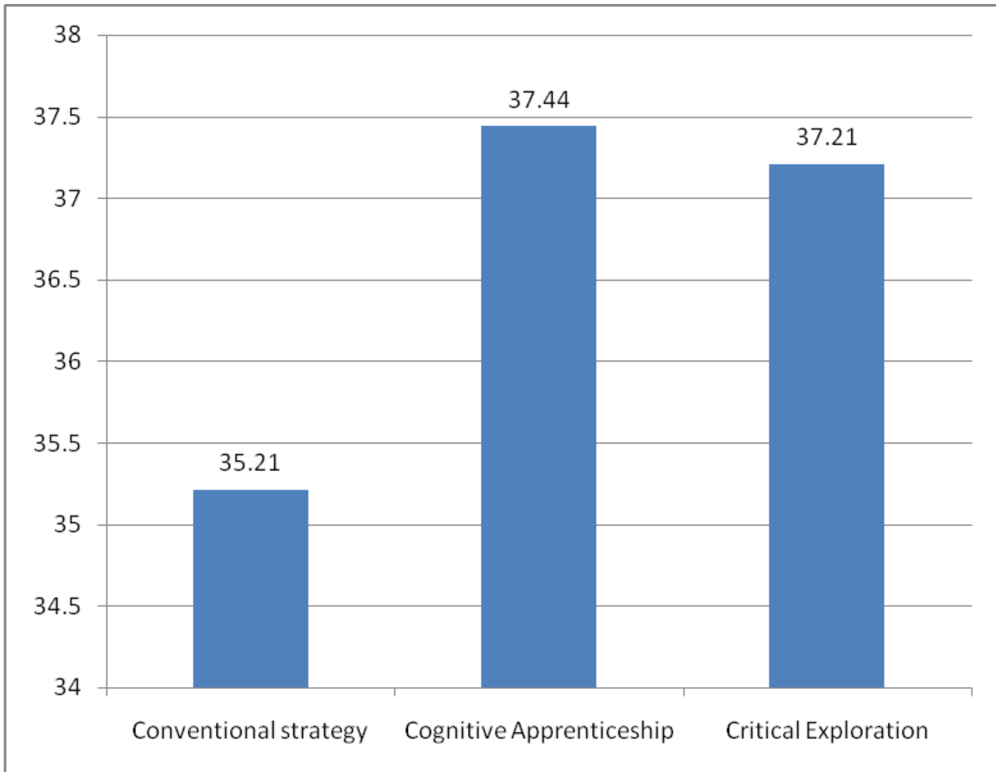

Figure 4.11: Bar chart showing estimated marginal means of Posttest Attitude scores according to gender and control group.

Figure 4.11 shows that the mean score of participants exposed to cognitive apprenticeship strategy was 37.444, Critical Exploration Strategy treatment Group had 37.205, while students in Conventional group had 35.201 than the one in the Conventional Strategy group. The Duncan post hoc analysis was conducted on the posttest mean and the result is presented in Table 4.9.

Table 4.9: Duncan Post Hoc Analysis According to Treatment

Treatment	N	Mean	Treatment		
			1. Cognitive Apprenticeship Strategy	2. Critical Exploration Strategy	3 Conventional Strategy
1. Cognitive Apprenticeship Strategy	90	37.444			*
2. Critical Exploration Strategy	90	37.209			*
3. Conventional Strategy	90	35.201	*	*	

*Pairs of group significantly different at P.05

Table 4.9 shows that the mean score of participants exposed to cognitive apprenticeship strategy was significantly better than the scores under critical exploration strategy, while critical exploration strategy was better than conventional strategy in the mean attitude scores. This revealed that the direction of increasing effect of instructional strategy (treatment) on Basic Science attitude was that conventional strategy did not work better than critical exploration strategy, while cognitive apprenticeship strategy worked slightly (37.4/ 37.2) better than critical exploration strategy. The Duncan post hoc analysis was conducted on the posttest mean and the result is presented in Table 4.10.

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 3x2x2ANCOVA Post-Test Science Process Skills in Basic Science among Students by Treatment, Gender and Parental Support

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	220.322[a]	12	18.360	1.452	.143	.064
Intercept	5670.636	1	5670.636	448.530	.000	.636
Process skills	11.775	1	11.775	.931	.335	.004
Treatment	84.766	2	42.383	3.352	.037	.025
Gender	17.844	1	17.844	1.411	.236	.005
Parental supportiveness	16.312	1	16.312	1.290	.257	.005
treatment * gender	2.984	2	1.492	.118	.889	.001
treatment* parentalsupp	1.163	2	.581	.046	.955	.000
gender * parentalsupp	.472	1	.472	.037	.847	.000
treatment*gender*parentalsupp	24.765	2	12.382	.979	.377	.008
Error	3249.174	257	12.643			
Total	116978.000	270				
Corrected Total	342169.496	269				

R Squared=.064 (Adjusted R Squared=) *Significant of P<0.05

Table 4.10 shows a significant main effect of treatment of science process skills in Basic Science among the students ($F_{(2,257)} = 3.352$; $P<0.05$, $\tilde{\eta}^2 = 0.025$).The effect size is 2.5%. This means that there is difference in the means of treatment in science process skills in Basic Science among participants in the conventional, cognitive apprenticeship and critical exploration teaching strategies. Hence, hypothesis one(c) was not confirmed statistically. To determine the actual source of the observed significant differences as indicated in the ANCOVA, Estimated

Marginal Mean analysis was carried out on the mean scores of the groups, this is presented in Table 4.11.

Table 4.11. Estimated Marginal Mean analysis of Post-test Science Process Skills According to Treatment and control

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Conventional Strategy	19.528	.576	18.394	20.661
Cognitive Apprenticeship Strategy	21.280	.472	20.352	22.209
Critical Exploration Strategy	19.904	.494	18.932	20.876

Table 4.11 shows that the mean score of participants exposed to cognitive apprenticeship strategy is higher than those of the critical exploration and conventional strategy groups. Also, the mean scores of participants exposed to critical exploration strategy and conventional strategy are almost the same. This is represented in Figure 4.12:

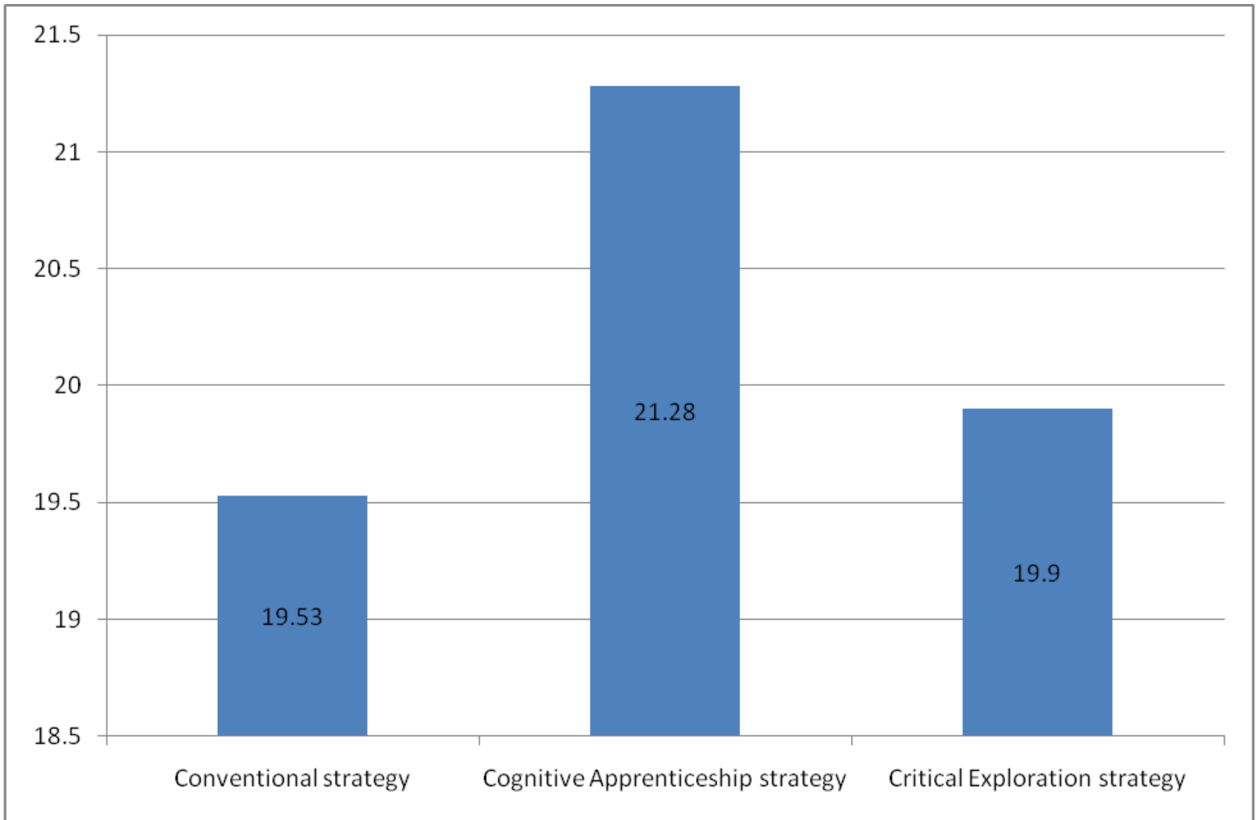

Figure 4.12: Bar chart showing estimated marginal means of science process skills according to treatment and gender

The Duncan post hoc analysis was carried out and it is presented in Table 4.12.

Table 4.12: Duncan Post Hoc Analysis Posttest Science Process Skills According to Treatment Group

Treatment	N	$\bar{x}$	Treatment		
			1. Cognitive Apprenticeship Strategy	2. Critical Exploration Strategy	3 Conventional Strategy
1. Cognitive Apprenticeship Strategy	90	21.280[a]		*	*
2. Critical Exploration Strategy	90	19.904[a]	*		*
3. Conventional Strategy	90	19.904[a]	*	*	

*Pairs of group significantly different at P< 0.05

The result from Duncan analysis in Table 4.12 shows that group 1 (Cognitive apprenticeship strategy) was significantly different from critical exploration strategy and conventional strategy in their science process skills' scores. Critical exploration strategy and conventional strategy were not significantly different from each other in science process skills. These show that the direction of increasing effect of instructional strategy (treatment) on Science process skills was: Conventional strategy not working better than critical exploration, while cognitive apprenticeship strategy worked better than critical exploration strategy

Main effect of Parental support

4.2.2a Ho2a: There is no significant main effect of parental support on students' achievement in Basic science.

The results from Table 4.4 showed that there is no significant main effect of parental support on students' achievement in Basic Science (F $_{(1,257)}$ = 0.023; P>0.05, $\tilde{\eta}^2$ = 0.000). This means that there is no significant main effect of Parental support on students' achievement in Basic Science among participants. Hence, Ho2a was not rejected. Table 4.13 is presented as:

Table 4.13 : Estimated Marginal Mean analysis of Post-Test Achievement scores According to Parental support

Parent supportiveness	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
LOW	11.460[a]	.380	10.712	12.209
HIGH	11.523[a]	.166	11.195	11.851

Table 4.13 shows that the mean score of participants in high Parental support ($\bar{x}$=11.523) is higher than those of the low Parental support ($\bar{x}$=11.46) groups: Also, the mean scores of participants exposed to high and low parental support are almost the same. Hence, the difference in their mean scores was not significant.

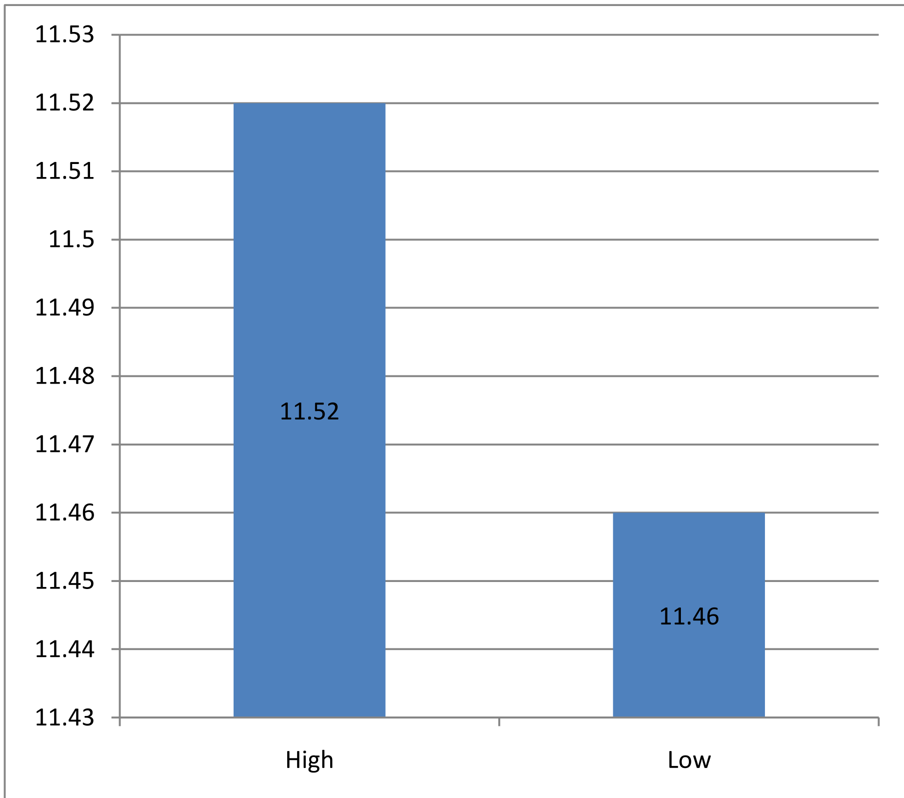

Figure 4.13: Bar chart showing posttest achievement scores according to Parental Support

Figure 4.13 shows that the mean score of participants with high parental support was 11.52, that of participants with low parental support were 11.46, but the difference in their mean scores was not significant.

4.2.2b Ho2b: There is no significant main effect of parental support on students' attitude to Basic Science

The results from Table 4.7 showed that there was no significant main effect of parental support on students' attitude to Basic Science ($F(_{1,257})$ = 1.756; P>0.05, $\tilde{\eta}^2$ = 0.007). The effect size of .7% is too small to be considered significant. This means that there was no significant main effect of parental support on students' attitude to Basic Science among participants. Hence, Ho2b was not rejected.

Table 4.14 is presented as:

Table 4.14: Estimated Marginal Mean analysis of Post-Test Attitude scores According to Parent Support.

Parental support	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
LOW	37.343	.081	37.184	37.502
HIGH	37.226	.035	37.156	37.296

Table 4.14 shows that the mean score of participants in low parental support ($\bar{x}$=37.343) is higher than those in high parental support ($\bar{x}$=37.226) groups. Also, the mean score of participants in the two groups are almost the same. Hence, the difference in their mean scores was not significant.

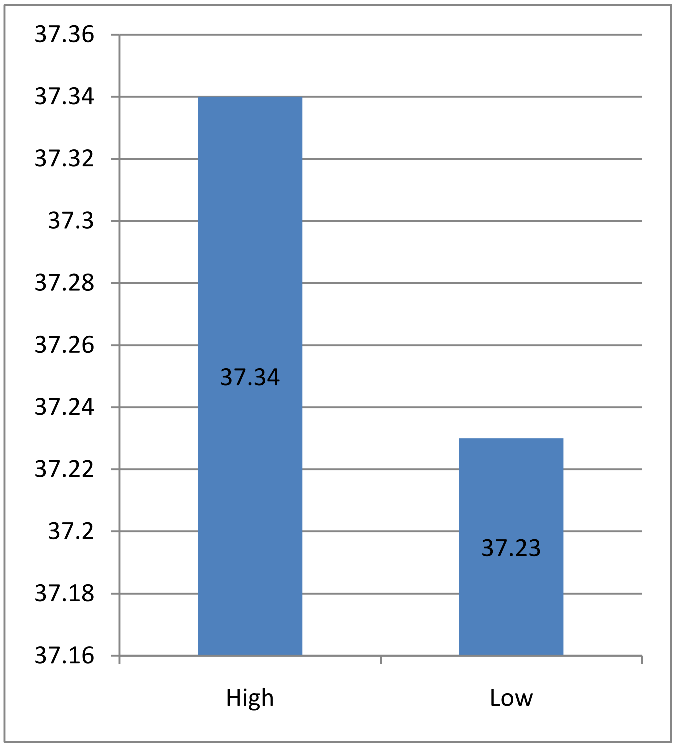

Figure 4.14: Bar chart showing estimated marginal mean of posttest attitude scores according to Parental Supportiveness

Figure 4.14 shows that the mean score of participants with low parental support was 37.343, that of participants with high parental support were 37.226, but the difference in their mean scores was not significant.

4.2.2c Ho2c: There is no significant main effect of parental support on students' science process skills in Basic Science.

The results from Table 4.10 shows that there is no significant main effect of parental supportiveness on students' science process skills in Basic Science ($F_{1,257}$ = 1.290; P>0.05, $\tilde{\eta}^2$ = 0.005). The effect size of .5% is too small to be considered significant. This means that there is no significant main effect of parental support on students' science process skills in Basic Science. Hence, Ho2c was not rejected.

Table 4.15 is presented as:

Table 4.15: Estimated Marginal Mean analysis of Post-Test Science process skills scores According to Parent support

Parent support	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
LOW	19.898	.546	18.822	20.974
HIGH	20.577	.239	20.106	21.047

Table 4.15 shows that the mean score of participants with high Parental support (20.577) is higher than those of with low parental support (19.898). Also, the mean difference score of participants exposed to high and low parental support was not significant.

Main effect of gender

4.2.3a Ho3a: There is no significant main effect of gender on students' achievement in Basic Science.

The results from Table 4.4 shows that there is no significant main effect of gender on students' achievement in Basic Science ($F_{(1,257)}$ = 2.478; P>0.05, $\tilde{\eta}^2$ = 0.010).The effect size of .1% is too small to be considered significant. This means that there is no significant main effect of gender on students' achievement in Basic Science among male and female participants. Hence, Ho3a was not rejected.

Table 4.16 is presented as:

Table 4.16: Estimated Marginal Mean analysis of Post-Test Achievement scores According to Gender

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	11.166	.292	10.592	11.740
Female	11.818	.294	11.238	12.397

Table 4.16 shows that the mean score of participants in the female group is higher than those of the male group. Also, the mean difference score of participants exposed to both male and female was not significant.

4.2.3b Ho3b: There is no significant main effect of gender on students' attitude to Basic Science

The results from Table 4.7 showed that there is no significant main effect of gender on students' attitude to Basic Science ($F_{1,257}$ = 2.525; P>0.05, $\tilde{\eta}^2$ = 0.010).This means that there is no significant main effect of gender on students' attitude to Basic Science among male and female participants. Hence, Ho3b was not rejected.

Table 4.17: Estimated Marginal Mean analysis of Post-Test Attitude scores According to Gender

GENDER	Gender Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
MALE	37.355	.062	37.232	37.477
FEMALE	37.215	.062	37.092	37.338

Table 4.17 showed that the mean score of male participants ($\bar{x}$=37.355) is higher than that of the female ($\bar{x}$=37.215) group. Also, the mean difference score of participants exposed to both male and female was not significant.

4.2.3c Ho3c: There is no significant main effect of gender on students' science process skills in Basic Science.

The results from Table 4.10 shows that there is no significant main effect of gender on students' science process skills in Basic Science ($F_{(1,257)} = 1.411$; $P>0.05$, $\tilde{\eta}^2 = 0.005$). The effect size of .5% is too small to be considered significant. This means that there is no significant main effect of gender on students' science process skills in Basic Science among male and female participants. Hence, Ho3c was not rejected.

Table 4.18: Estimated Marginal Mean analysis of Post-Test Science Process Skills scores According to Gender

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	19.885	.419	19.060	20.709
Female	20.590	.422	19.759	21.421

Table 4.18 shows that the mean score of female participants ($\bar{x}$ = 20.590) is higher than that of the male ($\bar{x}$ = 19.885) group. Also, the mean difference score of participants exposed to both male and female was not significant.

Interaction effects of treatment and parental support

4.2 4a Ho4a: There is no significant interaction effect of treatment and parental support on students' achievement in Basic science.

The results from Table 4.4 shows that there is no significant interaction effect of treatment and parental support on students' achievement in Basic Science ($F_{(2,257)}$ = 0.418; P>0.05, $\tilde{\eta}^2$ = 0.003). The effect size of .3% is too small to be considered significant. This means that there is no significant interaction effect of treatment and parental support on students' achievement in Basic Science. The effect size of 0.3% was negligible. Hence, Ho4a was not rejected.

4.2.4b Ho4b: There is no significant interaction effect of treatment and parental support on students' attitude to Basic Science.

The results from Table 4.7 shows that there is no significant interaction effect of treatment and parental supportiveness on students' attitude to Basic Science (F$(_{2,257})$ = 1.247; P>0.05, $\tilde{\eta}^2$ = 0.010). The effect size of .1% is too small to be considered significant. This means that there is no significant interaction effect of treatment and parental support on students' attitude to Basic Science among participants. The effect size of 0.1% was negligible. Hence, Ho4b was not rejected.

4.2.4c Ho4c: There is no significant interaction effect of treatment and parental support on students' science process skills in Basic Science.

The results from Table 4.10 shows that there is no significant interaction effect of treatment and parental support on students' science process skills in Basic Science ($F_{2,257}$ = 0.046; P>0.05, $\tilde{\eta}^2$ = 0.000).This means that there is no significant interaction effect of treatment and parental support on students' science process skills in Basic Science among participants. Hence, Ho4c was not rejected.

Interaction of treatment and gender

4.2. 5a Ho5a: There is no significant interaction effect of treatment and gender on students' achievement in Basic Science.

The results from Table 4.4 shows that there is no significant interaction effect of treatment and gender on students' achievement in Basic Science (F $(_{2,257})$ = 0.056; P>0.05, $\tilde{\eta}^2$ = 0.000). This means that there is no significant interaction effect of treatment and gender on students' achievement in Basic Science among participants Hence, Ho5a was not rejected.

4.2.5b Ho 5b: There is no significant interaction effect of treatment and gender on students' attitude to Basic Science.

The results from Table 4.7 shows that there is significant interaction effect of treatment and gender on students' attitude to Basic Science ($F_{(2,257)} = 3.494$; $P<0.05$, $\tilde{\eta}^2 = 0.026$). The effect size of 2.6% was negligible. Hence, H0 5b was not rejected. This means that there is significant interaction effect of treatment and gender on students' attitude to Basic Science among participants. The magnitude of the significant interaction effect is presented in descending order of magnitude: Cognitive Apprenticeship on male students ($\bar{x}$ = 37.672), followed by Cognitive Apprenticeship on female students ($\bar{x}$ = 37.217),followed by Conventional strategy on female students ($\bar{x}$ = 37.215), followed by Critical Exploration on female students ($\bar{x}$ = 37.212),followed by Exploration on male students ($\bar{x}$ = 37.205), and followed by Conventional strategy on male students ($\bar{x}$ = 37.187). This is displayed in figure 4.15.

Figure 4.15 shows the graphical presentation of the magnitude of interaction effect of Treatment and Gender.

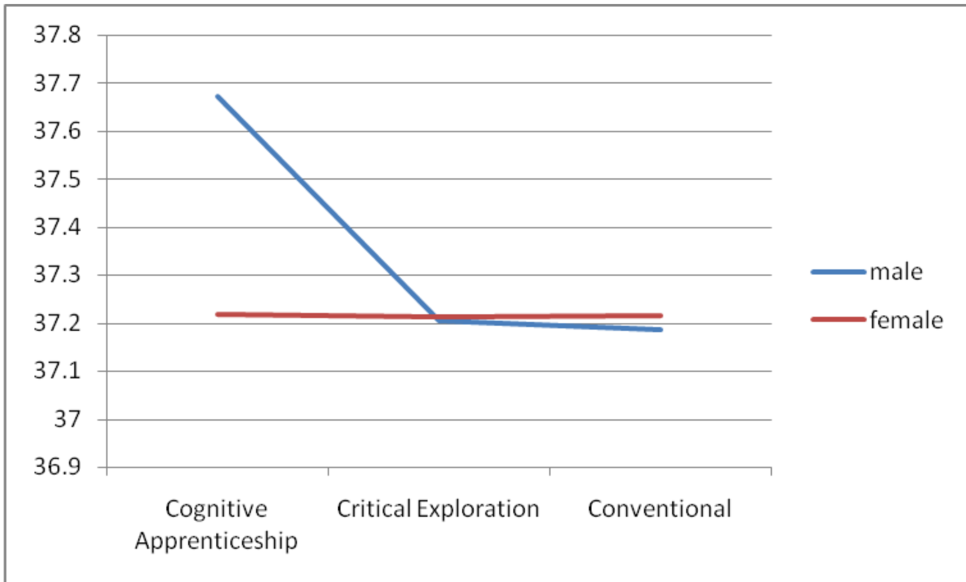

Figure 4.15: Graphical presentation of the magnitude of interaction effect of Treatment and Gender. Source: Researcher.

Figure 4.15 reveals the graphical presentation of the magnitude of interaction effect of Treatment and Gender. The graph is disordinal, showing that the significant effect of Treatment and Gender are inseparable.

4.2.5c Ho5c: There is no significant interaction effect of treatment and gender on students' science process skills in Basic Science.

The results from Table 4.10 showed that there is no significant interaction effect of treatment and gender on students' science process skills in Basic Science ($F_{(2,257)}$ = 0.118; P>0.05, $\tilde{\eta}^2$ = 0.001). The effect size of 0.1% was negligible. This means that there is no significant interaction effect of treatment and gender on students' science process skills in Basic Science. Hence, Ho5c was not rejected.

Interaction effects of parental support and gender

4.2.6a Ho6a: There is no significant interaction effect of gender and parental support on students' achievement in Basic Science.

The results from Table 4.4 shows that there is no significant interaction effect of gender and parental support on students' achievement in Basic Science ($F_{(2,257)} = 0.004$; $P>0.05$, $\tilde{\eta}^2 = 0.000$). This means that there is no significant interaction effect of gender and parental support on students' achievement in Basic Science. Hence, Ho6a was not rejected.

4.2.6b Ho6b: There is no significant interaction effect of gender and parental support on students' attitude to Basic Science.

The results from Table 4.7 shows that there is no significant interaction effect of gender and parental support on students' attitude to Basic Science ($F_{(2,257)} = 1.616$; $P>0.05$, $\tilde{\eta}^2 = 0.000$).This means that there is no significant interaction effect of gender and parental support on students' attitude to Basic Science. Hence, Ho6b was not rejected.

4.2 6c Ho6c: There is no significant interaction effect of gender and parental support on students' science process skills in Basic Science.

The results from Table 4.10 shows that there is no significant interaction effect of gender and parental support on students' science process skills in Basic Science ($F_{(1,257)} = 0.037$; $P>0.05$, $\tilde{\eta}^2 = 0.000$).This means that there is no significant interaction effect of gender and parental support on students' science process skills in Basic Science. Hence, Ho6c was not rejected.

Interaction effects of treatment, parental support and gender

4.2.7a Ho7a: There is no significant interaction effect of treatment, gender and parental support on students' achievement in Basic Science.

The results from Table 4.4 shows that there is no significant interaction effect of treatment, gender and parental support on students' achievement in Basic Science ($F_{(2,257)}$ = 1.321; P>0.05, $\tilde{\eta}^2$ = 0.010).The effect size of .1% was negligible; this means that there is no significant interaction effect of treatment, gender and parental support on students' achievement in Basic Science. Hence, Ho7a was not rejected.

4.2.7b Ho7b: There is no significant interaction effect of treatment, gender and parental support on students' attitude to Basic Science.

The results from Table 4.7 shows that there is no significant interaction effect of treatment, gender and parental support on students' attitude to Basic Science ($F_{(2,257)}$ = 1.272; P>0.05, $\tilde{\eta}^2$ = 0.010).The effect size of .1% was negligible; this means that there is no significant interaction effect of treatment, gender and parental support on students' attitude to Basic Science. Hence, Ho7c was not rejected.

4.2.7c Ho7c: There is no significant interaction effect of treatment, gender and parental support on students' science process skills in Basic science.

The results from Table 4.10 shows that there is no significant interaction effect of treatment, gender and parental support on students' science process skills in Basic Science ($F_{(1,257)}$ = 0.979; P>0.05, $\tilde{\eta}^2$ = 0.008). The effect size of .8% was negligible; this means that there is no significant interaction effect of treatment, gender and parental support on students' science process skills in Basic Science Hence, Ho7c was not rejected.

4.3 Discussion

4.3.1a Effects of Treatment on Students' Achievement in Basic Science

There was significant main effect of treatment on students' achievement in basic science (F (2,257)= 66.56; $\tilde{\eta}^2$ = .34). The students in the cognitive apprenticeship strategy group ($\bar{x}$= 13.35) performed better than those exposed to conventional strategy ($\bar{x}$= 7.90) and those in critical exploration strategy ($\bar{x}$= 13.23) also performed better than those in conventional strategy ($\bar{x}$= 7.90).

Students learn better when they are consciously involved in the teaching and learning process rather than when the teacher is more active in the teaching and learning process than the students. Vygotsky, (1978) believed that students should utilize the input of others to build or construct their own learning through collaborative experiences (Martins, 2009). Cornelius-White (2007) found that students using more learner-centred methods often performed at a higher level than those using teacher-centered method.

4.3.1b Effect of Treatment on Students' Attitude to Basic Science

Treatment had significant main effect on students' attitude to basic science (F (2,257) =3.59; $\tilde{\eta}^2$ = .03). Participants that were exposed to cognitive apprenticeship strategy had the highest adjusted mean score ($\bar{x}$= 37.44) than those that used critical exploration strategy ($\bar{x}$= 37.21) and conventional strategy ($\bar{x}$= 35.20). A students' attitude towards science is more likely to influence achievement in science than achievement influencing attitude in the sense that attitude precedes achievement (Craker, 2006). Studies have revealed the influence of methods of instruction on students' attitudes towards science (Adesoji, 2008; Gok and Silay, 2008). These studies on attitudes generally explore how attitude influences success.

4.3.1c Effect of Treatment on Students' Science Process Skills in Basic Science

Treatment had significant main effect on students' science process skills (F (2,257)= 3.35; $\tilde{\eta}^2$ =.03. Participants under the cognitive apprenticeship strategy ($\bar{x}$= 21.28) had better posttest science process skills than those under critical exploration strategy ($\bar{x}$=19.90) and conventional strategy ($\bar{x}$=19.53). Cognitive apprenticeship and Critical exploration strategies are activity-based rather than passivity, which had been proved to enhance students' science process skills. Science process skills are activity-based skills which can be acquired through training and direct experience. Gbolagade, (2009) emphasized the importance of appropriate teaching strategies in the development of both the individual and the society. Students must be exposed to situations which demand the knowledge and skills they are required to acquire and use. 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 to ensure students make the connection between science processes involved within an investigation and science content (Karen, 2009). Science process skills mean using subject content as a means for exposing students to the real processes of science.

Furthermore, constructivist teaching incorporates cooperative learning and is sometimes referred to as top-down (Slavin, 2003), where students begin with a complicated problem and solve it using basic skills and some teachers' guidance. The advantage of hands-on activities, according to Martins (2008), is that the teacher can observe how children are working within a controlled environment to evaluate their progress. The children's performance will demonstrate their proficiency in the skills employed in the process.

There were significant differences in the effect of treatment on Basic Science achievement, attitudes and science process skills of students exposed to Cognitive apprenticeship strategy, Critical exploration strategy and conventional strategy as shown in Table 4.4,4.7 and 4.10. The findings showed that the two treatment groups: Cognitive apprenticeship strategy and Critical exploration strategy, enhanced students' achievement, attitudes and science process skills than the conventional strategy.

The findings in this study showed that there was a significant difference in the achievement, attitude to Basic Science and science process skills of students exposed to Cognitive apprenticeship, Critical exploration and those in Conventional strategies. Students in Cognitive apprenticeship teaching treatment -group had the highest adjusted posttest mean achievement scores (13.90), followed by critical exploration teaching treatment- group (12.78), while students in the conventional teaching strategy group had the least adjusted mean achievement score (7.79).

The result obtained has shown that students learn better when they are consciously involved in the teaching and learning process rather than when the teacher is more active in the teaching and learning process than the students. The two treatment strategies are activity-based rather than passive. Cognitive apprenticeship teaching strategy has proved to be the best in enhancing students' achievement, attitude to Basic Science, and science process skills, possibly due to the nature of the strategy whereby the teacher first explains the concept before the students carry out other processes in the teaching and learning situation. Just as an apprentice first takes instruction from his teacher and follows such in the execution of an assignment, so also is this situation. The strategy is found to be better than critical exploration whereby students first think about the concept on their own before the teacher finally gives them the correct feedback. Nevertheless, this study has proved that the two treatment strategies are better than conventional strategy which often adopts lecture method in the delivery of academic content.

This result corroborated the findings on educational curriculum for secondary schools in Malaysia by the Ministry of Education, Malaysia (2002), Duckworth, (2006), Ogbonna (2007) as well as Agommuoh and Ifeanacho (2013), who found and remarked that cognitive apprenticeship and critical exploration teaching strategies are effective in improving students' academic achievement. The result further strengthened the position of Ajayi (2001), (Madu (2004) and Ogundare (2008), who vehemently opposed the lecture-based instruction which they referred to as teacher-centred and full of passive acquisition of knowledge by students who do not have conceptual understanding but memorize the learning content. The finding does not agree with that of Brenda and Robert (2003), who found and argued that the conventional lecture method could not be totally ignored.

4.3.2. Effects of gender on students' academic achievement, attitude to Basic Science and science process skills.

The result obtained in this study revealed that there was no significant main effect of gender on students' academic achievement, attitude to Basic Science and science process skills. This means that gender has no significant role to play in determining students' academic achievement, attitude to Basic Science and science process skills. The current age of the participants could be responsible for this because they are still very young and do not really know what they would do for the future. They are all learning and struggling together without really knowing what the future holds for them. The homogeneous environment in which the students live, which is an agrarian community, exposed all the students to the same experience which may also have an effect on their educational programmes.

The result, whereby gender is not important, upholds the earlier findings of Ogunkola (2000), Agommuoh and Nzewi (2003), Akinbobola (2004), Ebere (2006), Ayanda (2006) Alake (2007) and Babajide (2010), who found that gender has no significant influence on students' achievement, attitude to science subjects and science process skills. These researchers discovered in their studies that there was no significant difference in students' learning outcomes of boys and girls in terms of achievement, attitude to and adoption ofscience process skills in science subjects. However, the result obtained in this study negates the submissions of Ogunleye (2002), Ogunneye (2003), Raimi (2003), Ezehora (2004), Abakaliki (2004), Ezirim (2006), Animasahun (2007) and Asoegwu, (2008), who found that gender has significant influence on students' achievement, attitude to science subjects and science process skills. They concluded that gender plays significant role in the learning outcomes of learners in favour of males.

4.3.3. Effect of parental support on students' academic achievement, attitude to Basic Science and science process skills.

The result obtained showed that there was no significant main effect of parental support on students' academic achievement, attitude to Basic Science and science process skills. This kind of result could be traced to the fact that many parents have neglected their parental roles. Many are scrambling for wealth and other social activities at the expense of consciously getting involved in their children's academic endeavours. The current situation whereby the government of the day in the state (where this study was carried out) embarks on free education programme including free uniform has made many parents to believe that they do not really have any responsibilities to carry out on their children. Hence, they fail to buy necessary text-books for them, they do not bother to monitor what their children do in school, and do not even care to motivate their children towards learning science subjects. That may be the reason that many of these students drop science subjects when they get to the senior secondary school classes. Therefore, the result obtained in this study further affirms the apathy, non-challant and care-free attitude of parents towards the academic activities of their children.

The finding therefore further strengthens the earlier findings of Onabanjo (2000), who concluded that parental support was not important in students' achievement in science subjects. However, the finding is totally opposed to Nord and West (2001), US Department of education (2000), Shiu (2002) who gave overwhelming evidence that parental support in children's education is linked to children's school success. For instance, Shiu (2002) examined parental support in Taipei and found significant relationship between parental support in their children's education and their academic achievement. Furthermore, numerous studies have shown that family, home environment and parental aspiration have great influence on students' achievement (Martin, 2000; Ezeasor, 2003).

The findings of this study negates that of Jeynes (2005) who found that parental support is the key in improving academic achievement of children. Parental support, according to Jeynes (2005) determines how well children do in school. Yaya (2010) added that children from broken homes and unstable marriage relations perform poorly in school, possibly because of lack of adequate parental support However, the result obtained here really show that majority of the parents of these students are either not serious or have totally shifted the responsibilities of their children's education on the government which is practicing free education in the state. This might be the reason for insignificance of parental supportiveness found in this study.

4.3.4. Interaction effect of treatment and gender on students' academic achievement in Basic Science.

There was no significant interaction effect of treatment and gender on students' academic achievement in Basic Science. However, there was significant interaction effect of treatment and gender on students' attitude to Basic Science, but no significant interaction effect of treatment and gender on science process -skills. The study has revealed that gender has no specific role to play to enhance the effectiveness of the two treatment strategies. This means that the strategies are strong enough to enhance the academic achievement of any kinds of students regardless of gender.

This result further strengthens the earlier findings of Akinbobola (2004) and Alake (2007), who discovered that there was no significant difference in students' learning outcomes of boys and girls in terms of parental support in and attitude to science subjects. However, the significant interaction effect of treatment and gender on students' attitude to Basic Science means that gender role cannot be ignored as far as students' attitude to Basic Science is concerned. In other words, the two treatment strategies: Cognitive apprenticeship and Critical exploration, allow for healthy competition of gender, and these competitive roles further enhance the effectiveness of the two strategies. This result disagreed with the findings of Abakaliki (2004) and Ezirim (2006), who found significant effect of gender on students' attitude to science. Furthermore, no significant interaction effect of treatment and gender was found on science process -skills. This means that the two treatment strategies are strong enough to have effects on students' science process -skills without any special consideration for gender. This result also buttressed the earlier submissions of Ogunkola (2000), Agommuoh and Nzewi (2003), who concluded that gender was not important in students' science process -skills.

4.3.5. Interaction effect of treatment and parental support on students' academic achievement in Basic Science, attitude to Basic Science and science process skills

There was no significant interaction effect of treatment and parental support on students' academic achievement in Basic Science, attitude to Basic Science and science process skills. The result means that irrespective of the parental status, the strategies enhanced achievement, attitude and skills.

The result upholds the findings of Onabanjo (2000), who found no significant main effect of students' parental support on students' performance in social studies. However, the result is opposed to the findings of Jeynes (2005), who concluded that parental support has a significant positive effect on children across races.

4.3.6. Interaction effect of gender and parental support on students' academic achievement, attitude to Basic Science and science process skills.

There was no significant interaction effect of gender and parental support on students' academic achievement, attitude to Basic Science and science process skills. This means that combined effect of gender and parental support do not influence academic achievement, attitude to Basic Science and science process skills. Since the government subsidized students' facilities in schools through provision of amenities such as tables, school uniform, breakfast, lunch, the treatment has relative equitable effect on both sexes and it has equitable effect on high and low parental status. This result is not surprising because the students concerned are young and exposed to the same condition in the learning process. That they have not really determined what they would do in future could possibly account for gender importance. At the same time, parents have assumed that all responsibilities about the education of the students are to be borne by the government of the day which upholds free education. Hence, there cannot be any significant interaction effect of gender and parental support on students' academic achievement, attitude to Basic Science and science process skills.

This result buttressed the earlier findings of Kratzig and Arbuthnott (2006) on non-significant interactive effect of treatment, gender and parental support on students' achievement, attitude and science process- skills. However, the result negates the submission of Adodo (2007) who observed that there was significant positive relationship between parental support and students' academic achievement.

4.3.7. Interaction effect of treatment, gender and parental support on students' academic achievement, attitude to Basic science and Science process skills.

The results in Table 4.4, 4.7 and 4.10 revealed that the three-way interaction effect of treatment, parental support and gender was not significant on students' achievement and science process- skills. This means that the potency of the two intervention strategies were strong enough to influence students' academic achievement, attitude to Basic Science and science process - skills irrespective of their gender and parental support. The treatment was equitable for both male and female participants in respect of tasks given to them during the treatment procedure. Such tasks are: students observing others performing tasks and recording what they observed, manipulating apparatus, and measuring classmates' height and weight. The tutorial group leaders also interacted effectively with the mates, thereby making the two treatments to be learner centered. This was made possible since the government has either provided or subsidized the necessary materials such as: uniforms, books, furniture, laboratory equipments and resource persons for the students, irrespective of levels of parental support. This finding could be traced to the uniqueness of the two strategies which make learning interesting and participatory, whereby students got interested and performed well without recurring to any influence of gender and parental support. This kind of revelation would be of great advantage to students who had formerly been overwhelmed with disadvantage complex about their gender or had been derived parental support because all these factors would no longer hinder them from excellent performance as long as they are exposed to Cognitive apprenticeship and Critical exploration teaching strategies.

This result upholds the earlier findings of Akinbobola, (2004) and Alake (2007) who discovered that there was no significant difference in students' learning outcomes of boys and girls in terms of process skills in and attitude to science subjects. However, it negates the submission of Asoegwu (2008) who concluded that the interaction effect of gender makes necessary contribution to the achievement of learners in Basic Science.

4.4 Summary of findings

The findings in this study are summarized thus:

1. There was significant main effect of treatment on students' achievement, attitude to Basic Science and science process skills. Cognitive apprenticeship strategy is more effective in enhancing students' academic achievement, attitude to Basic Science and science process skills than critical exploration and conventional strategies.

2. There was no significant main effect of parental support on students' academic achievement, attitude to Basic Science and science process skills.

3. There was no significant main effect of gender on students' academic achievement, attitude to Basic Science and science process skills.

4. There was no significant interaction effect of treatment and parental support on students' academic achievement in Basic Science, attitude to Basic science and science process skills.

5. There was no significant interaction effect of treatment and gender on students' academic achievement in Basic Science. However, there was significant interaction effect of treatment and gender on students' attitude to Basic Science, but no significant interaction effect of treatment and gender on science process skills.

6. There was no significant interaction effect of gender and parental support on students' academic achievement, attitude to Basic Science and science process skills.

7. There was no significant interaction effect of treatment, gender and parental support on students' academic achievement, attitude to Basic Science and science process skills.

CHAPTER FIVE

5.0: SUMMARY, EDUCATIONAL IMPLICATIONS, RECOMMENDATIONS AND CONCLUSION

5.1 Summary

This study, investigated the effects of Cognitive apprenticeship and Critical exploration strategies on students' achievement, attitude to and science process skills in Basic science. It also investigated the moderating effects of gender and parental supportiveness of students on learning outcomes in Basic Science. The research design adopted was pretest-posttest control group, quasi-experimental design using 3x2x2 factorial matrix. Two hundred and seventy Basic Science students (133 Males and 137 Females) in JSS II from nine intact classes participated for the study. Four Basic Science topics were used in the study. They were: (i) Living things, (ii) Changes in matter, (iii) Changes in living things and (iv) Changes in non-living things. Seven hypotheses were tested at 0.05 level of significance.

Eight instruments were used to collect data for the study. They are:

i.Basic Science Students' Achievement Test(BSSAT)

ii. Students' Basic Science Attitude Scale (SBSAS)

iii. Students' Basic Science Process Skills Scale (SBSPSS)

iv. Parental Support Scale (PSS)

v. Teachers' Instructional Guide on Cognitive Apprenticeship Strategy (TIGCAS)

vi. Teachers' Instructional Guide on Critical Exploration Strategy (TIGCES)

vii. Teachers' Instructional Guide on Conventional Strategy (TIGCS)

viii. Evaluation Sheet for Research Assistant Performance during Training (ESARAP)on:-

(a)Cognitive Apprenticeship Strategy.

(b) Critical Exploration Strategy.

(c) Conventional Strategy.

The findings of the study revealed that:

1. There was significant main effect of treatment on students' achievement, attitude to Basic Science and science process skills. Cognitive apprenticeship strategy was more effective in enhancing students' academic achievement, attitude to Basic Science and science process skills than critical exploration and conventional strategies.

2. There was no significant main effect of parental support on students' academic achievement, attitude to Basic Science and science process skills.

3. There was no significant main effect of gender on students' academic achievement, attitude to Basic Science and science process skills.

4. There was no significant interaction effect of treatment and parental support on students' academic achievement in Basic Science, attitude to Basic science and science process skills.

5. There was no significant interaction effect of treatment and gender on students' academic achievement in Basic Science. However, there was significant interaction effect of treatment and gender on students' attitude to Basic Science, but no significant interaction effect of treatment and gender on science process skills.

6. There was no significant interaction effect of gender and parental support on students' academic achievement, attitude to Basic Science and science process skills.

7. There was no significant interaction effect of treatment, gender and parental support on students' academic achievement, attitude to Basic Science and science process skills.

5.2 Educational Implications

The exposure of learners to Cognitive Apprenticeship and Critical Exploration Strategies has been found to positively affect the learning outcomes of students' Basic science achievement, attitudes and science process skills. Findings have therefore revealed the importance of using teaching strategies that are participatory and learner- centred where learners are trained to control and direct their learning processes effectively. The general educational slogan which says "I forget what I hear, I remember what I see, I often do what I have participated in" is important here. The era of teacher-centred activities in delivering academic content is gone; learners learn better when they take active part in the learning process. Also, the whole universe has become a global village with the advent of computers. Hence, Nigerian educational practices should be in line with global best practices which focus on students' active participation in learning.

Bandura social learning theory emphasizes the importance of observing and modeling the behaviours, attitudes, and emotional reactions of others. Bandura (1977) states: "Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own action to inform them what to do. Fortunately, most human behaviour is learned observationally through modeling: from observing others, one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action.''(P22). Social learning theory predicts human behaviour in terms of continuous reciprocal interaction among cognitive, behavioral, and environmental influences.

Bandura' theory improves upon the strictly behavioraul interpretation of modeling provided by Miller and Dollard (1941). Bandura's work is related to the theories of Vygotsky and Lavy, which also emphasize the central role of social learning as utilized in this research.

This theory, combined with cognitive apprenticeship strategy, and considering the parent support and the gender of the students involved, one can obtain the following results:

1. The highest level of observational learning will be achieved by first organizing and rehearsing the modeled behaviour symbolically and then enacting it overtly. Coding modeled behaviuor into words, labels or images results in better retention than simply observing.

2. Individuals will adopt a modeled behaviour if it results in outcomes they value.

3. Individuals will adopt a modeled behaviour if the model is similar to the observer has admired status and it has functional value which can improve level of performance.

Students perform better in 'changes in non-living things' using Cognitive apprenticeship strategy than other concepts used in the study. This was because students' task performance involved minds-on, hands –on activities, in accordance with National Research Council, (2007), which asserted that a systematic study of the universe in the form of integrated science cannot but involve the active participation of learner if he is to acquire necessary skills that will make him function in the scientifically and technologically oriented world. Also, in Critical exploration strategy students performed better in 'changes in matter', as observed by Minner, Levy and Centuary (2010), where students used almost all of their senses and learning became more permanent and hands-on activities got them to acquire experiences.

5.3 Conclusion

The study has shown that Cognitive apprenticeship and Critical exploration teaching strategies were more effective in improving the students' achievement, attitude to and process - skills in Basic Science than conventional teaching strategy. The study found that Cognitive apprenticeship strategy was more effective than Critical exploration teaching strategy. Hence, Critical exploration teaching strategy was more effective than the conventional teaching strategy in teaching the selected concepts in Basic Science. However, Cognitive apprenticeship strategy and critical exploration teaching strategies can be used to foster the learning of selected concepts in Basic Science, irrespective of gender and parental supportiveness.

The strategies encouraged students to take control of their learning (as they are learner-centred strategies) thus making students think critically when compared with traditional conventional teaching method which emphasized teacher-activity over pupil involvement. The right selection and appropriate use of instructional strategies therefore, may result in better achievement and favourable attitude and skills on the part of the learners.

5.4 Recommendations

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

1. In order to improve students' performance in Basic Science, Cognitive apprenticeship and Critical exploration teaching strategies are recommended to secondary school Basic Science teachers for teaching the subject in Nigerian Secondary Schools.

2. Teaching strategies, such as cognitive apprenticeship and critical exploration strategies that reduce their gender differences in living and non-living things' achievement, its attitude and process skills as recorded in this research, could be used as a basis for reducing anxiety in learning for both male and female students.

3. Teachers should facilitate the use of Cognitive apprenticeship and Critical exploration teaching strategies in schools to enhance positive attitude of students towards Basic Science. This will also improve their skills and achievement in the subject and engage students in meaningful and quality classroom activities which can foster or enhance learning of Basic Science.

4. Teachers should develop activities that will allow active students' participation in the teaching and learning of Basic Science. These are activities in which students concentrate, experience enjoyment and are provided with immediate intrinsic satisfaction that builds a foundation of interest for the future.

5. Students should be allowed to use their skills with all instructional resources in Basic Science classroom instructions in order for students to yield positive attitude towards Basic Science. Cognitive apprenticeship and Critical exploration strategies (which give a multi-sensory instruction) should be embraced by teachers and curriculum planners as better strategies compared to the teacher- centred conventional strategy.

6. There is need for training of pre-service Basic Science teachers on the effective use of Cognitive apprenticeship and Critical exploration teaching strategies.

7. Systematic ways in which practicing teachers and would-be teachers can be trained in the use of cognitive apprenticeship and critical exploration strategies should be integrated into the Basic Science curriculum.

8. Finally, 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 Cognitive apprenticeship and Critical exploration teaching strategies in the teaching of Basic Science.

5.5 Limitations of the study

Some constraints were encountered in the process of carrying out this study and they limited the generalizability of the results. These constraints are stated as follows:

The study was conducted in only nine junior secondary schools in three local government areas of Osun state (Iwo, Ayedire and Olaoluwa). Therefore, future researchers need to replicate this study using larger population in Osun state. Also, only four selected concepts in Basic Science were used for the study. Future researchers should use more concepts related to this area.

Only a few Basic Science teachers were employed by the government of Osun state. Other Basic Science teachers are National Youth Service Corps members. This seriously impeded the teaching and learning of Basic Science. Some principals were not favourably disposed to giving permission to conduct the study. They felt that the study would disrupt the school time- table and prevent teachers of the junior secondary schools (JSS) involved in the study to finish the scheme of work already scheduled for the session. Also, those teachers that could not be involved in the study during the normal school hour did so after the school hour. Due to active involvement of students during the lesson periods, they were not bored, but rather excited and always looked forward to more exciting lessons. This was largely due to the learning strategies used by the researcher- a strategy that was learner-centered.

Parental support and gender are the moderator variables used in the study. It is however possible that many other moderator variables like mental ability, self -efficacy, self- concepts, location of school, school type, and personality traits, could limit the extent to which the result of this study could be generalized. The findings would serve as a foundation for future studies in the area of cognitive apprenticeship strategy and critical exploration strategy, and their proper utilization for effective teaching and learning of Basic Science in the junior secondary schools.

5.6 Contribution to Knowledge

1. The study has shown that students of Basic Science can learn better when exposed to Cognitive apprenticeship and Critical exploration teaching strategies.

2. The study also demonstrated that Cognitive apprenticeship is a preferred teaching strategy as far as the teaching of Basic Science is concerned.

3. Further, the study showed that parental supportiveness may be necessary where government failed to subsidize students' facilities and other basic needs for learning.

4. Also, students' achievement can be greatly enhanced through the use of the right and functional teaching strategies irrespective of gender.

5. The study would form empirical evidence for subsequent researches in Basic Science and other science related disciplines.

6. The findings of the study would also assist students to have an improved or a more positive attitude to Basic Science, improved science process skills and to a large extent, determine the achievement of students in Basic Science.

5.7 Suggestions for further study

The researcher conducted this study only in three Local Government Areas of Osun State. It could be replicated in other Local Government Areas in Osun State and more states in Nigeria in order to give room for valid generalization. The study could be replicated in schools in other geo-political zones in Nigeria, with more Local Government Areas, and more stdents.

Future studies should focus on the use of Cognitive apprenticeship and Critical exploration teaching -strategies in other subjects such as Physics, Chemistry, Biology, Agricultural science and Mathematics. It is also suggested that similar studies be conducted on other moderating variables like socio-economic status, mental ability and subject specialization.

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APPENDIX (IA)

UNIVERISTY OF IBADAN

FACULTY OF EDUCATION

DEPARTMENT OF TEACHER EDUCATION

BASIC SCIENCE STUDENT' ACHIEVEMENT TEST (BSSAT)

Introduction

The purpose of this study is to collect data on student's academic achievement in some selected concepts in Basic Science.

SECTION A

Name of School:…………………………………………………………………………

Name of Student:………………………………………………………………………...

Class:……………………………………………………………………………………..

Gender….…………………………………………………………………………………

Time allowed: One hour.

SECTION B

Instruction

Tick the best option from A-D on your answer sheet

1. An area of environment where living organisms live is a/an _______

   (a) house (b) ecology (c) habitat (d) rock

2. Aquatic organisms are characterized by

   (a)gills, arms and wings (b) webbed feet, legs and gills (c) air filled parts, fins and wings (d) fins, gills air-filled parts and webbed feet

3. Man is different from other primates because.

(a) He possesses largest brain, highly developed for thinking and speech (b) Grasp things with his hand (c) can stand upright (d) has nails and not claws.

4. Among the primate groups are

(a) rabbit, lizards, ascaris (b) toad, frogs, gorilla (c) fishes, sheep, cow (d) man, gorilla, chimpanzee

5. Human beings are from the sub-groups of mammals called

(a)aves (b) animals (c) primate (d) mammals

6. The period of rapid growth and development of secondary sexual characteristics is ___________

(a) adulthood (b) adolescence (c) childhood (d) infancy

7. In man, the developmental age of 0-2 year is_________ period

(a)childhood(b) adulthood (c) infancy (d) adolescence

8. Growth and development are not affected by one of the following factors

(a) Hereditary (b) disease (c) exercise (d) nationality

9. The following are signs of puberty in boys except (a) deep voice (b) enlarge penis (c) Facial hairs (d) matured uterus

10. Which of the following is biotic factor?

(a) Air (b) snail (c) Soil (d) stream

11. Abiotic factors includes (a) wind, light, plants, water (b) wind, light, soil, water (c) wind, light, snail, water (d) None of the above.

12. The increase in size in living organisms is referred to as_____

(a) development (b) growth (c) maturity (d) puberty

13. Biologist who study habitats are called?

(a) Zoologist (b) Botanist (c) Ecologist (d) Agriculturist

14. Hormones responsible for growth are secreted by ________ glands

(a) Adrenal and Pituitary (b) Pancreas and Adrenal (c) Thyroid and Adrenal (d) Thyroid and Pituitary

15. When matter changes from a liquid to a solid, it _______

(a) melts (b) freezes (c)evaporates (d) condenses

16. Which state(s) of matter has no definite volume and shape?

(a) gas only (b) liquid only (c) liquid and gas (d) solid only

17. Which of the following is NOT a characteristic of chemical change?

(a) it involves great heat change (b) new atoms are formed (c) new substances are formed (d) there is change in the mass of substance that undergo the change.

18. When iron rusts, the kind of change that takes place is

(a) State (b) Physical (c) Chemical (d) Mixture

19. The most suitable method of separating an insoluble solid from a liquid is _________(a) Evaporation (b) Magnetization (c) Sublimation (d) Filtration

20. Which of the following can sublime on heating? (a) Sodium chloride (b) Ammonium chloride (c) Sugar (d)Sulphur

21. All of these methods can be used to separate a soluble solid from a solution except

(a)filtration (b) evaporation (c) crystallization (d) precipitation

22. People often hang their clothes out to dry. This is an example of

(a) Freezing (b) condensation (c) sublimation (d) evaporation

23. Process of evaporation increases when liquids are exposed to

(a)expansion (b) heat (c) condensation (d) contraction

24. Matter consists of _________

(a) plants (b) water (c) particles (d) sands

25. An example of a chemical change is ___ (a) Melting of ice (b) Dissolution of salt water

(c) Rusting of Iron (d) Magnetization of blade

APPENDIX (1B)

ANSWER SHEET

BASIC SCIENCESTUDENTS' ACHIEVEMENT TEST (BSSAT)

Instruction: Tick the best option from A to D personal information (Bio Data)

Name of School:

Gender Male ( ) Female ( )

Class: J SS ____________________

S/N	A	B	C	D
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				

APPENDIX (II)

STUDENTS' BASIC SCIENCE ATTITUDE SCALE (SBSAS)

Introduction: This scale I to investigate your attitude towards Basic Science

SECTION A

Personal information (Bio Data)

Name of School:

Gender: Male ( ) Female ( )

Class: J S S ___________

Date:

SECTION B

Read the following statement carefully, and mark the correct response as it is applicable to you for each of the items. There are four options ranging from strongly Agree (SA) Agree (A) Disagree (DA) to strongly Disagree (SD)

SA - For the statement you fully agree with

A - For the statement you slightly agree with

DA - For the statement you slightly disagree with

SD - For the statement you strongly disagree with

S/N	STATEMENT	SA	S	DA	SD
1.	I always enjoy basic science class				
2.	The knowledge of basic science is relevant to everyday life				
3.	I hate basic science because we are made to accept and believe what our teacher told us in the class without testing them				
4.	The terms used in basic science made me to dislike the subject				
5.	Basic science helps to develop scientific attitude				
6.	I feel bored during basic science class because the concepts are difficult to understand.				
7.	Basic science helps to develop scientific skills.				
8.	Basic science helps to reason logically				
9.	Basic science lesson is a waste of time				
10.	I have feeling that I can read Integrated science and understand it.				
11.	Basic science lesson is not a waste of time				
12.	Basic science is interesting than any other science because it involves practical works				
13.	I dislike basic science because of the chemicals in the laboratory				
14.	I always feel happy in basic science lesson because I always participate in class activities.				
15.	Basic science involves a lot of calculation which I hate				
16.	I enjoy basic science class because I work with my hands to handle and manipulate equipment in the class				
17.	I always look forward to basic science lesson				
18.	The difficult terms used in basic science drives me away from the				

	subject				
19.	I like basic science because of the teacher that is teaching the subject				
20.	Basic science activities are interesting to perform				
21.	The teacher that is teaching basic science made me to dislike the subject				
22.	I don't like the time we do basic science in our class				
23.	Experimenting in basic science is not exciting				
24.	I don't like studying basic science in my leisure time				
25.	If basic science is not taught in school, schooling will not be interesting.				

APPENDIX III

STUDENTS' BASIC SCIENCE SKILLS RATING SCALES (SBSSRS)

Section A: Personal Data

1. Name of School:
2. Gender: Male ( ) Female ( )
3. Class:

Section B:

Instruction: Please use the following scale to rate the students' skills acquisition through observation.

Students Name	Observation						Recording						Classification						Measurement						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	

APPENDIX IV

PARENTAL SUPPORT SCALE FOR EDUCATION

This scale is a self–developed instrument specifically designed to elicit information on adolescent perceived knowledge of parental support. The instrument consist of 10- items structured in a 5-point likert format, with responses ranging from 5 strongly agree to 1 strongly disagree. Typical items in the scale is ‘’my parents tells me that a person must work hard in order to do something well’’. The reliability of the scale was determined with a two week pre-test procedure. The scale has reported reliability coefficient alphas of .75 from a two week test re-test reliability method.

S/N		SA	A	U	D	SD
1.	My parents check my home work frequently					
2.	My parents ask for my school assessment results regularly					
3.	My parents help me with some difficult problems					
4.	My parents make me feel that I can do well					
5.	My parents tell me that a person must work hard in order to do something well					
6.	My parents tell me that a person must do something carefully in order to do it well					
7.	My parents expect me to be the best student in my class					
8.	My parents help me choose my friends					
9.	My parents deprive me of my independence					
10.	My parents regulate my activities with my peers					

Minimum score obtainable is 10, while the maximum score is 50. To determine High and Low Parental support therefore, the maximum score is taken to percentage level which is 50 x 2= 100. Therefore, a score of 60% and above is taken to be High Parental support score, while scores falling below 60% are considered as Low Parental support scores.

APPENDIX V

Teacher's Instructional Guide on Cognitive Apprenticeship Strategy in Basic Science (TIGCASBS).

Lesson 1

Class: JSS II

Topic: Living Things

Time 80 minutes

Reference Books: Science Teachers Association of Nigeria

Nigerian basic sciences project pupils' Textbook two pages; 14-20

Exam Focus Integrated Science for JSCE by Adebayo Begun, Uguwumba, Sallau and Saromi. Pages; 1-2

Instructional materials: charts, diagrams, model, weighting scale, meter rule.

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

(i) Mention the different habitats of living things.

(ii) List the distinguishing characteristics of organisms found in different habitats (land, air, water)

(iii) Describe intelligence as a characteristic of human being.

(iv) Apply basic intelligence skills like observation, measurement of time and weight inference.

Previous knowledge: Students have been taught living and non-living things in Junior Secondary School one which may be helpful in understanding the concept of living things.

Introduction: The following questions are asked based on students' previous knowledge.

1. What are living things?
2. What are the characteristics of living things.

3. Describe a habitat.

The answers to the questions are based on Student Basic Science Cognitive Apprenticeship strategy. **The research assistant presents the concept to the students.**

Presentation:

Step I: Research assistant introduces living things as the concept to be taught to the students.

Step II: Research assistant displayed organisms from aquatic and terrestrial habitat for students to observe.

Step III: Students perform a task of observing the organisms of different habitat in their notebooks in the presence of research assistant.

Step IV: Students are supported by the research assistant to perform a task of classifying the organisms found in different habitats with their distinguishing characteristics.

Step V: Students are encouraged by the research assistant to explain intelligence as a characteristic of human beings.

Step VI: Students are to compare their performance with other students by exchanging ideas.

Step VII: Research assistant and students are to work on the task that students cannot do.

Step VIII: Research assistant gives assignment to students.

Lesson II

Topic: Changes in matter

Time: 80 Minutes

References Books: Science Teachers Association of Nigeria. Nigerian Basic Science project pupils' textbook two. Pages; 26-34

Exam Focus Integrated Science for JSCE by Adebayo- Begun, Ugwumba, Sallau and Saromi.

Instructional materials: Ice block, common salt, water, chart.

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

(i) Describe different ways matters changes

(ii) Identify the changes as temporary or permanent.

(iii) Distinguish between temporary and permanent changes.

(iv) State the causes of such changes.

Previous knowledge: students have been taught living and non-living things in their junior secondary school one which may be helpful in understanding the concept of changes in matter.

Introduction: The following questions are asked based on students' previous knowledge.

List three states of matter.

Give two examples of each state.

Explain why water boils when heated

Mention the factors that bring about temporary and permanent changes.

Presentation:

Step I: The research assistant introduces changes in matter as the concept to be taught.

Step II: Research assistant heat salt solution to dryness to recover salt while students observe.

Step III: Students burns a piece of paper to give ash in the presence of research assistant.

Step IV: Students are supported by the research assistant while burning paper so as to protect them from being injured.

Step V: The research assistant ask students to mention causes of changes in matter.

Step VI: Students are to interact with each other on the changes in matter with the help of the research assistant.

Step VII: Students are allowed to ask questions on how they perform the task by the research assistant.

Step VIII: Research assistant gives assignment to students.

Lesson III

Topic: Changes in Living Things

Time: 80 minutes

Reference Books: Science teachers association of Nigeria Nigerian Basic Science project pupils Textbooks two.

Exam focus integrated science for JSCE by Adebayo-Begun, Ugwumba, Sallau and Saromi .pages 26-34

Instructional Materials

Posters showing: Babies, students, teachers and parents.

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

(i) Recognize increase in height, weight and size as growth changes.

(ii) Recognize transition from infancy to adolescence and to adulthood as developmental changes.

(iii) Identify the characteristics features of the different developmental stages.

(iv) Group the growth and developmental changes as temporary or permanent changes.

Previous knowledge: Students have been taught living and non-living things in their Junior Secondary school one which may be helpful in understanding the concept of changes in living things.

Introduction: The following questions are asked based on students' previous knowledge:

1. What do you understand by the term growth?
2. List the factors that are necessary for growth

Presentation

Step I: Research assistant introduces changes in living things as the concept to be taught.

Step II: Research assistant performs the task in taking the measurement of two students of gender balance (male and female) to describe growth and development in living things while students observe.

Step III: Students perform the same task as they work in pairs measuring their height and mass.

Step IV: Students are supported by the research assistant to perform the task by writing the figures obtained from each student down.

Step V: Students are encouraged by the research assistant to raise questions on the task being performed and to mention factors necessary for growth.

Step VI: Students are to compare what they measure with other students.

Step VII: Students are to explain to research assistant on how they took the measurements.

Step VIII: Research assistant gives assignment to students.

LESSON IV

Topic: Changes in Non-living things.

Time: 80 minutes

Reference Books: Science Teachers Association of Nigeria. Nigerian Basic Science Project pupils' Textbook Two.

Exam focus integrated science for JSCE by Adebayo-Begun, Ugwumba, Sallau and Saromi.Pages35-36

Instructional Materials: Candle sticks, ice blocks, firewood, kerosene, matches, cubes of sugar, beaker.

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

Observe and describe changes in non-living matter.

Group such changes as physical or chemical

State the characteristics of physical and chemical changes.

Previous knowledge: Students have been taught living and non-living things in their Junior Secondary school one which may be helpful in understanding the concept of changes in non-living things.

Introduction: The following questions are asked based on students' previous knowledge:

1. Explain changes in non-living things.
2. List three factors that bring about temporary and permanent changes.
3. The answers to the questions are based on student basic science Cognitive Apprenticeship strategy. The teacher presents the concept to the students.

Presentation

Step I: The research assistant introduces changes in non-living things as the concept to be taught.

Step II: Research assistant performs a task on temporary changes as candle wax melts when heated which later turns to its solid state when cooled to students to observe.

Step III: Students perform a task on permanent changes when a matchstick is lighted and burnt while the product could not be change to original matchstick in the presence of research assistant.

Step IV: Students are supported by the research assistant to perform the task on candle wax.

Step V: Students are to mention the differences between physical and chemical changes in the presence of research assistant.

Step VI: Students are to compare their performance with others on the task they perform.

Step VII: Students are to explain the task they perform to the research assistant.

Step VIII: Research assistant gives assignment to students.

APPENDIX VI

TEACHER'S INSTRUCTIONAL GUIDE ON CRITICAL EXPLORATON STRATEGY ON BASIC SCIENCE (TIGCESBS).

LESSON I

Topic: Living Things

Time: 80 minutes

References: Science Teachers Association of Nigeria. Nigerian Basic Science projects pupils textbook two pages 1-2

Exam focus integrated science for JSCE by Adebayo-Begun,Ugwumba,Sallau and Saromi.

Instructional Materials: Charts, diagrams, model, weighing scale, metre rule.

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

(i) Mention the different habitats of living things.

(ii) List the distinguishing characteristics of organisms found in different habitats. (land, air, water).

(iii) Describe intelligence as a characteristic of human being.

(iv) Apply basic intelligence skills like observation, measurement of time and weight inference.

Previous knowledge: students have be taught living and non-living things in Junior Secondary school one which may be helpful in understanding the concept of living things.

Introduction: The following questions are asked based on students' previous knowledge.

1. What are living things?
2. What are the characteristics of living things?
3. Describe a habitat.

The answers to the questions are based on student critical exploration strategy and process skills. The teacher presents the concept to the students.

Presentation

Step I: Research assistant introduces living things as the concept to be taught to the students.

Step II: Students raised questions based on their curiosity about the concept to research assistant.

Step III: Students are encouraged by the research assistant to put actions(explore) on the questions raised in classifying organisms into different habitats with their distinguishing characteristics.

Step IV: Students performs task of classifying organisms into different habitats and also explains intelligence as a characteristic of human being to the research assistant.

Step V: Research assistant encourages students to think on what they observe and provide feedback.

Step VI: Students are encouraged by the research assistant to express all the ideas in their mind on the concept.

Step VII: Research assistant gives assignment to the students.

LESSON II

Topic: Changes in matter

Time: 80 minutes

References: Science Teachers Association of Nigeria. Nigerian Basic Science projects pupils textbook two.

Exam focus integrated science for JSCE by Adebayo- Begun, Ugwumba, Sallau and Saromi pgs.1-2

Instructional materials: ice block, common salt, water, chart.

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

(i) Describe different ways matter changes.

(ii) Identify the changes as temporary or permanent changes.

(iii) State the causes of such changes.

Previous knowledge: Students have been taught Living and Non- Living things in their Junior Secondary school one which way be helpful in understanding the concept of changes in matter.

Introduction: The following questions are asked based on students' previous knowledge.

List three states of matter.

Give two examples of each state.

Explain why water boils when heated.

The answers to the questions are based on student critical exploration strategy.

The teacher presents the concept to students using critical exploration strategy to explain the concept.

Presentation:

Step I: Research assistant introduces changes in matter as the concept to be taught.

Step II: Students raise questions based on their curiosity about the concept to research assistant.

Step III: Students are encouraged by the research assistant to put actions (explore) on the questions raised by differentiating between temporary and permanent changes.

Step IV: Students perform the task on temporary and permanent changes in the presence of the research assistant.

Step V: Research assistant encourages students to think on what could have caused the changes.

Step VI: Research assistant encourages students to express all the ideas in their mind on the concept.

Step VII: Research assistant gives assignment to students.

Lesson III

Topic: changes in living things

Time: 80 minutes

Class: JSS II

Reference Books: Science Teachers Association of Nigeria. Nigeria Basic Science project pupils' Textbook Two.

Exam focus integrated science for JSCE by Adebayo-Begun, Ugwumba, Sallau and Saromi pages; 1-2.

Instructional materials: poster showing babies, students, teachers and parents.

Behavioral objectives: At the end of the lesson, students should be able to:

(i) Recognize transition from infancy to adolescence and to adulthood as developmental changes.

(ii) Identify the characteristic features of the different development stages.

(iii) Group the growth developmental changes as temporary or permanent changes.

Previous knowledge: Students have been taught living and non-living things in the junior Secondary school one which may be helpful in understanding the concept of changes in living things.

Introduction: The following questions are asked based on students' previous knowledge.

What do you understand by the term growth?

List the factors that are necessary for growth.

Presentation

Step I: Research assistant introduces changes in living things as the concept to be taught.

Step II: Students raised questions based on their curiosity about the concept to research assistant.

Step III: Students are encouraged by the research assistant to put actions (explore) on the questions raised by working in pairs to measure their classmates' height and mass.

Step IV: Students performs the task relating to the solution towards the questions raised through feedback from their thought process.

Step V: Students are encouraged by the research assistant to think and summarize the factors necessary for growth which could have caused variance in the task they perform in their notebooks.

Step VI: Students are encouraged by research assistant to express all the ideas in their mind on the concept using simple sentences.

Step VII: Research assistant gives assignment to students.

Lesson 1V

Topic: Changes in Non- Living Things

Time: 80 minutes

Class: JSS 2

Reference Books: Science Teachers Association of Nigeria. Nigerian Basic Science Project Pupils' Textbook Two.

Exams Focus Integrated Science for JSCE by Adebayo-Begun,Ugwumba,Sallau and Saromi. Pages; 35-36.

Instructional materials: ice blocks, firewood, candle sticks, kerosene, matches, cube of sugar, beaker, Tripod stand, Bunsen burner.

Behavioral objectives: At the end of the lesson student should be able to:

(i) Observe and describe changes in non- living matter.

(ii) Group such changes as physical and chemical changes.

(iii) State the characteristics of physical and chemical changes.

Previous knowledge: Students have been taught living and non- living things in their junior secondary school one which may be helpful in understanding the concept of changes in non-living things.

Introduction: The following questions are asked based on students' previous knowledge.

Explain changes in non-living things

What are the factors that bring about temporary and permanent changes in matter?

Presentation:

Step I: Research assistant introduces changes in non-living things as the concept to be taught to students.

Step II: Students raised questions based on their curiosity about the concept to research assistant.

Step III: Students are encouraged by the research assistant to put actions (explore) on the questions raised by performing tasks on the concept using candle wax and matchstick to differentiate between physical and temporary changes.

Step IV: Research assistant observes students performing the task.

Step V: Students are encouraged by the research assistant to think and summarize the differences between physical and chemical changes in their notebooks.

Step VI: Students are encouraged by the research assistant to express all the answers using simple sentences.

Step VII: Research assistant gives assignment to students.

APPENDIX VII

TEACHERS' INSTRUCTIONAL GUIDE ON CONVENTIONAL SRATEGY ON BASIC SCIENCE (TIGCSBS)

Lesson 1

Topic: Living Things

Time: 80 minutes

Class: JSS 2

Reference Books: Science Teachers Association of Nigeria. Nigerian Basic Science Project pupils' Textbook Two.

Exam Focus Integrated Science for JSCE by Adebayo-Begun,Ugwumba,Sallau and Saromi. Pages 1-2

Instructional materials: Chart, diagrams, Pictures, Model, Metre rule, clock, weighing scale.

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

(i) Mention the different habitats of living things

(ii) Identify the living organisms in different habitats.

(iii) Apply basic intelligence skills for example observation, measurement of time and weight inference.

Previous knowledge: Students have been taught living and non-living things in their junior secondary school which may be helpful in understanding the concept of living things

Introduction: The following questions are asked based on student's previous knowledge:

1. What are living thing?
2. What are the characteristics of living thing?

3. Describe a habitat

Presentation:

Step I: Research assistant introduces the lesson by asking students questions on their previous knowledge.

Step II: Research assistant presents instructional materials and discusses living things as the content of the lesson to the students.

Step III: Research assistant summarizes the concept to the students.

Step IV: Research assistants instruct students to write the blackboard summary in their notebooks.

Step V: Research assistant evaluates the lesson by asking students some questions on habitats, characteristics of organisms in different habitats, intelligence as a characteristic of human being.

Step VI: Research assistant gives assignment to students.

Lesson II

Topic: Changes in matter

Time: 80 minutes

Class: JS 2

Reference Books: Science Teachers Association of Nigeria. Nigerian Integrated Science Project Pupils' Textbook Two.

Exam Focus Integrated science for JSCE by Adebayo-Begun,Ugwumba, Sallau and Saromi. Pages : 26-34.

Instructional materials: Chart, ice block, common salt, water.

Behavioral objectives: At the end of the lesson, students should be able to:

(i) Describe different ways matters change.

(ii Identify the changes as temporary or permanent.

(iii) Distinguish between temporary and permanent changes.

(iv) State the cause of such changes.

Previous knowledge: Students have been taught living and non-living things in their junior secondary school one which may be helpful in understanding the concept of changes in matter.

Introduction: The following questions are asked based on students' previous knowledge:

1. List three states of matter.
2. Give two examples of each state.
3. Explain why water boils when heated.
4. Mention the factors that bring about temporary and permanent changes.

Presentation

Step I: Research assistant introduces the lesson by asking students questions on their previous knowledge.

Step II: Research assistant presents instructional materials and discusses changes in matter as the content of the lesson to the students.

Step III: Research assistant summarizes the concept to the students.

Step IV: Research assistant instructs students to write the blackboard summary in their notebooks.

Step V: Research assistant evaluates the lesson by asking students to state the differences between temporary and permanent changes.

Step VI: Research assistant gives assignment to students.

Lesson III

Topic: Changes in living things

Time: 80 minutes

Class: JSS2

Reference books: Science Teachers Association of Nigeria. Nigerian Basic Science Project pupils' Textbook Two.

Exam focus Integrated science for JSCE by Adebayo-Begun, Ugwumba,Sallau and Saromi. Pages; 26-34.

Instructional materials: Posters showing: babies, students, teachers and parents.

Behavioural objectives: At the end of the lesson, student should able to:

(i) Recognized increase in height, weight and size as growth changes.

(ii) Recognize transition from infancy to adolescence and to adulthood as developmental changes.

(iii) Identify the characteristic features of the different developmental stages.

(iv) Group the growth and developmental changes as temporary or permanent changes.

Previous knowledge: Students has been taught living and non-living things in their junior secondary school one which may be helpful in understanding the concept of changes in living things.

Introduction: The following questions are asked based on students' previous knowledge.

1. What do you understand by the term growth?

2. List the factors that are necessary for growth.

Presentation:

Step I: Research assistant introduces the lesson by asking students questions on their previous knowledge.

Step II: Research assistant presents instructional materials and discusses changes in living things as the concept of the lesson to students.

Step III: Research assistant summarizes the concept to the students.

Step IV: Research assistant instructs students to write the blackboard summary in their notebooks.

Step V: Research assistant evaluates the lesson by asking students some questions on factors necessary for growth.

Step VI: Research assistant gives assignment to students.

Lesson: IV

Topic: changes in Non – Living – Things

Time: 80 minutes

Class: JSS 11

Reference Books: Science Teachers Association of Nigeria. Nigerian Basic Science Project Pupils' Textbook Two.

Exam Focus Integrated Science for JSCE by Adebayo-Begun, Ugwumba, Sallau and Saromi. Pages; 35-36.

Instructional materials: Candle sticks, ice blocks, firewood, kerosene, matches, cubes of sugar, beaker.

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

Observe and describe changes in matter.

Group such changes as physical or chemical changes.

State the characteristics of physical and chemical changes.

Previous knowledge: students have been taught changes in non-living things in their junior secondary school one which may be helpful in understanding the concept of physical and chemical changes.

Introduction:

The following questions are asked based on students' previous knowledge.

What do you understand by the term growth?

List the factors that are necessary for growth.

Presentation:

Step I: Research assistant introduces the lesson by asking students questions on their previous knowledge.

Step II: Research assistant presents instructional materials and discusses changes in non-living things as the concept of the lesson to the students.

Step III: Research assistant summarizes the concept to the students.

Step IV: Research assistant instructs students to write the blackboard summary in their notebooks.

Step V: Research assistant evaluates the lesson by asking students some questions on the differences between physical and chemical changes.

Step VI: Research assistant gives assignments to students.

APPENDIX VIIIA

EVALUATING SHEET FOR ASSESSING RESEARCH ASSISTANT PERFORMANCE ON THE USE OF COGNITIVE APPRENTISHIP STRATEGY (ESARAPCAS)

Name of Teacher: ---
School: --
Date: ------------------

Guidelines Involved	V. Good 5	Good 4	Average 3	Poor 2	V. Poor 1
Research assistant introduces the lesson to the students.					
Research assistant performs a task so students can observe.					
Students perform the task in the presence of the research assistant.					
Students are supported by the research assistant when in dilemma.					
Students are to verbalize their knowledge and thinking with the help of research assistant.					
Students are to compare their performance with others.					
Research assistant and students solve the difficult task that students cannot do.					
Research assistant gives assignment to students.					

APPENDIX VIIIB

EVALUATING SHEET FOR ASSESSING RESEARCH ASSISTANT PERFORMANCE ON THE USE OF CRITICAL EXPLORATION STRATEGY (ESARAPCES)

Name of Teacher: ---

School: --

Guidelines Involved	V. Good 5	Good 4	Average 3	Poor 2	V. Poor 1
Research assistant introduces the lesson to the students.					
Students are left alone to raise questions based on their curiosity on the concept.					
Students put into action (explore) a lot of activities that enhance learning of the content in the presence of research assistant.					
Students observe the Research assistant on the correct feedback relating to the content to be studied.					
Students are allowed to think and summarize the demonstration and provide feedback to research assistant					
Students are encouraged by research assistant to express all the answers in their mind using simple sentences.					
Research assistant give assignment to students.					

APPENDIX VIIIC

EVALUATING SHEET FOR ASSESSING RESEARCH ASSISTANT PERFORMANCE ON THE USE OF CONVENTIONAL STRATEGY (ESARAPCS)

Name of Teacher: --

School: ---

Date: ------------------

Guidelines Involved	V. Good 5	Good 4	Average 3	Poor 2	V. Poor 1
Research assistant introduces the lesson to the students.					
Research assistant presents instructional materials and discusses the content of the lesson to the students. .					
Research assistant summarizes the concept to the students.					
Research assistant instructs students to write the blackboard summary in their notebooks.					
Research assistant evaluates the lesson by asking students some questions.					
Research assistant gives asssignment to students.					

APPENDIX IX

PICTORIAL PRESENTATIONS OF TREATMENT PROCEEDINGS